Human Radiation Dosimetry Using Electron Paramagnetic Resonance in Tooth Enamel Biopsy Samples

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Purposes: Dental enamel is the only living tissue that indefinitely maintains a record of its exposure to ionizing radiation. Electron paramagnetic resonance (EPR) dosimetry in tooth enamel has been applied for dose reconstruction for epidemiological studies of different cohorts, including Hiroshima atomic bomb survivors, Chernobyl clean-up workers and other victims of unintended exposures to ionizing radiation. Several international inter-comparisons of EPR enamel dosimetry have demonstrated a high accuracy and reliability for this method. The main disadvantage of standard EPR enamel radiation dosimetry, however, is the necessity for large, 100 mg, enamel samples to achieve adequate signal-to-noise. This necessitates the use of extracted teeth for dose measurements, making the application of EPR in dental enamel for immediate, after-the-fact dosimetry problematic. The present study endeavored to improve the sensitivity of EPR measurements sufficiently to make the use of minimally-invasive *in vivo* enamel biopsies feasible for retrospective radiation dosimetry.

Materials and methods: Enamel samples were obtained from teeth extracted in the normal course of dental treatment. Enamel biopsy samples of 2-4 mg in weight were obtained using a high-speed dental hand-piece with a tapered fissure or diamond bur, and an enamel chisel. EPR measurements were performed at microwave frequencies in the standard X-band (9 GHz) and at higher frequencies in the Q-band (34GHz).

Results: Q-band EPR measurements completely resolved the radiation-induced EPR signal in enamel from the radiation-independent native, background EPR signal--which is the major limiting factor in sensitivity for X-band EPR. A comparative study of electron paramagnetic resonance radiation dosimetry in Q- and X-bands showed that Q-band is able to provide accurate measurements of radiation doses below 0.5 Gy, with tooth enamel samples as small as 2 mg. This sample size is less than 1% of the total amount of tooth enamel in a molar tooth.

Conclusion: Q-band EPR in dental enamel significantly increases the sensitivity for detecting absorbed ionizing radiation by completely resolving the radiation-induced EPR signal from the radiation-independent native, background EPR signal. An enamel sample of 2 mg can be easily obtained in an emergency requiring rapid, after-the-fact radiation dose measurements. And, the minimal enamel defect can be rapidly and readily restored using modern, light-cured restorative composites. It is estimated the biopsy and restoration of the enamel defect can be done by a skilled operator in approximately 3 minutes. Separation of the radiation-induced and the radiation-independent native, background EPR signals makes dose response measurements much easier in comparison with conventional X-band measurements in which these signals overlap, necessitating special methods for measuring radiation doses below 0.5 Gy.

We also have tested Q-band EPR radiation dosimetry in micro-samples of bone, dentine and fingernails. The overall results are very promising. We believe that application of Q-band measurements could have significant impact on EPR human biodosimetry. One could also envision the development of a fast and less invasive method for collection of small enamel samples for EPR Q-band dose measurements in radiation accident scenarios, and for obtaining enamel samples for randomized clinical studies of radiation exposure in the general population.

Diagnostic image of dental ankylosis by Limited cone beam CT : Two cases reports

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Purposes: In the permanent tooth delayed case presented conventional radiographs did not help in the diagnosis. It reports on the dental ankylos is that underwent limited cone beam CT and to assess limited cone beam CT is useful in diagnosis these cases.

Materials and methods: Case 1. Eight years old girl was referred by dental office with chief complaint of malocclusion. There fistel formation right upper right central incisor region. Impaction of the tooth , hypoplasia of the root and radiolucent area around the crown were reveled on radiographs. The limited cone beam CT was performed on PSR-9000 (Asahi Roentgen Ind. Co., Ltd. Kyoto Japan). The ill-defined resorption on the cervical margin of tooth and radiolucent area around the crown recommended on image. In image diagnosis was dentigerous cyst and dental ankylosis. After diagnostic imaging a tooth was extracted. And it was diagnosed by the pathological examination of the dentigerous cyst and the dental ankylosis. Case2. Fourteen years old boy was referred by dental office with chief complaint of malocclusion. There is no change though the orthodontic therapy is begun for the delay of the upper right central incisor tooth. The limited cone beam CT was performed on PSR-9000 (Asahi Roentgen Ind. Co., Ltd. Kyoto Japan). The ill-defined resorption on the cervical margin of tooth was recommended on image. In image diagnosis was the adhesion teeth. After diagnostic imaging a tooth was extracted. And it was diagnosed by the pathological examination of the dental ankylosis. A tooth was extracted, and it was diagnosed by the pathology examination of the dental ankylosis.

Result: The ill-defined resorption on the impacted tooth not admitted on conventional radiography was detected in limited cone beam CT.

Conclusion: The limited cone beam CT was very useful in the diagnosis of the dental ankylosis. Therefore the limited cone beam CT scan is the effective imaging methods for diagnosis dental ankylosis and the decision of the treatment methods.

O-3

Possible prognostic radiological criteria concerning the bisphosphonate-related-osteonecrosis of the jaw based on CBCT imaging

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Purposes: To assess the morbidity of bisphosphonate-related-Osteonecrosis of the jaw (BRONJ) in accordance to the radiological findings acquired by CBCT-imaging.

Materials and methods: This retrospective study involved 50 BRONJ patients who were treated with i.v. bisphosphonates and were examined with the ProMax 3D Unit (Planmeca Oy, Helsinki Finland). The radiological criteria used to evaluate the severity of the disease include: single or multiple irregular radiolucencies or osteolysis showing a moth-eaten appearance, areas of sequestration, ill-defined cortical borders, areas of diffuse radiopacity, bone expansion and periosteal reaction. The radiological findings were correlated to the clinical status-quo and the persistence of the disease.

Results: This study shows that recalcitrant cases of BRONJ acquire a complex radiological profile with mixed radiolucencies and radiopacities and regional formation of sequestra. In early stages the disease can be defined by the incipient alterations of the trabecular pattern of the surrounding cancellous bone. Acute phases of the disease appear with a periosteal reaction (osteomyelitis with periostitis), whereas more asymptomatic cases reveal a more compensatory profile with predominating sclerotising areas. Finally an osteolytic affection of the cortical borders of the mandible leads to a higher possibility of a pathological fracture.

Conclusion: CBCT-modality can be used not only to establish the diagnosis of BRONJ, but also to determine the stage and the prognosis, especially in terms of a follow-up examination.

O-4

Conversion of Conventional Radiographic Examination of Trabecular Bone Pattern Value into the Value of Density Measurement from Intra Oral Digital Radiography

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Purposes: To determine conversion value of gray scale density measurement from intra oral conventional radiographic examination of edentulous maxilla and mandible using intra oral digital radiography, as one effort to increase the value of conventional radiograph in diagnostic procedure.

Materials and methods: Periapical radiography examination of pararelling technique both conventional radiography and the digital ones were performed on 18 male and 34 female patients with edentulous maxilla and mandible. The trabecular bone pattern of 42 maxillary region and 61 mandibular region in the region of interest was classified into five grades. The gray scale density measurement was measured within marked area at the region of interest in the image of periapical digital radiograph in the same corresponding trabecular region. To gain the conversion value regarding age, gender and region in the jaws, an analysis to get the regression equation were made.

Results: The Kappa value for the inter observer and intra observer objectivity in evaluating the bone density were 0.71 – 0.85. The strength of the radiographic conventional value to predict the gray scale density measurement of digital ones is high and was gained from the regression analysis with the R^2 of 0.75-0.8. The analysis of regression equation for the maxilla and the mandible were separated and the age, gender and region in the jaws were included.

Conclusion: It is possible to convert the conventional intra oral radiographic value of the trabecular bone pattern to the value of gray scale density measurement of intra oral digital radiography. The regression equation of the conversion was resulted with the inclusion of the age, gender and region in the jaws.

Key weords: conversion value, intra oral conventional radiography, intra oral digital radiography, regression equation of the conversion

O-5

The relationship between architectural parameters of bone image and mechanical properties of trabecular bone of pig mandible by finite element analysis

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Purposes: To investigate the contribution of bone architectural parameters in the assessment of the mechanical properties and the direction-related mechanical properties of trabecular bone of pig mandible.

Materials and methods: Mandibles were obtained from three male micro-pigs twelve months old and each weighing around 44 kg. A total of 41 bone plates from body and condyle were measured two-dimensionally with direct digital intraoral radiography. From those plates, 65 cylindrical specimens were obtained and measured three-dimensionally with a micro-computed tomography. Through finite element analysis, Young's moduli of three orthogonal directions were calculated.

Results: The trabecular bone of pig mandible had higher Young's modulus in the longitudinal direction than in other directions. Multiple linear regression analyses showed that the bone volume fraction(BV/TV) and the structure model(SMI) index together improved the predictability of Young's modulus in the longitudinal direction of pig mandible.(adjusted $R^2 = 0.595$, $p<0.05$)

Conclusion: The trabecular bone of pig mandible is mechanically anisotropic and stiffest in the longitudinal direction in which the BV/TV and the SMI are predictable of Young's modulus. The directions of imaging projection and force should be considered together when predicting the mechanical properties of the mandible with architectural parameters of trabecular bone image.

O-6

Three-dimensional filtering and region growing methods for precise bone segmentation applied to cone beam computed tomography images

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Purposes: To improve the accuracy of bone segmentation procedures in dental cone beam computed tomography (CBCT) images, several two- and three-dimensional (2D & 3D) filtering methods were examined. CBCT images having high and isotropic spatial resolution, but the noise is comparatively high due to the low exposure. By reducing the noise in images, the attempt to improve the MPR image quality was carried out. And the 3D region growing method was examined for the volumetric data of CBCT images for the bone segmentation.

Materials and methods: CBCT examinations were taken using CB Throne (Hitachi Medical Systems, Japan). Principal exposure parameters were as follows; I-mode, 10 cm FOV in diameter, 120 kV, 15 mA, 0.2 mm in slice thickness and 10 s exposure time (CBCT). Digital filtering procedures for Gaussian smoothing, Laplacian sharpening, etc. in two- and three-dimensions were applied for the improvement of MPR images of CBCT images. Images processed were a clinical case of Mucocele in the maxillary sinus. The three-dimensional processing and displaying software for medical images, both Amira/Avizo (ZIB Berlin, Mercury Computer Systems, USA) and OsiriX were used for 3D displaying. The 3D region growing method for 512 slices of CBCT images was examined. As usual the region growing was started at the seed point. Six neighboring voxels in 3D space was evaluated for either being extracted and integrated as the bone region or not. The extraction condition was set as the threshold value at various CT numbers. The closing procedure, the repeat of dilation and reduction was carried out.

Results: The 2D and 3D filtering procedures for Gaussian smoothing, Laplacian sharpening worked for the improvement in the different way. The processing on the superior-inferior direction in 3D filtration worked effectively. The effect of the simple noise reduction filter is seemed to be no changes in bone segmentation in spite of extreme reduced noise. Due to the example which the Sobel filtering, noise-resistant edge-detection filter, was applied as either 2D or 3D local operator, the difference was appeared less significantly in CBCT images in comparison with those in MDCT images. The 3D region growing method using six neighboring voxels in 3D space worked well for CBCT images. The CBCT image's voxels have 'CT numbers' which are proportional to bone mineral contents of objects. Several threshold CT numbers were examined for the optimization of the region growing. The resultant 3D image by the volume rendering were obtained.

Conclusion: For the imaging of dento-alveolar and maxillary sinus regions, the depiction of thin bone structure with the high accuracy is important. Three-D filtering methods have the possibility to improve the accuracy of bone segmentation in three-dimensional displaying of CBCT images. Based on these finding 3D region growing method was examined for 3D visualization. The bone region on CBCT images was extracted using the 3D region growing method, but there was the limitation for the thin and fine structure depiction. The combination with the 3D filtration as pre-processing procedures will improve the quality of the bone segmentation.

O-7

Effect of alendronate on the healing process of the extracted socket of ovariectomized rat using in vivo micro-CT

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Purpose: The purpose of this study was to longitudinally observe the healing process of extracted socket in the OVX (ovariectomized) rat model using in vivo micro-CT and to examine the inhibitory effect of alendronate on alveolar bone resorption following tooth extraction.

Material and Method: Five-weeks Sprague-Dewley 20 rats were randomly assigned to one of three groups: sham-operated (N = 5), OVX divided into two groups: saline-treated group (N = 7) and alendronate-treated group (N = 8). The saline-treated group was administered with daily saline solution (0.1ml/100g) respectively while the alendronate-treated group was given a daily amount of 1 mg/kg alendronate (Sigma-Aldrich Corp. Korea). Before the micro-CT scanning (Iksan Radiographic Laboratory, spatial resolution 50 X 50 μm), the extractions of left maxillary 1st molars of each groups rat were done. In vivo micro-CT scannings of the jaw were done at baseline, 2 week intervals during 6 weeks. Radiopacity of extracted wound and the other site of jaw (right maxillary 1st molar area) were measured. Bony healing pattern and 3-dimensional micro-CT bony parameters of extracted wound of each group were longitudinally observed and analysed.

Result: Radiopacity of OVX group showed lower values than that of sham group. Radiographic opacity of OVX-alendronate group had been more increased by 4 weeks after extraction compared with OVX-saline group. The height difference of residual ridge between OVX-alendronate group and OVX-saline group was remarkable. Increased formation of bony spicules and bony calcifications on extracted wound were also observed by 4 weeks, but differences of this healing pattern and micro-CT parameters between each groups were not remarkable

Conclusion: Jaw bone density of OVX rat showed lower values. Alendronate seems to resist the bony resorption of jaw in OVX rat. Healing process of extracted wound was longitudinally observed on in vivo micro-CT multiplanar image.

O-8

Analysis of Condylar and Disc Function of the Temporomandibular Joint using 3T Pseudodynamic MRI

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Purpose: 3T- pseudodynamic MRI was used to examine the temporomandibular joint (TMJ) in an attempt to clarify condylar and disc functions.

Materials and methods: Nine test subjects (eight TMJ Arthrosis positive and one negative) were guided to bite 0 to 4 (sometimes 5) bite blocks in positions ranging from closed to fully open. Sagittal images were obtained via 3T-MRI equipment (Signa3.0T, GE Healthcare) with dual surface coil for TMJ. Acquisition parameters were TR/TE: 1800/10, Thickness/Space (mm): 2.0/1.0, FOV (inches): 14x11, Matrix: 448x224, Time (sec): 40. Imaging showed on the central condylar area parallel to the sagittal plane, the articular eminence point (Em), the condylar head point (Cd), the anterior border point of the articular disc (Da) and posterior border point of the articular disc (Dp). Points were digitized and corrected using the Em point as the origin of coordinate axes. There was identification and examination of functional MR findings ((3) trajectory and (7) velocity patterns), clinical findings (pain, clicking, crepitus, limitation of mouth opening, etc.) and static MR findings (joint effusion, bone change, joint space, disc displacement, disc shape). Da and Dp was discriminated to 7 grading and the contour of Dp was classified into 3 types.

Results: Test subjects showed three functional diagnosis patterns: 1/ Normal trajectory and velocity patterns of Cd, Da, Dp (1 case); 2/ Normal hemilateral trajectory and velocity patterns of Cd, Da, Dp (2 cases); 3/ Abnormal trajectory and velocity patterns of Cd, Da, or Dp (5 cases) From sixteen joints of eight patients, six joints were revealed as abnormal only by functional analysis, six joints could obtain additional findings to static MR findings by functional analysis. Four joints appeared normal, including two joints with abnormal static MR findings (joint effusion) and no functional abnormality. In 75% of cases (12/16 joints), functional analysis was effective. Da identified as being normal by function analysis appeared in all Cd positions (condylar position to the articular fossa) as an almost distinct contour (Grade 5). Da identified as being abnormal by function analysis appeared as a slightly indistinct contour. Dp appeared as curved (C type), flat (F type) and convex (V type) contours at middle to final open Cd positions. Grade 6 (superior and inferior retrodiskal layer recognized) at middle to final open Cd position appeared as a V type contour and had normal function. Grade 4 (superior and inferior retrodiskal layer not recognized) and Grade 5 (superior retrodiskal layer recognized) at middle open Cd position had no specific contour type and function.

Conclusion: Improving on conventional analysis of the articular disc as a single rigid body, we developed a method for analyzing functions of the anterior and posterior articular border together with condylar head by studying trajectory and velocity patterns. Affected side and extent of morbidly were clearly revealed by a new functional analyzing method by 3T-MRI that has been underused till now.

Diagnostic performance of MRI for detection of osseous abnormalities of the temporomandibular joint: correlation with cone-beam CT

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Purposes: With cone-beam computed tomography (3DX) as the reference method, the aim of the study was to determine the diagnostic accuracy of magnetic resonance imaging (MRI) for assessment of osseous abnormalities of temporomandibular joint (TMJ).

Materials and methods: Fifty five patients with temporomandibular disorder (TMD) underwent imaging with 3DX and MRI. 3DX images were evaluated by two observers together depending on a standardized classification method that includes eight different types (Type 1- Type 8) of osseous abnormalities as follows; Type 1: Destructive and erosive bony changes of condyle Type 2: Flattening of the articular surface of the condyle Type 3: Deformity of the condyle Type 4: Sclerosis of the condyle Type 5: Osteophyte Type 6: Ankylosis Type 7: Erosion of the articular fossa and/or eminence Type 8: Sclerosis of the articular fossa and/or eminence. For detection of osseous abnormalities by MRI; sagittal MR images, proton density weighted images and T2-weighted images were evaluated independently by 3 observers without previous knowledge about findings of 3DX images. Interobserver agreement and diagnostic performance of MRI in detecting various types of osseous abnormalities was tested by calculating Cohen's k, overall sensitivity and specificity.

Results: On the basis of the reference method (3DX), among 106 joints, the number of joints with Type 1, 2, 3, 4, 5, 6, 7 and 8 abnormality was 24, 19, 28, 20, 14, 5, 18, and 21, respectively. By using Cohen's k, the interobserver agreement was determined to be fair in all types of osseous abnormalities except in Type 8 was poor. The mean sensitivity of MRI in detecting Type 1, 2, 3, 4, 5, 6, 7 and 8 abnormality was 0.57, 0.26, 0.65, 0.39, 0.43, 0.30, 0.54 and 0.33, respectively, whereas the mean specificity was 0.86, 0.93, 0.92, 0.95, 0.84, 0.98, 0.90 and 0.93, respectively.

Conclusion: Although good specificity (84-95%) was obtained with MRI, it showed relatively low sensitivity (26-65%) in detecting the osseous abnormalities of TMJ .The value of MRI in the detection of TMJ osseous abnormalities was considered limited.

Influence of the clenching for the tempro-mandibular joint space with MRI

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Purposes: Sometimes, the orthodontic treatment was caused the patients to clench. The frequently clenching makes the temporo-mandibular joint space narrowing and tends to cause of temporo-mandibular joint disorders in the cases with the unstable occlusion. This factor was already common thing in the dental field but was not proved well. We analyzed the influence of clenching for the temporo-mandiblar joint space, including the relationship of the unstable occlusion.

Materials and methods: The Magnetic resonance images of ten adult male volunteers with the individual normal occlusion and no symptom in the temporo-mandibular joints were used as the subjects. The dynamic scan images (20 phases taking within 10 minutes during each subject clenching) of temporo-mandibular joints with Signa Horizon LX1.5 T (GE, Milwaukee, USA) were used for this analysis as materials. The dynamic images were taken with Fast SPGR sequence. In these images, we measured the distance of the joint space thickness in every phase. The occlusion analyzer OCCLUZER FPD-707(Scimolex, Yamanashi, Japan, OCCLUZAR) was used for analyzing the occlusion of the subjects. With the OCCLUZER, we measured the area size of occlusal contact area and occlusal forces of each subject, divided in the incisors region and the canine-premolar region, the molar region. We observed these data to demand the coefficient of correlation between the change of the temporo-mandibular joint space and the individual occlusion.

Results: The joint space of the subjects group, that had large area size of the occlusal contact area and large occlusal force in molar region, was not led to big decrease of the thickness during clenching. On the other hand, the temporo-mandibular joint space of the subjects group, that had large area size of the occlusal contact area and large occlusal force in canine-premolar region, was decreased the thickness during clenching.

Conclusion: We recognized that the thickness of the temporo-mandibular joint space was influenced by the occlusion in molar region during clenching. The orthodontists should guide the occlusion of the patients to get the large area size of the occlusal contact area and large occlusal force in the molar region. It will be able to avoid the joint space narrowing.

O-11

Entities of temporomandibular joint effusion observed on T2-weighted MR images

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Purposes: The purpose of this study was to clarify entities of joint effusion (JE) observed on T2-weighted MR images by analyzing signal intensities in T2-weighted and FLAIR images.

Materials and methods: Subjects consisted of 21 patients (31 joints) with JE based on the classification criteria of Larheim et al. Corrected sagittal T2-weighted (TR/TE 3300/85 ms) and FLAIR (TR/TE 9000/122 ms, 9000/168 ms) images obtained in the closed-mouth position were used for analysis. Regions of interest (ROI) were set at JE, cerebrospinal fluid (CSF), and gray matter (GM), and their signal intensities were measured. The signal intensity of GM was used to obtain the signal intensity ratio (SIR). The signal intensities of JE and CSF on T2-weighted images were compared with those on FLAIR images. The Pearson product-moment correlation coefficient was used for statistical analysis. The suppression ratios of the signal intensities of JE and CSF in FLAIR imaging were also compared.

Results: The SIR of JE showed a strong correlation (correlation coefficient 0.81(FLAIR TR/TE 9000/122 ms), 0.94 (TR/TE 9000/168 ms)) between T2-weighted images and FLAIR images. However, no correlation was observed for CSF. The average suppression ratio of the signal intensity by FLAIR imaging was 36.9% (FLAIR TR/TE 9000/122 ms) or 16.3% (TR/TE 9000/168 ms) for JE, and 75.6%(TR/TE 9000/122 ms) or 71.7%(TR/TE 9000/168 ms) for CSF.

Conclusion: Using FLAIR imaging, entities of JE were clarified, and it was concluded that the JE was not a simple accumulation of fluid, but a fluid accumulation containing protein elements and synovial tissue.

O-12

Clinical and radiological findings of synovial chondromatosis in temporomandibular joint--18 case reports

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Purpose: To study the clinical and radiological findings of synovial chondromatosis (SC) in temporomandibular joint (TMJ) and provide references for the early diagnosis and treatment.

Material and Methods: To review the clinical and radiological data of SC in TMJ in Peking University School of Stomatology from January of 1990 to June of 2008. 18 cases in TMJ undertook surgery and verified by pathological examinations.

Results: Among 18 SC patients, the ratio of female to male was 1.6:1. The ages ranged from 32 to 67 years old and the courses of diseases from 2 months to 20 years. Pain, asymmetric face, swelling of preauricular region, limitation of mouth-opening and crepitation were the chief complaint. Physical examination could find swelling in joint area, preauricular tenderness, limitation of motion, deviation of mandible, click, open bite, etc. As to imaging findings, the positive detection rate for bony changes and/or loose bodies on plain radiographs, CT and MRI were 33.3%, 53.8% and 72.7%, respectively. The detection rate rose to 85.7% with combining CT and MRI examinations. Three patients had bony destruction of middle cranial base and intracranial extension.

Conclusion: Although X-rays can show widening of joint space with variable presence of transopacity loose bodies, it still had a limitation in the diagnosis of SC, especially for early diagnosis. CT is a good choice for showing osseous condylar and glenoid fossa abnormalities and loose bodies that could not be detected by plain X-rays. MRI could show the changes of TMJ structure, including synovial fluid, capsular expansion, disc position, and hypointensive loose bodies not well calcified. The increase of positive detection rate of SC was related with using MRI examination more frequently. The combination of CT and MRI can improve the accuracy of the diagnosis of SC.

O-13

The effect of head position on the alveolar bone height of maxilla in panoramic view

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Purposes: The purpose of this study was to evaluate the effect head position on the measurement of the distances from the alveolar crest to the maxillary sinus floor or the nasal sinus floor in panoramic radiography. Materials and methods: Panoramic radiographs of 40 dry skulls were taken at seven angles, standard head position(0°), +5°, +10°, +20°, -5°, -10° and -20° Frankfort line angled with horizontal plan. Anteroposterior positioning of skull was set with bite device of panoramic radiographic machine. All radiographs were acquired at 57 kV, 2.0 mA, 17.6 s. We investigated the distances at three points, mesial alveolar bone crests of right and left maxillary first molars and left maxillary central incisor. We measured vertical alveolar bone length, horizontal deviation of landmark in maxillary and nasal sinus floor of angled positions with a standard position, and the oblique length from the alveolar crest to the landmark. The differences in mm between the measurements in standard head position and other vertical angled head position were compared as mean values (mean) and standard deviations (SD). We used SPSS version 12.0 statistic program (SPSS inc., Chicago, USA) for statistical analysis.

Results: Concl The means of the vertical alveolar bone length of the maxillary central incisor showed the significant difference in 2.2 mm, 4.5 mm and 1.3 mm between standard head position and +10°, +20° and -20° angled head positions. And the right maxillary first molar showed the significant difference in 0.4 mm and 1.4 mm in +20° and -20° angled head positions (p<0.05). The means of horizontal deviation at the same measuring point of maxillary central incisor did not show statistical significant difference according to vertical head position, but right and left maxillary first molars increased along with vertical angles (p<0.05). The means of the oblique length from the alveolar crest to the same measuring point of the maxillary central incisor showed significant difference in +20°, +10°, and -20° vertical angled head positions(p<0.05). And the left maxillary first molar showed the significant difference in -10° and -20° vertical angled head positions (p<0.05).

Conclusion: The patient's Frankfort line angle with horizontal plane in panoramic radiographic taking may affect alveolar bone height and positioning, so we should take quality assessment of diagnostic imaging when we use panoramic radiography as a diagnostic tool for dental implant.

O-14

CT Anatomy of The Anterior Superior Alveolar Nerve Canal: Macro and Microscopic Study

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Purposes: With the increasing rate of various surgical interventions on the jaw bones, such as dental implant placement and bone grafting, the necessity of knowledge of imaging anatomy of the jaw bone neurovascularization has increased, as well as the importance of medical risk management. As proposed in Guidelines for dental implant imaging, it is needless to say the diagnostic description of the inferior alveolar canal or maxillary nasopalatine canal is indispensable. High-resolution magnetic resonance imaging had been reported to reveal that mandibular incisive and genial spinal canal structures contained a neurovascular bundle as well as the maxillary nasopalatine canal. Clinically, on computed tomography (CT) axial images we have noticed the dotted, fine tubular structures in maxillary bone, supposed the anterior superior alveolar nerve canal. However, no descriptions on CT anatomy of this canal and its contents were reported. This study aims to reappraise the course of the anterior superior alveolar nerve canal in maxillary bone, and to clarify the component of its contents.

Materials and methods:

Materials: Three human heads and two jaw bone specimens (2 maxillae) from formalin-perfused cadavers, donated for practice of anatomy at this institute, were investigated.

Methods: We verified the course of the anterior superior alveolar nerve canal on CT images obtained from cadavers' heads using Cone-beam CT. After that, the canal structure branched from the inferior orbital canal were dissected macroanatomically and compared with CT images. Microanatomically, two bone specimens taken from infraorbital region were examined to visualize the anterior superior alveolar nerve canal using micro-CT. To verify the micro-CT findings, every specimen was sectioned to allow comparison to histological observations.

Results: By the gross anatomy, it was demonstrated the close correspondence between the course of the anterior superior alveolar nerve canal on Cone-beam CT images and that of neurovascular bundle dissected out of the canal structure branched from the inferior orbital canal. Microscopically, it was verified that the anterior superior alveolar nerve canal on CT images contained neurovascular bundles including the artery, the vein, and the nerve.

Conclusion: After coming out of the infraorbital canal, the anterior superior alveolar nerve canal passes across the maxillary bone in the infraorbital region to the nasal side, then it goes down along the side wall of piriform aperture. Besides, it should be aware that the anterior superior alveolar nerve canals are filled with neurovascular structures.

O-15

ULTRASONOGRAPHY AS A USEFUL TOOL IN DIAGNOSIS OF ORO-FACIAL LESIONS

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ULTRASONOGRAPHY(USG) is one of the important advances in the field of radiology. It plays wide role in the diagnosis of various medical problems.In the field of Maxillofacial area, it has still an unexplored dimension to it. The paper presently looks at the various areas of its utilisation in the head and neck area specifically to delineate and to diagnose various inflammatory / infectious/ neoplastic conditions and auto-immune conditions affecting the oral soft tissues. We have been using this imaging modality for over 5 years and its inexpensiveness over many other imaging modalities is its main advantage for a population as India.

O-16

Pulse Doppler sonography of the facial artery in the submandibular gland in patients with hyposalivation ---special reference to the number of drugs taken---

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Reduction of blood flow velocity in the artery of salivary gland after acid stimulation is observed frequently in hyposalivation patients. Some authors suggested that this finding might caused by the autonomic dysfunction. Therefore, we investigated relationship between the number of drugs which can cause hyposalivation and the pulse Doppler sonographic finding.

Purpose; To investigate a relationship between the number of drugs which can cause hyposalivation and the pulse Doppler sonographic finding, and discuss a possible role of autonomic dysfunction in drug-induced hyposalivation.

Materials and Methods; We evaluated a change of the maximum blood flow velocity in the facial artery in the submandibular gland before and after acid stimulation in 67 patients with hyposalivation.

Results; No significant difference was observed between the number of the drugs taken and the quantity of salivation. No correlation was observed between the degree of the change of salivation quantity and that of the changes of the maximum blood flow velocity (r=-0.287). A moderate negative correlation was observed between the degree of the change rate of the maximum blood flow velocity by acid stimulus and the number of the drugs taken. The change rate of the maximum blood flow velocity was significantly lower in the group taking 2 or more drugs than any other groups.

Discussion Based on the result of this investigation, it was suggested that the change rate of the maximum blood flow velocity in the facial artery in the submandibular gland after acid stimulation using pulse Doppler sonography might help differentiate drug and /or autonomic dysfunction-induced hyposalivation from other cause-induced hyposalivation.

O-17

Diagnosis for hyperplasia of the tendon and aponeurosis of masticatory muscles with square mandible

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Purposes: A method to diagnose hyperplasia of the tendon and aponeurosis of masticatory muscles with square mandible was investigated in our patients.

Materials and methods: The subjects were 26 patients diagnosed with hyperplasia of the tendon and aponeurosis of masticatory muscles (16 surgical and 10 non-surgical cases). The patients had experienced a limitation of mouth-opening for a prolonged period, and the mean duration of symptom was 14 years (12 years in surgical and 15 years in non-surgical cases). The mean age at the initial examination was 42 years (40 years in surgical and 44 years in non-surgical cases). The mean mouth-opening was 24 mm (21 mm in surgical and 27 mm in non-surgical cases), and no limitation of anterior or lateral movement was present. MRI examination is suitable for imaging the tendon and aponeurosis of masticatory muscles, but it does not detect interference of the zygomatic arch with the coronoid process during mouth opening as evaluation of the coronoid process. To identify the muscle bundle/tendon attachment site, the area of the coronoid process was measured.

Results: The diagnostic criteria employed were the presence of long-term latent disturbance of mouth opening, a hardened, anteriorily projecting anterior margin of the masseter muscle covering the anterior border of the mandibular ramus during maximum mouth opening, and hyperplasia retaining a morphology similar to that of the normal coronoid process, and exclusion of mouth-opening disturbance associated with temporomandibular joint disorder. The area of the coronoid process was significantly different between the patient and control groups ($p < 0.05$).

Conclusion: It was suggested that measurement of the area of the coronoid process contributes to the diagnosis of this disorder.

O-18

Reliability of 3-D laser scanner imaging for facial soft tissue measurement

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Purposes: Surgical orthodontic practice is moving toward 3-dimensional (3-D) cephalometric analysis employing computed tomography (CT). Computed tomography enables evaluation of not only hard but soft tissues, allowing greater predictability of changes in facial configuration between before and after treatment. One serious drawback of CT, however, are artifacts caused by dental metallic materials. In particular, artifacts disturb evaluation of the mid-facial area. Facial configuration data also can be obtained with a 3-D laser scanner. If the obtained data are sufficiency precise, they can complement CT data disturbed by metal artifacts. The purpose of this study was to evaluate the reliability of 3-D laser scanner imaging and compare it with CT in respect to measurement of facial soft tissue.

Materials and methods: Subjects consisted of 15 patients at the preoperative stage of orthognathic surgery, all categorized as skeletal Class III and aged 18-29 years. Patients were scanned with the 3-D laser scanner VMH-300F (UNISN, Osaka, Japan; 0.5 mm scanning pitch) and the multi-detector CT Somatom Plus4 VolumeZoom (Siemens, Erlangen, Germany; 1 mm collimation, Pitch 1.25, 100 mAs, 120 kVp). Three-dimensional CT images were generated by volume rendering technique and surface data from the face were extracted. The surface data and 3-D facial profiles were superimposed and their consistency determined. The mean distance between corresponding data points in both data sets was calculated using reverse-engineering and inspection application Imageware12 (UGS PLM Solutions, MO, USA).

Results: The mean distance was 1.32+/-1.03 mm. The 3-D facial profiles obtained with the 3-D laser scanner showed good consistency with the surface data obtained with CT when spatial resolution of both systems was taken into consideration.

Conclusion: It can be concluded that 3-D laser scanner imaging is a reliable and valuable complement to CT data from facial soft tissue.

O-19

A case of a large Maxillary Carcinoma involving oral cavity in a 10 year-old boy

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Purpose: In Bangladesh, incidence of Oral Squamous Cell Carcinoma (OSCC) is about 90-95% of all oral malignant neo-plasms resulting in 20-30% of all cancer. High incidence of oral cancer in Bangladesh is thought to be related with betel leaf/nut, chewing tobacco and other oral chewing habbit. OSCCs are more frequent in the 5th to the 7th decades of life, uncommon in adolescence and rarely seen in children. Only 1-6% of patients with OSCC under the age of 40.

Results: We report a unique case of OSCC affecting a 10-year-old boy who attended BIRDEM hospital, Dhaka, with a volu-minous growth on his left maxilla. The histological examination revealed an invasive squamous cell carcinoma. CT scan showed that lesion involving left maxillary antrum, ethmoid sinus, orbit with the involvement of inferior rectus muscle, upper gingivae, check, infratemporal fossa with bony destruction of wall of the left maxillary antrum, alveolar process of maxilla and lateral aspect of hard palate The clinical details of this rare case will be discussed in conjunction with some important consid-erations in dealing with this type of malignancy in children.

Conclusion: The possibility of the existence of a carcinogenic effect of abnormal chewing habit, tobacco, and alcohol in such a young boy was absent. Thus , other factors should be investigated, these factors include a genetic predisposition, previous viral infections, feeding habits, immunodeficiency states, socioeconomic status and oral hygiene. Because of its uniqueness and rarity, cases are often misdiagnosed and inappropriately treated leading to delay in definitive treatment, resulting in a poor prognosis of these patients. Although several studies have been attempted to identify the risk factors for OSCC in young patients, little is known about its possible etiology and therapeutic management.

O-20

Imaging characteristics of mucoepidermoid carcinoma and the correlation with histopathologic grades

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Purpose: The purpose of this study is to analyze imaging characteristrics of mucoepidermoid carcinoma (MEC), and to corre-late them with histopathologic grades.

Materials and methods: We analyzed 31 patients diagnosed as MEC, who were treated in Seoul National University Dental Hospital during the period or years 2002 to 2008. Out of 31 patients, preoperative MR images and 17 preoperative CT images were analyzed. Histopathologic grades were classified as high-, intermediate-, and low-grade. The imaging characteristics analyzed on the MR and/or CT images were tumor margin, internal architecture, signal intensity, and infiltration into surround-ing structures such as bony involvement. In addition, possible correlation among clinical data, histopathologic grades, and image findings were investigated.

Results: Of all 31 cases, 21 cases were revealed as low-grade, 9 as intermediate-grade, and 1 as high grade. The location of the lesion was in the major salivary gland in 6 of the cases, minor salivary gland in 23 cases, and intrabony lesion in 4 cases. All MECs in the 23 preoperative MR images displayed ill-defined margins, except for two of the low–grade MECs which showed well-defined margins. T2- weighted images showed a large variety of signal intensities ranging from low to high regardless of the histopathologic grades. Infiltration into the surrounding structure was seen in 16 cases (1 high-, 4 intermediate-, and 11 low-grade). Of them, bony infiltration was seen in 9 cases (3 intermediate-, and 6 low-grade). Stage grouping according to TNM classification showed no significant correlation with histopathologic grades.

Conclusion: Our results showed that the tumor margin, signal intensity, and infiltration into the surrounding structure were not reliable in differentiating between low-, intermediate- and high-grades. We did not find statistically significant correlation between the clinical tumor stage, histopathologic grade and imaging characteristics.

Effect of Ancer® 20 Injection and chemotherapy on leukopenia during external beam radiotherapy for head and neck cancer

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Purpose: The purpose of this study was to evaluate the clinical influence on leukocyte of Ancer® 20 Injection and chemotherapy during external beam radiotherapy (EBRT) for head and neck cancer.

Materials and methods: All patients with head and neck cancer underwent EBRT and were given 6 mg per day peroral Cepharanthin® in the same period. We evaluated the effect of Ancer® 20 Injection on leukopenia during EBRT. Ten patients (5 males and 5 females, median age; 63 years) were administered Ancer® 20 Injection during EBRT. The total dose of EBRT for these patients was 38-64 Gy (median 52 Gy). Twenty patients (12 males and 8 females, median age; 71 years) were not administered Ancer® 20 Injection during EBRT. No patient underwent combined chemotherapy in these two groups. Then we evaluated the effect of chemotherapy on leukocyte during EBRT. Ten patients (5 males and 5 females, median age; 63 years) were treated by EBRT without chemotherapy. Twenty three patients (11 males and 12 females, median age; 69 years) were treated by EBRT with chemotherapy. The total dose of EBRT for these patients was 44-70 Gy (median 54 Gy). All patients were administered Ancer® 20 Injection during EBRT. We examined the blood test four times before, during and after EBRT and evaluated the maintenance rates of white blood cell, lymphocyte and neutrophil in the blood at each term.

Results: The maintenance rates of white blood cell, lymphocyte and neutrophil of the group with Ancer® 20 Injection were higher than that of the group without Ancer® 20 Injection in almost all term. But there were no significant differences between the two groups. For the group without concomitant chemotherapy, the average maintenance rates of lymphocyte at the first half during radiotherapy, the second half during radiotherapy, and one month after radiotherapy were 92.5 %, 74.2 % and 78.0 %, respectively. While for the group with concomitant chemotherapy, these values were 66.0 %, 50.7 % and 65.5 %, respectively. There were significant differences in the first half during radiotherapy and the second half during radiotherapy between the group without concomitant chemotherapy and the group with concomitant chemotherapy (P<0.05). The maintenance rates of white blood cell and neutrophil of the group without concomitant chemotherapy were higher than the group with concomitant chemotherapy in almost all terms but there were no significant differences between these two groups.

Conclusion: The administration of Ancer® 20 Injection may be useful to prevent the leukopenia for the patient with head and neck cancer treated by EBRT. The combined chemotherapy reduced the maintenance rates of lymphocyte in the blood during EBRT, even if Cepharanthin® and Ancer® were administered.

How accurately do CT images detect extent of mandibular invasion in patients with squamous cell carcinoma on mandibular gingiva?

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Purposes: Surgical planning and procedure depend on the extent of mandibular invasion in patients with squamous cell carcinoma, making accurate determination of extent important. CT imaging is especially useful for delineating change in hard tissue and is used to determine mandibular invasion preoperatively. Although it has been proven that CT is able to detect accurately the presence of mandibular invasion, no studies have investigated how accurately CT images can detail its extent. The purpose of this study was to determine how accurately CT images detected the extent of mandibular invasion in patients with squamous cell carcinoma of the mandibular gingiva.

Materials and methods: Subjects consisted of patients with squamous cell carcinoma of the mandibular gingiva. Fourteen cases (9 men and 5 women, mean age: 67.5 years, age range: 52-80 years) were selected in which CT examination was carried out prior to mandibulectomy at our institution between 2004 and 2007. Axial and cross sectional CT images were retrospectively reviewed by one oral radiologist and one oral surgeon. Presence of invasion of the mandibule and mandibular canal on CT images was assessed in all cases. Extent of mesial and distal invasion was also evaluated on cross sectional CT images in patients with mandibular invasion. Imaging results were compared with histopathological findings.

Results: CT correctly revealed mandibular invasion in 10 out of 11 cases. CT correctly excluded mandibular invasion in 2 out of 3 cases. Among 11 cases, CT correctly showed invasion of the mandibular canal in 2 out of 3 cases, and excluded it in 6 out of 8 cases. Extent of mandibular invasion was accurately demonstrated in 6 out of 10 cases on CT images. Although CT accurately determined extent of distal invasion, extent of mesial invasion was narrower on CT images than proved histopathologically in one case. In the remaining 3 cases, extent of both mesial and distal invasion on CT images was inaccurate, being wider or narrower that the width of one or two teeth than proven histopathologically. CT correctly showed invasion of the mandibular canal in 2 out of 3 cases, and excluded it in 6 out of 8 cases.

Conclusion: CT images can detect not only the presence but the extent of mandibular invasion accurately in most patients with squamous cell carcinoma on the mandibular gingiva.

CHARACTERIZATION OF CERVICAL LYMPH NODES WITH HEAD AND NECK MALIGNANCEIS THROUGH ULTRASONOGRAPHY

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Purposes: Cervical lymphadenopathy is a common finding in in Head & Neck malignancies. It is well accepted that clinical examination alone cannot be considered as a diagnostic tool to justify the involvement of cervical lymph nodes especially deep or small nodes. The objective of the present study was to evaluate normal cervical lymph nodes through ultrasonography & to identify the ultrasonographic changes in the cervical lymph nodes in Head & Neck Carcinoma.

Materials and methods: The study group comprised of thirty subjects of Indian origin from Bangalore, aged between 44- 72 years. The study consisted of 10 subjects of control group & 10 subjects from head & neck carcinoma. Each subject was examined clinically for all the lymph nodes in head and neck region including submental, submandibular and cervical group of lymph nodes. Then each subject underwent ultrasonographic examination of the submental & submandibular lymph nodes & cervical lymph nodes using high frequency transducer (11 MHz).

Results: Ultrasonography detected five times the number of lymph nodes palpated through clinical examination. Ultrasonographic criteria like S/L ratio (p being n.s.) and necrosis (p = 0.000) which were useful to differentiate the normal lymph nodes and metastatic lymph nodes.

Conclusion: Ultrasonography is a useful imaging modality in assessment of normal and pathologic lymph nodes like metastatic lymph nodes. Distribution of lymph nodes & grey-scale sonographic features are useful to identify the cause of cervical lymphadenopathy. Ultrasonography is non-invasive, inexpensive procedure, which does not involves radiation thus making it a safe, easily available and viable imaging modality.

Key Words: Cervical lymph nodes; high frequency ultrasonography; metastatic lymph nodes; S/L ratio; echogenicity; necrosis.

Cone-beam CT in the assessment of Mandibular Invasion of lower gingival carcinoma

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Objective: The objective of this study was to compare the diagnostic accuracy of cone–beam CT with that of panoramic images for assessing mandibular invasion by lower gingival carcinoma.

Materials and methods: Fifty patients (30 men and 20 women, mean age 65 years, range 34-81 years) with squamous cell carcinoma of the lower gingiva who were examined by both digital panoramic radiography and cone-beam CT at Tokyo Medical and Dental University Dental Hospital between June 2004 and October 2007 were included in this study. As a cone–beam CT apparatus, 3D Accuitomo, image intensifier type (Morita Corp., Kyoto. Japan) was used. Five oral radiologists used a 6 – point rating scale to evaluate the images for the presence or absence of alveolar bone and mandibular canal involvement by tumor. These findings were correlated with histopathological findings, which were considered the gold standard. We calculated and compared the area under the receiver operating characteristics curve (Az value) and the sensitivity and specificity of the two imaging modalities.

Results: In evaluations of both alveolar bone and mandibular canal involvement by tumor, the mean Az value for cone-beam CT (0.918 and 0.977, respectively) was significantly higher than that of panoramic radiography (0.793 and 0.872, respectively). The mean sensitivity for cone- beam CT (89% and 99%, respectively) was significantly higher than that for panoramic radiography (73% and 56%, respectively). There was no significant difference in the mean specificity. While cone-beam CT could provide high resolution three dimensional images, the image quality around the alveolar crest was often hampered by severe dental artifacts and image noise, resulting in difficulties in detecting subtle alveolar invasion by tumor.

Conclusion: Cone-beam CT was significantly superior to panoramic radiography in the evaluation of mandibular invasion by lower gingiva carcinoma. Its diagnostic value in detecting subtle alveolar invasion, however, may be limited by sever dental artifacts and image noise.

Utility of appropriate windowing for MR images in differentiating benign tumors and cysts

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Purposes: Both benign tumors and cysts in the oral and maxillofacial region show clear borders and homogeneously high signal intensity on MR T2-weighted images. It is often difficult to differentiate them without contrast-enhancement. Windowing for brightness and contrast adjustment may be useful in the interpretation of relative signal intensities on MR images. The purpose of this study was to determine whether appropriate windowing for T2-weighted images was helpful in differentiating them without invasion by contrast-enhancement.

Materials and methods: Twenty-six lesions (13 benign tumors, and 13 cysts), whose T2-weighted images obtained by auto-windowing showed clear borders and homogeneously high signal intensity, were examined retrospectively. The windowing parameters of axial images were re-adjusted to emphasize contrast only inside lesions using automatic density adjustment. The re-adjusted images were reviewed by 3 experienced oral radiologists and categorized by internal homogeneity of lesion into 4 grades: 0, heterogeneous; 1, slightly heterogeneous; 2, slightly homogeneous; and 3, homogeneous. We determined whether windowing was useful in differentiating between benign tumor and cyst.

Results: For cyst, the rate of homogeneous (3, homogeneous and 2, slightly homogeneous) was 66.7% (26/39) and heterogeneous (1, slightly heterogeneous and 0, heterogeneous) was 33.3% (13/39). For benign tumor, the rate of homogeneous was 33.3% (13/39) and heterogeneous was 66.7% (26/39). While the rate of homogeneous for cyst was higher than that for heterogeneous, the rate of heterogeneous for benign tumor was higher than that for homogeneous.

Discussion: While cyst is characterized pathologically as an epithelium-lined cavity containing fluid or semisolid material, benign tumors are formed by abnormal proliferation of cells and tissues. That is why the signal intensity of a cyst is more homogeneous than that of a benign tumor. Appropriate windowing for T2-weighted images emphasized the difference induced in signal intensity by these characteristics.

Conclusion: Appropriate windowing on T2-weighted images is helpful in differentiating benign tumors and cysts which have clear borders and homogeneously high signal intensity on T2-weighted images.

Differential diagnosis of fibro-osseous lesion - An attempt to facilitate classification using bone complexity -

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Purpose: Differential diagnosis of fibro-osseous lesions (FOLs) in the jaws is often difficult, as the internal condition of lesions can change over time. FOLs are complicated lesions shown on panoramic view and are histopathologically classifiable into 3 groups: tumor; dysplasia; and inflammation. We have thus advocated using 5 types of image pattern for the differential diagnosis of FOLs. In this study, we tried to achieve simplicity of classification using bone complexity from histopathological images.

Materials and methods: Twenty cases of FOL were investigated, covering 5 radiographic patterns: focal (n=3); target (n=6); lucent (n=4); calcification (n=3); and multiconfluent (n=4). Tiling histopathological images in the central area of a full-section specimen were transformed into binary images and then into 8-bit scale images using image-analysis software. Bone complexity was calculated from pixel counts for the area of osteoid tissue and length of the perimeter, using the following formula: complexity = $(area)^2/(perimeter)$. From these results, 3 groups were created according to significant differences in bone complexity (Welch's test, P<0.01): N1, low bone complexity; N2, middle bone complexity; N3, high bone complexity. In addition, mean density of each lesion on intraoral film was measured by regions of interest (points selected at random) for dentinal area in teeth and hard tissue area within the lesion using a densitometer. Each new group was analyzed by radiographic pattern and lesion density.

Results: Mean density of lesions on intra-oral film was 0.913 in N1, 1.237 in N2 and 1.043 in N3. No calcification or lucent pattern was seen in N1. Target pattern was common in N2, but not seen in N3. Multiconfluent pattern was seen in all groups. Focal pattern was apparent in N1 and N3, but not N2.

Conclusion: Mean density of all groups differed significantly. Focal pattern reflects a trend for increasing osteoid tissue was not in accord with this new classification. No lucent or calcification patterns were seen in N1 because of the relatively small amount of osteoid tissue included in the lesion. As multiconfluent and target patterns showed the most complex patterns and formed osteoid tissue of varying sizes in lesions were heterogeneous, classification of these patterns requires attention to the manifestation of radiographic findings. Ideally, the pattern of FOL can be divided into three patterns easily from the radiographic pattern. However, we cannot currently confirm sufficient trends in this study. These represent an issue for the future.

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Aneurysmal Bone Cyst of Gnathic Bones: Clinical Presentation and Imaging Finding

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Purposes: To investigate the imaging feature and clinical presentation of aneurysmal bone cyst (ABC) of gnathic bones.
Materials and methods: The records including diagnostic radiograph images of 27 patients were retrospectively analyzed.
Results: The age of the 27 patients ranged from 0.6 years to 62 years (means, 23.4 years). The numbers of males and females were 10 and 17. Of 27 patients, 7 were secondary event in another bone lesion. 20 mandibular cases and 7 maxillary tumors were located. On conventional radiographs, the lesion was presented an expansile osteolytic lesion. In mandible, its longest dimension along with the long axis of the host bone. The zone of transition between tumor and normal bone was indistinct and not sclerotic. The cortical bone was thin or/and breakthrough and periosteal reaction was not seen. The multilocular antrum transversed by intralesional septa were presented in 13 cases. CT imaging demonstrated multiple internal septations (n=7) and fluid-fluid level (n=3). On MRI, the lesion was displayed as large bony destruction area, had homogeneous hypointensity on T1-weighted images, homogenous hyperintensity on T2-weighted images. Bone expansion in ABC had eccentric (n=15), central (n=3) and parosteal (n=1) pattern.
Conclusion: A comprehensive imaging modality and clinical presentation can improve diagnostic accuracy of ABC.

O-28

Diagnosis and Embolization of AVM in the mandible

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Purpose: To analyze the x-ray plain film, CT, MRI and DSA of the arteriovenous malformations (AVM) in the mandible and report our experience to embolize them.
Patients and Methods: 46 consecutive patients with AVM of mandible were comprised of this study group. The imaging data related to X -ray plain film, CT, MRI and DSA. 39 cases were indicated for direct puncture embolization and 7 cases for transarterial embolization. Coils only were acted as embolization material for 16 cases, coils mixed with NBCA for 21 cases and coils mixed with ethanol for 9 cases.
Results Different signs were demonstrated on X-ray plain film. The AVM of the mandible was also differentiated two groups on DSA and CT scan.Two group features were delineated on CT scan: one group was characteristic as varix formation and unilocular radiolucency on CT scan, and the other as dispersed vasculr blush on DSA and multilocular radiolucency on the CT scan. The first group was indicated for direct puncture embolization and the second just for transarterial embolization. The immediate venogram and control arteriogram after the procedure were both obtained that documented a significant thrombosis of the lesion in all patients. The long follow-up revealed persistent control of symptom in all patients and high incidence of infection from extrinsic body came from coils mixed with NBCA. Comparison of different embolization materials showed ethanol or coils mixed with ethanol should be advocated.
Conclusion. The embolization approach of AVM in the mandible should be selected according to CT and DSA feature. Ethanol embolization may be a definitive and safe method in the treatment of mandibular AVM.
Key Words: Mandible AVM Embolization Ethanol

O-29

The frequency of detecting other latent disorders with implant CT

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Purposes: The number of CT scanning for dental implant therapy which started as an option of prosthodontic treatment in our institution has led to 1062 in these 8 years from January in 2000 to December in 2007. We aimed to verify the meaning of screening of dental implant CT image at soft tissue display.

Materials and methods: The subjects were the previous 1062 implant cases accumulated for these 8 years in our institution. We had used full-body CT (X Vigor Real made by Toshiba company) and had kept scanning in intercuspal position under the following condition, tube voltage:120Kv, tube current:100 mA, in order to decrease radiation dose as possible without loss of image quality. The extent of scanning was about 50 mm beneath or below occlusal plane, limiting either maxilla or mandible, while about 100 mm in the whole jaws.

Results: The results we obtained were as follows, 1 case suspected pleomorphic adenoma, 2 cases suspected disorders accompanied by lymphnodal calcification, 6 cases diagnosed as maxillary sinusitis, 3 cases suggested anterior disk displacement in the temporomandibular joint, 12 cases suggested either chronic alveolar osteitis or chronic osteomyelitis, and 3 other disorder such as slight facial calcification. As a whole, the frequency of detecting other latent disorders was less than 0.3 %.

Conclusion: Now is a transition period from full-body CT to dental cone beam CT (CBCT). One of merits of CBCT is surely decrease of radiation dose, but loss of information of soft tissue could be named as one of its demerits. Consequently, the frequency of detection with CBCT was supposed to be smaller than that with full-body CT. The above frequency of detection revealed in our institution might enable a natural transition from full-body CT to dental cone beam CT.

O-30

Relationship between the direction of indicating rod of stent and the recommended path of implant fixture insertion considering residual ridge on implant CT

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Purposes: The purpose of this study was to assess the relationship between the direction of the indication rod of stent for ideal prosthetic design and recommended path of the possible implant fixture placement considering residual ridge resorption.

Materials and methods: Experimental group consisted of 326 site in 106 patients who came to Seoul National University Dental Hospital for implant prosthetics. We took the computed tomography of each patient and used ToothPix® software for reformatting program. We investigated the direction of indicating rod, the bony defects, the bony sclerosis, and root proximity of the adjacent teeth. We used SPSS statistic program for frequency analysis and crosstabulation.

Results: The upper anterior region showed the highest incidence of changing the direction of indication rod (80.8%) and the upper molar region showed least incidence (30.3%). The highest type of recommended change in upper anterior and premolar region was lingual rotation of apical end with buccally parallel shift (42.3% and 36.4%, respectively). In the lower molar area, buccal rotation of apical end was the highest type of recommended change. Considering bony defects, upper premolar area (22.7%) and molar area (29.3%) showed higher frequency of irregular residual ridge crest. Considering bony sclerosis, lower molar area (30.3%) showed higher frequency of focal sclerosis. Considering the root proximity of adjacent teeth, upper premolar area (20%) showed higher frequency compared with the other areas.

Conclusion: The results of this radiographic investigation almost corresponded to the previous ones of clinical studies about alveolar ridge resorption. Using CT can help us make a decision on where and how to place implant, and make a successful implant prosthetics.

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Guidelines for dental implant imaging produced by a committee on clinical practice guidelines of the Japanese Society for Oral and Maxillofacial Radiology

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Clinical practice guidelines are recognized as critically important to an evidence-based practice. Although the guidelines for dental implant imaging have already been provided by Europe and the United States, these guidelines are not sufficient for Japanese dental practitioners because of inadequate description about the use of computed tomography (CT) which shows increasing clinical availability in Japan. Therefore, the Japanese Society for Oral and Maxillofacial Radiology organized a committee on clinical practice guidelines in order to produce the Japanese guidelines for dental implant imaging with special reference to CT. In this paper, we present the second version of the clinical practice guidelines for dental implant imaging. The contents are as follows; 1) Measurement accuracy and acquisition protocol of CT 2) Clinical application of CT: Multidetector-row CT (MDCT) versus cone-beam CT (CBCT) 3) Bone quality evaluation using CT 4) Appropriate stent marker for CT examination 5) Management of CT data 6) Clinical significance of MRI 7) Imaging evaluation of time-course changes of bone structure 8) Radiation exposure and risks

O-32

Quantitative analysis of metallic artifacts on CT images: The effect of quantity, type, angle, and position of metal materials

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Purposes: Streak artifact by metal material is one of the image artifacts associated with the computed tomography (CT). It is caused by the severe attenuation in the intensity of the x-ray beam as it passes through the metal material, resulting in missing data. This artifact seriously degrades image quality, obstructs the underlying anatomical and pathological structures, and leads to images unsuitable for diagnosis. Therefore, it is important to understand the characteristic of this artifact in order to develop the reduction method. The purpose of our study was to quantitatively analyze the streak artifacts of metal materials appeared on CT images in correlation with quantity, type, angle of placement, and position in a phantom study.

Materials and methods: Metal cubes of aluminum, titanium, and gold were evaluated by placing in a water-filled polypropylene box with various numbers of cubes (one to three cubes), angle of placement (zero and 45 degree), and positions (center, left, and upper positions), and then were scanned using MDCT at the slice thickness of 2.5 mm, tube voltage of 120 kVp, and tube current of 150 mA. Artifact areas on axial CT images were quantified using ImageJ 1.40 g software by establishing the attenuation value of black and white components. The white component consisted of white areas and streaks surrounding the cube in all directions. The black component was band-like or black streaks radiated from the angles of the cube. The artifact areas of each type, angle of placement, and position were compared.

Results: Gold caused the largest artifact areas, followed by titanium, and aluminum. The more number of the metal, the more artifact areas were produced. Forty five degree-rotated metals usually produced more artifact areas than unrotated metals. Metals in the center position did not always cause the largest artifact areas. Comparing white and black components of the same metal type, angle of placement, and position, white component was larger than black component in most conditions.

Conclusion: We could quantitatively measure the black and white metal artifact areas in MDCT by using the image processing software. Gold produced the largest artifact areas among tested materials. The artifact areas were increased with the increased quantity of metal. When metal material was rotated or placed in different positions, the artifact areas were changed according to the alteration of material's orientation. White artifact area was larger than black artifact area in almost scan conditions.

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Intraoperative Computer Tomography for maxillofacial surgery

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Purposes: Today, image guided surgery routinely relies on preoperatively acquired image data. Hence with the progress of surgery the image data differs more and more from the actual anatomical situs. Another problem in image guided surgery is patient to image registration. It is time-consuming and error-prone but at the same time most crucial for accurate navigation. The accuracy of a system for fully automated registration of intra-operatively acquired computer tomography (CT) image data was evaluated technically and clinically

Materials and methods: The system for intra-operative imaging and registration consists of a moving CT gantry (Somatom Emotion, Siemens, Forchheim, Germany) mounted on rails in the floor, and an operating table (AWIGS, Maquet, Rastatt, Germany) with translucent patient rest. During CT imaging, the positions of patient and CT gantry are tracked, using the infrared camera of the navigation system (VectorVision Sky, Brainlab, Heimstetten, Germany). Hence after transfer of the image data to the navigation system via PACS, registration can be performed fully automatically. The accuracy of this system was evaluated in a phantom study and in patient cases, using artificial landmarks for evaluation of the target registration error (TRE).

Results: In the phantom study automated registration succeeded with an average accuracy of 1.5 mm or below and was uniform over the volume of the head. In the patient study, registration succeeded with an average accuracy of 2 mm or below. In comparison to pair-point registration with maxillary templates, registration accuracy was almost similar in the region of face and anterior skull base, but superior in the region of neurocranium and lateral skull base.

Conclusion: The investigated concept is an accurate registration method. With the uniformity of registration accuracy over the volume of the skull much flexibility is given to the surgeon. Furthermore intraoperative workflow is enhanced by automated registration.

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Digital Volume Tomography for image guided foreign body removal

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Purposes: Digital Volume Tomography (DVT) combines lower cost, less radiation dose and less dental metal artefacts, as compared to conventional computer tomography (CT). These properties make the use of this imaging modality desirable for image guided maxillofacial surgery. In a sequence of studies at our department the use of image data from a Newtom DVT for image guided surgery was investigated. The use-case was navigated foreign body removal with pair-point registration using a maxillary splint.

Materials and methods: All studies compared a Newtom 9000 DVT to a Siemens Somatom spiral CT scanner. In a phantom study the detection limits of various typical foreign body materials in DVT were compared to CT. In another phantom study, geometric accuracies of CT and DVT were compared. The accuracy of fiducial marker registration and use of a navigation system were measured using CT and DVT image data. Finally, in a clinical study DVT image data was used for image guided foreign body extraction in patient cases.

Results: CT and DVT did not differ relevantly in the detection of radio-opaque foreign bodies. Either method failed with foreign bodies of low radio-opacity. CT geometry was slightly more accurate than DVT geometry. However, DVT and CT showed similar registration accuracy. DVT based removal of foreign bodies using a navigation system was successful in all patient cases.

Conclusion: DVT proved to be a suitable alternative to CT for image guided surgery. It is now in routine use for navigated foreign body removal at our institution.

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Perspectives in Orbital Reconstruction

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Purposes: Nearly 40 percent of all maxillofacial traumas involve the orbital structures. In most cases, an area consisting of more than half of the inferior orbital wall medial to the infraorbital groove and canal is affected. Enophthalmos, muscle entrapment, diplopia and visual acuity disturbance due to the enlargement of orbital volume are severe complications in posttraumatic orbital deformities, when primary reconstruction is not correctly achieved. Symmetrical orbital reconstruction is important therefore, for both functional and aesthetic reasons. Surgical exploration is indicated if either the inferior or medial wall is displaced by more than 3 mm. Many methods for the reconstruction of bony orbital defects have been described, in which different kinds of autologous and/or alloplastic grafts, according to the defect size, are inserted into the orbit. Estimating the degree of augmentation is usually an intra-operative decision, which depends on the surgeon's experience. A volume excess persists after the operation in about 8.5% of treated patients and lead to an enophthalmos, especially if the deep orbital cone is affected or scarring renders the identification of stable posterior landmarks difficult.

Results: Advances in imaging techniques for diagnostics and associated technologies (i.e. stereolithographic models) within recent years have led to improved preoperative planning for craniomaxillofacial surgeons. In particular, the application of navigation-aided procedures for orbital reconstruction has proved to be essential. The development of powerful public domain computers has made it possible to increase the amount of CT/CBCT/MRI information that can be used, leading to more accurate virtual hard or soft tissue images and models.

Conclusion: It is possible to facilitate the operative procedure in complicated situations by using computer-assisted preoperative planning (CAPP) on the one hand and industrially produced titanium meshes and plates on the other. Preforming titanium meshes for orbital floor reconstruction combined with CAPP leads to a more individualized treatment.

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Guidelines for proper placement of Temporary Anchorage Devices: CBCT Research

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Purposes: To measure in a group of patients the interradicular space between the maxillary 2nd premolar and 1st molar which is commonly used as installation sites for mini-implants and to suggest a simple guide for safety installation.

Materials and methods: Cone beam CT (CBCT, PSR 9000N model, Asahi roentgen Co., Kyoto, Japan)s were performed on 35 patients to measure the interdental space and the distance between the surface of cortical bone and the narrowest interradicular area apically in 1mm intervals in 9 axial images from cementoenamel junction (CEJ). The CBCT data were analysed using ANOVA to evaluate the difference of the interradicular distance, cortical bone surface and narrowest interradicualar space. A T-test was also performed to evaluate sex and implantation side differences.

Results: Interradicular spaces became wider approaching the apical area; several axial planes showed statistically non significant differences from the CEJ to the root, and the average distance from the surface of the cortical bone to the area of the narrowest interradicular space was over 5mm in the most sections.

Conclusion: A larger insertion angle would increase the cortical bone contact amount; however it is difficult to apply various traction materials and may increase the danger of the maxillary sinus perforation. Guidelines for proper placement of mini implant were recommended from this study and some clinical applications of new surgical guide system that uses cone beam computed tomography (CBCT) images were also suggested to make a surgical guide for accurate placement of orthodontic mini-implants.

Evaluation of the implant angular deviation in surgical guide usage using the bone density values from computed tomography

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Purposes: While the ideal placement of dental implants should be determined by prosthetic parameters, the exact positioning of the implant with respect to location and angulation is often difficult. To reduce alignment problems, numerous types of templates for radiographic diagnosis, CT-based prosthetic treatment planning or for precise bone-mapping were introduced. Some clinical reports mentioned that insertion phase should have been done with appropriate surgical guide but there are no information regarding the implant angulation deviation which had been occurred during the implant insertion phase. Thus, the aim of this clinical study was to analyze deviations of the implant angulations which had been drilled with a surgical guide but inserted without a surgical guide by observing the bone density of the implant site.

Materials and Methods: 27 patients (15 male and 12 female) who were referred for implant placement and treated with t 123 Tapered Swiss Plus implants were included in this study. A five step examination procedure was followed as; First a custom initial template for CT scanning was fabricated for all patients, following a standardized CT scan was performed with this template, then the obtained CT data for each patient was imported to the planning software (Stent Cad, Media Lab. Software, La Spezia, Italy) allowing both surgeon and restorative dentist to simulate implant placement on the 3D model. The next step a rapid prototyping machine using the principle of stereolithography was utilized to fabricate the stereolithographic models and guides. The precise angulation, mesio-distal and bucco-lingual positioning of each implant as planned using 3D computer simulation software is transferred to the SLA surgical guide. The surgery was performed with this surgical guides and at the last stage new CT scans were taken. The locations and axes of planned and placed implants were compared using a software, which fused the CT images taken before and after implant placement (Rhinoceros 4.0, McNeel Ins, Seattle,WA,USA). The difference between the variables were tested statistically independent t-test and Pearson Chi square test (p<0,05).

Results: 15 male patients with 64 implants and 12 female patients with 60 implants were uneventfully treated. The angulation differences between the actual position of each implant with its position in the planning and the haunsfield unit values of the bone of the implant region were analyzed (p<0,05). In general, the correlation between angular deviation and bone density found statistically significant (p<0,05) while no significant correlation found on the age-bone density and age-angular deviation groups (p>0,05).

Conclusions: The SLA surgical guides which had been used in this clinical study had no guidance for the implant insertion phase which can be effect from the density of the bone. However there are no such studies which were point out the relationship between the bone density and the angular deviation. In this clinical study highly correlation found between the bone density and the angular deviation (p<0.05). Detailed information about the bone density will help the surgeon identify optimum implant sites, thereby improving the success rate of the procedures.

Dental Caries in the Dens in Dente Area

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Purpose: Dens in dente in other words dens invagination is considered a frequent site of dental caries. However, our previous retrospective study did not detect any distinct dental caries lesions originating from the dens in dente on full-mouth intra-oral radiographs of 1549 subjects. Therefore, we reviewed the histopathological findings of dens invaginations from the perspective of anti-caries properties. Materials and methods: Fourteen extracted upper lateral incisors with dens in dente were examined. According to the classification proposed by Oehlers (1957), twelve invaginations were type I and two were type III. A series of cross-sectional specimens were studied using an optical microscope, scanning electron microscope (SEM), and electron probe micro-analysis (EPMA).

Results: Although there was no radiographically visible caries, microscopic limited caries lesions were observed in all specimens. Among these caries lesions, 7/14 were limited to the enamel surfaces, 2/14 were at the dentin-enamel junction (DEJ), and 5/14 had reached the dentin. Although enlarged dentin-tubes and discoloration of the dentin were seen in several specimens, there were no caries lesions causing apparent destruction of the enamel layer. Food debris in the invaginated fossa was seen in 8 teeth. On SEM findings, rodless enamel and irregular enamel structures were observed in the surface enamel layers of most dens invaginations. In addition, a soft tissue membrane-like structure was frequently observed on the enamel surface. In the two specimens, the orifice of the invaginated fossa was plugged with dental calculus. On EPMA, there were no abnormal concentrations of Ca, P or F in either the enamel or dentine. In the bottom of a deep teardrop-shaped invaginated fossa, the concentration of Mg (Magnesium) was seen.

Discussion: It is obvious that the dens invagination is regarded as an unclean area. Findings in the present study indicated that there were several adverse factors for the prevention of the caries such as food debris impaction and the irregular surface of the enamel. In addition, many caries lesions were found on microscopic observation. However, these caries lesions were small and mild. We think that the composition of the dens invagination has properties that contribute to the interruption of caries progression. These may include the distribution of rodless enamel, the soft tissue membrane like structure and dental calculus as the plugging material. In addition, the concentration of Mg may play a role in preventing caries by changing the composition of calcium phosphate such as Whitlockite.

Case reports of patients with Hypohydrotic Ectodermal Dysplasia.

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Purpose: Ectodermal dysplasia is an inherited heterogeneous disorder that causes malformation and malfunction of all tissues originating from ectoderm, such as hair, teeth, nail and sweat gland. Several types of this disorder have been reported including Hypohydrotic Ectodermal Dysplasia (HED) which is characterized by number of deformities including hypodontia or anodontia (abnormal dentition), abnormalities in hair, gland and skin. Here we report two unique cases of HED who attended BIRDEM hospital, Dhaka and review its radiological findings as well as oral rehabilitation.

Results: On panoramic radiograph of first case of a 10 years old boy with sever hypodontia, we found single molar tooth in both side of maxilla and impacted upper central incisors. His alveolar process was not completely developed. So there was reduction from the normal vertical dimension resulting in the protuberant lips. Panoramic radiographs of the second case of a 9 year old boy with non erupted teeth, revealed absence of teeth of both primary and permanent dentitions except two conical deciduous central incisors and one molar on each side of maxilla. This patient was also presented with two impacted permanent central incisors. In both cases, management includes oral hygiene instruction and removable prosthesis to satisfy the patient's esthetic and functional needs.

Conclusion: This is a rare disease and it is estimated to affect at least 1 in 17000 people world wide. Dental clinicians can be the first to diagnose such cases. The dental team should be aware of its radiological findings, sign and symptoms in order to provide the correct therapies for the functional and psychological needs of these patients.

Hypercementosis at the alveolar crest level

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Purposes: Hypercementosis is excessive deposition of cementum on the root surface. Although some cases of hypercementosis are idiopathic, certain circumstances favor the association with hypercementosis, including the following: supraeruption of a tooth because of the loss of an antagonist tooth, inflammation at the apex of a tooth, traumatic occlusion, and systemic diseases such as Paget's disease and hyperpituitarism. The excessive deposition of cementum occurs mainly on the apical two thirds of the root. Although in some instances the cementum is focally deposited, it occurs mainly on the apical region. We report focal (crestal) type of hypercementosis at the level of alveolar crest.

Materials and methods: We retrospectively studied crestal type of hypercementosis with periapical radiographs.

Results: On periapical radiographs, all cases were related to alveolar bone loss and were characterized by triangular shaped deposition of excessive cementum on the level of alveolar crest. Some had a history of periodontal treatment.

Conclusion: It is suggested that this type of hypercementosis is closely related to mild inflammation of periodontium at the crest level due to chronic periodontitis or local irritation from periodontal treatment.

Prevalence of mandibular three-rooted primary second molar in Taiwanese population by bite-wing radiographic study

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Purposes: The purpose of this retrospective study was to investigate the frequency of the occurrence identified by dental bitewing and periapical radiography and to determine the gender difference of primary three-rooted mandibular second molars in a Taiwanese (Chinese) population.

Materials and methods: A total of 227 patients' periapical and bitewing films were screened and examined to obtain bilateral existences of 185 (92 boys and 93 girls) mandibular primary second molars samples for this study. Radiographs were inspected by two experienced dentists using a magnifying view box. The criteria for the indication of an extra root were justified by the crossing of the translucent lines defining the pulp space and the periodontal ligaments in the primary mandibular second molars. The gender, symmetry, and frequencies of occurrence of primary three- rooted mandibular molars were recorded. Comparison of the occurrence of such primary three-rooted mandibular second molars according to gender was analyzed by means of the Fisher's exact test, and the relative incidence of such dental anomalies and the correlation between left- and right-side occurrences were determined by the McNemar's test.

Results: The 185 patients studied were aged between 2.5 and 11.9 years, with an average of 5.6 years. Eleven boys (11.96%) and seven girls (7.53%) were found to have primary three-rooted mandibular second molars among these 185 patients. No statistical gender-related difference ($p=0.309$) was found for the incidence of primary three-rooted mandibular second molars by Chi-square test. Collectively, the overall incidence of patients with such teeth was 9.73% (18/185), and the prevalence of teeth featuring such extra distolingual roots from the total teeth examined was 6.22% (23/370). The left primary mandibular second molar in female patients had the lowest incidence with an extra distolingual root (2.15%); the left-side occurrence of primary three-rooted mandibular second molar in male examinees had the highest incidence (6.52%) The occurrence of such mandibular three-root second molars on the right side and the left side between male and female showed no statistically significant difference ($p=0.309$). Of eighteen patients (9.73%) who displayed an extra distal lingual root with the mandibular primary second molars, five exhibited occurrence bilaterally 27.78% (5/18 individuals).

Conclusion: The present study investigated the prevalence of mandibular primary three-rooted second molars by retrospective study. It was found that 9.73% of the Taiwanese (Chinese) population patients showed such dental anomaly in the mandibular primary second molars. No significant association between sexes was found. The prevalence of a third root in the mandibular primary second molars may be important for dental practice and for reasons of anthropologic significance in the Asia race.

P-5

Cleidocranial dysplasia: A case report and review of radiological findings.

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Purpose: Cleidocranial dysplasia (CCD) is an uncommon, generalized skeletal disorder characterized by delayed ossification of the skull, aplastic or hypoplastic clavicles, and complex dental abnormalities. It is present at a frequency of one in one million individuals. The diagnosis of this condition is usually based on the presence of supernumerary teeth, partial or total absence of one or both the clavicles, and bony malformations and on clinical and familial evidence.

Results: Here we present a case of CCD and discuss the radiological findings in diagnosis of the condition. A 13 years old boy visited BIRDEM hospital and was diagnosed with CCD on the basis of history, clinical examination and radiological investigations. On clinical examination, the boy had elongated faces, short clavicle and scapula, a narrow chest and an easily opposable shoulder. He was presented with a long tongue with narrow but high arched palate and all deciduous teeth except mandibular central incisors were present. And he only had upper and lower first permanent molar teeth. We utilized orthopantomogram radiological examination to assess the location and number of retained deciduous and unerupted teeth. Hypoplastic clavicle and narrow, sloppy shoulders was observed by Chest X-ray. In lateral skull X-ray, an open fontanel and a wormian bone were observed. In metacarpal pharyngeal joint X-ray, we observed elongated second and third metacarpals, hypoplastic distal phalanges and a deformed, short middle phalanges of the third, fourth and fifth fingers with cone shaped epiphysis. All these radiological and clinical features indicate a typical case of CCD.

Conclusion: The clinical findings of CCD, although present at birth, are often either missed or diagnosed at a much later date because of its rarity. Some cases are diagnosed through incidental findings by physicians treating patients for unrelated symptoms or conditions. Radiographic findings of face and skull with typical bony and dental features are most commons methods of diagnosing CCD. Therefore, radiological investigations have a great role for the diagnosis of such syndrome.

P-6

Evaluation of unusual supernumerary teeth using cone-beam volumetric tomography

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Purposes: To investigate the usefulness of cone-beam volumetric tomography (CBVT) in cases of unusual supernumerary teeth.

Materials and methods: Three patients who were referred to Department of Oral Radiology, Faculty of Dentsitry, Mahidol University for evaluation of supernumerary teeth underwent CBVT with the 3D Accuitomo (J. Morita Mfg.Corp., Japan). The radiographic imaging areas 60 x 60 mm. were selected. The i-Dixel software was used to reconstruct and display multiplanar images and three-dimensional images.

Results: Three cases of unusual supernumerary teeth were evaluated: Case 1: A 15-year-old man with a complaint of mild paresthesia on the palate. Clinical examination revealed a conical fully erupted mesiodens located between maxillary central incisors. The periapical radiographs revealed additional two supernumerary teeth. One of them was an inverted unerupted tooth locating between the roots of maxillary right central incisor and an erupted mesiodens. The other one was a small inverted tooth with its crown superimposed the nasal floor. Lateral cephalometric radiograph did not show the exact position of these two teeth. CBVT images demostrated that two additional unerupted supernumerary teeth were aligned together in vertical direction and the pulpal canals of them were fused together. Furthermore, the superior one was actually embedded in the nasopalatine duct and perforated the nasal floor. Case 2: A 14-year-old man with a paramolar on left posterior mandible. Clinical examination revealed an additional small tooth positioning buccal to the mandibular second molar. Periapical radiograph did not show the pulpal relationships of them. CBVT images demonstrated the pulpal fusion of the paramolar and the mandibular second molar at the crown level. Moreover, the CBVT showed that the paramolar had incomplete root formation. Case 3: A 18-year-old man with a supernumerary tooth at upper right maxilla. Panoramic radiograph showed a small tooth-like radiopaque object locating near the roots of right maxillary first molar. Conventional tomography revealed its position at palatal side. However, these two techniques did not demonstrate the relationship of the supernumerary tooth to the roots of adjacent teeth. CBVT images demonstrated that the crown of supernumerary tooth was located between three roots of right maxillary first molar and the root of supernumerary tooth was located just below the floor of maxillary sinus and near the roots of right maxillary second premolar. Furthermore, small pericoronal radiolucency could be detected.

Conclusion: CBVT could demonstrate the positions and the relationships of unusual supernumerary teeth to other adjacent structures better than conventional radiographs.

Macro- and Micro-mechanical Analysis of the Enamel/ceramic Adhesive Interface in an Incisor Veneer Using the FE Submodeling and the Element Deactivation Approaches

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Purposes: Novel developments in dental computer aided design and computer aided manufacturing (CAD/CAM) systems have led to the success of ceramic veneers in treatment of acquired or congenital defects of anterior teeth affecting coloration, shape, and/or position. Retention of veneering materials to the tooth influences the survival rate in which depends primarily on an adequate adhesive bonded to enamel and ceramic substrates. Micro-leakages associated with resin monomers penetrating in enamel etched porosities arise as the key issue to cause damage accumulation and induce de-bonding in adhesive layer. The aim of this study was to investigate the macro- and micro- mechanical responses micro-mechanics and damage accumulation in a ceramic veneer adjacent to an incisal overlapped incisor using the submodeling and the element deactivation technologies.

Materials and methods: Section contours of an intact maxillary central incisor were acquired from Micro-CT (computed tomography) to construct 3-dimensional macro FE (finite element) model considered with buttjoint veneer design using mapping mesh approach. Ten loads from 10N-100N increment with 10N were applied with an angulation of 60° to the tooth longitudinal axis at the incisal edge in the macro model as the loading conditions to perform the simulations. The micro-model was constructed at an enamel-adhesive interface where was the stress concentration area in the macro model. The morphology and dimensions of the resin tags at the interface were assigned based on a SEM micrograph. Boundary conditions of the micro-model were determined from the macro-model results. An iterative code with the element deactivation technology was used while the local element stresses exceeding tensile strength in adhesive cement to simulate the micro-damage accumulation.

Results: Stress concentration within the cement occurred at the enamel-adhesive interface of the lingual side from the macro-models findings and at their resin tags base from the micro-models results. The maximum stress value in micro model was 13MPa exceeding the tensile strength (11.8MPa) of resin cement when loading condition was 50N. A simulated fracture path was found at the base of the resin tags along the enamel-adhesive interface.

Conclusion: This study indicated that the FE submodeling and the element deactivation technologies could simulate efficiently the micro-mechanical responses and the micro-damage accumulation noted at the enamel-adhesive interface.

A Cone-Beam CT in Assessing Proximal Caries of Primary Molar

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Purposes: The proximal caries can be detected by intraoral radiography with some limitation. The limited cone-beam volumetric imaging (CBVI) systems can be expected to be higher in accuracy not only in detection but also in estimation of the lesion depth. In the study, the visibility of caries lesion in both conventional intraoral radiography and CBVI was compared using extracted human primary teeth.

Materials and methods: Twelve extracted primary molars with proximal caries were used. The depth of the lesions was verified using a Micro CT (Micro Focus X-ray System, Shimadzu Corp., Kyoto, Japan) and classified into 3categories, limited in enamel (C1), penetrated into dentine (C2) and reached to the pulp (C3). A CBVI system used was a 3D Accuitomo (J. Morita Mfg. Corp., Kyoto, Japan) operated at 80kV and 4mA. An intraoral X-ray machine was also used. The images obtained were examined to determine the depth by an author.

Results: The CBVI images were more accurate in the estimation of the depth for any lesions than the intraoral radiographic images.

Conclusion: The results suggested that the limited CBVI could be used for assessment of the primary teeth.

Stafne bone cavity - Three cases report

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Stafne defect is known as Stafne bone cyst, also known as lingual mandibular salivary gland depression; latent bone cyst; static bone cyst; static bone defect or lingual cortical mandibular defect. In 1942, Stafne described a series of asymptomatic radiolucent lesions located near the mandible. The lesions represent a focal concavity of the cortical bone on the lingual surface of the mandible. Similar lingual cortical defects also have been noted more anteriorly in the mandible. These rare defects have been related to aberrant salivary gland tissue. In addition, one report has implicated the parotid gland as the cause of an apparent cortical defect in the upper mandibular ramus. The classic Stafne defect presents as an asymptomatic radiolucency below the mandibular canal in the posterior mandible, between the molar teeth and the mandibular angle. The lesion is typically well circumscribed with a sclerotic border. Most Stafne defects are unilateral, although bilateral cases may be seen. Posterior Stafne defects are not rare, having been reported in 0.3% of panoramic radiographs. A striking male predilection is observed, with 80% to 90% of all cases seen in men. Although the defect is believed to be developmental in nature, it does not appear to be present from birth. Most cases have been reported in middle aged and old adults, with children rarely affected. Stafne defect typically remain stable in size; hence the name static bone cyst. The diagnosis can usually be made on a clinical basis by the typical radiographic location and lack of symptoms. It can be confirmed by CT scans, MRI or sialography. Biopsy is usually not necessary to establish the diagnosis of Stafne defects of the posterior mandible. If biopsy is performed, normal submandiblar gland tissue is usually seen. However, some defects contain muscle, blood vessels, fat, connective tissue, or lymphoid tissue. Because anterior lingual salivary defects may be difficult to recognize, biopsy may be necessary to rule out other pathologic lesions. No treatment is necessary for patients with Stafne defects of the posterior mandible, and prognosis is excellent. Here we present three cases of Stafne defect.

Quantitative assessment of periimplant bone density (HU) on CBCT image

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Purposes: The primary aims of this retrospective study were to compare subjective bone quality and bone quality based on the Hounsfield scale in different segments of the edentulous jaw and to establish a quantitative and objective assessment of bone quality.

Materials and methods: Twenty eight randomly selected cone-beam computed tomographic (CBCT) scans were used for the analysis. One hundred twelve edentulous areas were selected for evaluation. Implant recipient sites were evaluated visually for Lekholm and Zarb classification. The same sites were subsequently evaluated digitally using the Hounsfield scale with Vimplant2.0^{TM}, and the results were correlated with visual classification. Data was subject to statistical analysis in order to determine any correlation between recorded HU and the regions of the mouth, by using the Kruskal-Wallis test.

Results: The highest unit/mean density value (311 HU) was found in the anterior mandible, followed by 259 HU for the posterior mandible, 216 HU for the anterior maxilla, and 127 HU for the posterior maxilla. These results demonstrate a strong correlation for HU with respect to the 4 regions of the mouth (p<0.001). The relationship between HU and type 4 bone was found to be significant (r=0.74).

Conclusion: Knowledge of the Hounsfield value as a quantitative measurement of bone density can be helpful as a diagnostic tool by using CBMercuRay^{TM} with Vimplant^{TM} software.

Density variability in cone-beam and fan-beam CT scanning of the maxillofacial region: An *in vitro* study

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Purposes: In cone-beam CT (CBCT) scanning of the maxillofacial region, the density values (CT values) are affected by various factors, such as scattered radiation and artifacts caused by beam hardening due to hard tissues situated within or outside the imaging volume. The variability in CT values caused by beam hardening is related to the size of the imaging volume and is apparently observed when a high-density object is scanned with a low-energy X-ray beam which is generally used in CBCT. The aim of this study was to clarify the effect of beam hardening on the density profile of CBCT in comparison with that of fan-beam CT.

Materials and methods: A cylindrical container, which was filled with water or radio-contrast medium at various dilution ratios, was used as the phantom. The CT values of the phantom were approximately 0, 300, 500, and 700 H.U.. A flat panel detector CBCT system (Alphard Vega, Asahi Roentgen, Kyoto, Japan) and a whole-body multi-slice CT scanner (MSCT) (Asteion, Toshiba Medical, Tokyo, Japan) were used. In the MSCT, scanning conditions were set at 80 or 120 kV, 150 mA, and 0.7 seconds/rotation with a 160 mm FOV equivalent to the diameter of the phantom. In the CBCT, the exposure conditions were 80 kV, 8mA, and a 17 second exposure time. The size of the FOV was changed to 5, 10, 15, and 20 cm. The density values of the phantom and their profile were analyzed using acquired images.

Results: In CBCT, CT values of phantoms were not stable and differed from those obtained by MSCT, especially on scanning with higher density objects with small imaging volumes (5 and 10 cm). Even a large imaging volume (15 and 20 cm), the CT values were not stable and the density profile was shown as a concave, downward curve. In the MSCT images obtained with 120 kV, CT values of phantoms were stable at various concentrations of contrast media, while CT value variation could be observed in higher density phantom images obtained with 80 kV X-rays. Even with the same tube voltage (80 kV), CT value variability was greater with CBCT than MSCT.

Conclusion: Beam hardening probably causes increases in CT value variability on CBCT imaging. To resolve this problem, an effective way may be through the application of an of image reconstruction algorithm which can reduce beam hardening and is generally used in MSCT.

Evaluations of trabecular bone density at potential dental implant sites using CT images

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Purposes: The survival rate of the dental implant highly depends on the bone quality. Basically, it is manifested that higher failure rate of implant is more likely in the poorer quality of the host bone. That is to say the good bone quality promotes more complete osseointegration, which leads to higher success rate of dental implant. Therefore, to assess the bone density before implant installation is one of the most important procedures. The purpose of this study was to evaluate the trabecular bone density in the potential dental implant sites by using computer tomography (CT) images.

Materials and methods: A total of 49 potential implant sites (11 anterior sites of maxilla; 13 posterior sites of maxilla; 6 anterior sites of mandible; 19 posterior sites of mandible) in the jaw bone of 22 human (10 men and 12 women) were selected in the China Medical University and Hospital. CT scans were made according to the following instrument and technical parameters: GE LightSpeed (General Electric Corp., Milwaukee, WI), 120 kV, 300~400 mAs, 240 mm field of view, 1.25 mm increments, 512×512 pixels. Bone density (in Hounsfield unit, HU) in the potential dental implant sites was measured with self-developed software (CTtool) in a standardized implant area based on the CT images. Descriptive statistics, between- and within-group comparison and correlation analysis were used for data analysis by the SAS statistical package (SAS Institute, Cary, NC). The *p*-value was set to 0.05 to detect the level of significance.

Results: The results showed that differences in bone density exists for the four regions within the mouth, with the anterior mandible yielding a mean density value of 673 HU (standard deviation, SD = 113 HU) > anterior maxilla, 592 HU (SD = 61.9 HU) > posterior mandible, 366 HU (SD = 127.3 HU) > posterior maxilla, with a mean density value of 285 HU (SD = 102.4 HU). These results provide a strong correlation for bone density with respect to the four regions of the jaw bone.

Conclusion: CT results demonstrated that trabecular bone densities may vary markedly when different areas of a potential implant site are compared. Different bone densities can be found in any of anatomical regions studied, e.g. anterior and posterior sites of maxilla and mandible, which confirms the importance of a site-specific host bone quality evaluation prior to implant placement.

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Is application of quantitative CT method helpful for quantitative measurement of bone density with cone-beam dental CT?

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Purpose: Our previous study showed that the pixel value of a cone-beam dental CT (dental CBCT) was not equal to CT number and that it was significantly affected by field of view and tube voltage. The purpose of the present study was to verify whether application of quantitative CT (QCT) method was helpful for quantitative measurement of bone density with dental CBCT.

Materials and methods: The left mandible of a mouth-opened head phantom Type PTU-1 (Kyoto Kagaku, Kyoto, Japan), a dry skull covered with a special urethane resin, was scanned with a dental CBCT unit CB Throne (Hitachi Medico, Tokyo, Japan) at a tube voltage of 60, 80, 100 and 120 kV. Field of view and tube current were fixed at 10 cmΦ and 15 mA, respectively. As reference materials for QCT, a bone mineral contents phantom Type UCA (Kyoto Kagaku, Kyoto, Japan) was used. This phantom consists of 20 blocks and each block, 10 x 15 x 30 mm3 in size, is composed of urethane resins and $CaCO_3$ at different concentrations. In order to investigate the effect of number of used reference material, 3, 4, or 5 blocks (reference blocks) were selected from the 20 blocks. The reference blocks were affixed to the surface of the lower jaw of the head phantom. Measurements of bone density were performed against another selected block (target block) whose $CaCO_3$ concentration was also known. The target block was set inside the oral cavity of the head phantom. The pixel values of the reference blocks and the target block on the obtained images were measured using an oval region of interest (ROI) 30 pixels in diameter. Pixel values for the reference blocks were used to produce conversion curves. $CaCO_3$ concentration in the target block was calculated using a conversion curve. Each experiment was repeated 3 times and obtained $CaCO_3$ concentrations for the target block were averaged for each experimental condition. Error rates against true concentration were calculated and compared.

Results and Discussions: The conversion curves and pixel values for the target block were markedly affected by tube voltage and number of reference block. Error rates with 3 reference blocks changed from 4.1 to 11.0% according to tube voltage. Rates with 4 and 5 reference blocks were 1.5 - 4.6% and 3.4 - 8.4%, respectively. These error rates seemed too high to allow accurate measurement of bone density. It is obvious that this was due to the reference materials. The reference materials influenced the pixel value of the entire image non-uniformly because images with a dental CBCT are reconstructed from imperfect projection data.

Conclusions: Because usage of reference materials influences the image non-uniformly, it can be concluded that application of the quantitative CT method is not helpful for quantitative measurement of bone density with cone-beam dental CT.

P-14

Unreliability of linear distance measurement with panoramic radiography.

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Purpose: Linear distance measurement with panoramic radiography is theoretically unreliable. Dentists specializing in fields other than oral radiology and general practitioners, however, often measure distance on clinical panoramic radiographs. Moreover, some reports have suggested that distance measurement with panoramic radiography is sufficiently reliable for routine clinical purposes. This situation is a cause of some concerns for oral radiologists. The purpose of this study was to prove the unreliability of distance measurement on clinical panoramic radiographs by comparing them with CT images, on which the most accurate distance measurement is possible.

Materials and methods: Images from patients examined both with panoramic radiography and CT for dental implant treatment planning in the premolar and molar regions of the mandible were used for this study. The panoramic radiographs were obtained digitally with a Fuji Computed Radiography System (Fuji Film, Tokyo, Japan). The vertical linear distance between the alveolar crest and the closest mandibular canal was measured on both images and compared. Measurement on the panoramic radiograph was performed using a DICOM viewer software and measured distance was calibrated using the magnification factor at focal plane. Measurement on the CT image was performed three-dimensionally using a 3-D DICOM viewer software, which enables MPR to be carried out freely.

Results and Discussions: Poor agreement was found between distances measured on panoramic radiographs and CT images. This result indicates that distance measurement with panoramic radiography is not as reliable as that with CT, which is recognized as the most reliable examination for distance measurement. We believe that this unreliability is due to 2 reasons. The first is the magnification factor, which is position-dependent. Structures at sites other than the focal plane are magnified with a deferent magnification factor. The second is the incident angle of x-rays to structures. Because x-rays don't necessarily direct perpendicularly to the straight line used to measure distance, the measured distance becomes shorter than the actual one.

Conclusion: Distance measurement on clinical panoramic radiographs is less reliable than CT images and cannot be recommended.

Validity of the KANT equation for age estimation from lower third molar radiographs

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The KANT equation (The name is an acronym of the Thai authors' first names) has been developed by Verochana and his colleagues in 2005. The equation: $Y = 9.309 + 1.673G + 0.303S$ (Y = age; G = Gat score; S =sex) is used for age estimation from the development of the lower left third molar radiographs. (The Gat score is first established by Gat et al in 1984.)

Purpose: To validate the accuracy of the KANT equation for age estimation from lower third molar radiographs in a group of Thai population.

Materials and methods: Five hundred and thirty nine panoramic radiographs of Thai subjects, 210 male and 329 female, 8.3 to 24.3 years old, were used. The stage of development of lower left and right third molars was assessed from the radiographs using the Gat score. Ages of the samples were calculated from their dates of birth and from the KANT equation. The real ages and those calculated from the KANT equation (KANT age) were analyzed using Pearson correlation and descriptive statistics.

Results: The KANT ages, calculated from the lower left and right third molars, were significantly correlated with the real age (r = 0.818, 0.808 respectively, P≤ 0.01). In the range of error ≤ ± 1 year, the KANT age was proved accurately in approximately 50% of cases. In the range of error ± 2 years, the accuracy was about 76%. The KANT equation had a tendency to predict the age accurately in individuals whose age were ≤ 20 years old.

Conclusions: The KANT equation can be used for age estimation for Thai populations, especially for individuals who were ≤ 20 years old. However, the accuracy of the equation for age estimation in the range of error ± 1 year was about 50% and in the range of error ± 2 years was 76%. The equation may need to be modified to increase accuracy.

A Rare Case of Periosteal Fasciitis Developed in the Temporomandibular Region

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Case

The patient was a 57-year-old female who was referred to the Department of Dentistry, Oral and Maxillofacial Surgery at Jichi Medical University Hospital for with a complaint of swelling of the left preauricular area. No abnormal findings were observed in the panoramic radiogaph. MR images(T1WI) showed a low signal in the left anterior ear canal with a 17×14-mm tumor mass with internal heterogeneity. CT images revealed a 19×17-mm tumor mass adjacent to the masseter muscle in the left anterior ear canal in addition to partial resorption of the mandible. No significant swelling was observed in the cervical lymph node. Adenoid cystic carcinoma, acinar cell carcinoma, and malignant lymphoma were suspected as differential diagnosis. Ultrasound-guided needle biopsy was performed, but it was difficult to make a definitive diagnosis. Partial resection of a deeper layer of the left parotid gland and a partial mandibulectomy were performed in March 2008 under general anesthesia. Histopathological examination revealed the proliferation of spindle cells with microvessels in myxoma in addition to partial lymphocyte infiltration. Immunohistological examination did not reveal any obvious neoplastic change. Histopathological diagnosis was periosteal fasciitis. At present, the patient has no recurrence of the symptoms and is currently being monitored on a follow-up basis.

P-17

A comparison of transcranial with panoramic TMJ radiographs to assess the movement of the mandibular condyle

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Purpose: To evaluate the difference of the movement of the mandibular condyles between transcranial and panoramic TMJ radiographs to view the movement of the mandibular condyles.

Materials and methods: Thirty-four paired transcranial and panoramic TMJ radiographs of patients were used to evaluate the movement of the mandibular condyle. The distances, from the most superior point of the mandibular condyle to the most inferior point of the articular eminence on both radiographs, were measured. The measurements were taken at closed state and maximum opening state of each radiograph on both side. Differences between matched pairs were analysed by paired t-test, with significance established at $P<0.05$.

Results: The mean distance, from the most superior point of the mandibular condyle to the most inferior point of the articular eminence on both radiographs, was statistically different at each side ($P<0.05$). At closing state, the mean distance measured on panoramic TMJ radiographs was longer than on transcranial radiographs (0.85 mm at right side, 1.20 mm at left side). But at maximum opening state, the mean distance on transcranial radiographs was longer (1.00 mm at right side, 0.62 mm at left side) than panoramic TMJ radiographs.

Conclusions: Panoramic TMJ radiographs could used to assess the movement of the mandibluar condyles as like transcanial radiographs.

Key word: Radiography, Panoramic; Temporomandibular Joint; Radiography, Transcranial

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Comparison of mandibular morphology between patients with temporomandibular joint osteoarthritis and asymptomatic normal subjects

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Purposes: The purpose of this study was to compare mandibular morphology between an asymptomatic normal group and patients with temporomandibular osteoarthritis

Materials and methods: The study sample consisted of 39 patients with temporomandibular joint osteoarthritis screened by computed tomography and 44 asymptomatic normal subjects. Panoramic radiographs were taken of all of the subjects. Linear and angular panoramic measurements were taken of the two groups' mandibular characteristics and a t test was used to compare them.

Results: The condylar head, condylar and ramal height of the osteoarthritic joints were significantly shorter than in the control group. Moreover, the gonial angles were significantly larger, and the condylar head showed a more distal inclination in the arthritic group. The unilaterally osteoarthritic patients showed significant differences between the affected and contralateral sides of the condylar head and condylar height and the condylar head angle.

Conclusion: The present study shows that the condylar head and condylar height were shorter, and the condylar head was more distally inclined in osteoarthritic joints.

Osseous abnormalities of the temporomandibular joint: diagnostic reliability of cone beam computed tomography with multidetector computed tomography

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Purposes: We compared the diagnostic reliability of cone beam computed tomography (CBCT) and multidetector computed tomography (MDCT) to detect osseous abnormalities of the temporomandibular joint (TMJ), using macroscopic observations as the 'gold standard'.

Materials and methods: The specimens were TMJ bone shapes in six cadavers which were sliced to a thickness of 2 mm. Image data used about 12 slices from each cadaver and the base data was 75 slices. Seventy- five slices underwent imagery using oblique sagittal CBCT and MDCT. The samples were macroscopically evaluated for osseous abnormalities, including cortical erosion or osteophytosis and sclerosis. The images were independently assessed for abnormalities using the same criteria. Observations with the two imaging modalities were compared with the macroscopic observations using the McNemar test.

Results: The condyle diagnostic accuracy was 0.99 for CBCT and 0.79 for MDCT. The sensitivity was 1.00 for CBCT and 0.75 for MDCT. The specificity was 0.98 for CBCT and 0.80 for MDCT. Significant differences were detected for the condyles between the CBCT and MDCT results. The fossa diagnostic accuracy was 0.96 for CBCT and 0.91 for MDCT. The sensitivity was 0.96 for CBCT and 0.88 for MDCT. The specificity was 0.96 for CBCT and 0.92 for MDCT. No significant differences were detected for the fossa between the CBCT and MDCT results.

Conclusion: The results show that CBCT is more useful for the assessment of bone structures in temporomandibular joint than MDCT. CBCT enables the observance of more details that help in diagnosis.

CT appearance of temporomandibular joint in patients with habitual luxation

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Purposes: Habitual luxation generally means that mandibular condyle repeatedly dislocate from its normal range as the difficulty of self-reduction. The morphology of articular eminence, or articular fossa, is thought a factor of the occurrence, and is seemed to be important for the planning of eminoplasty. However, radiological study regarding to the morphology was very few. This study examined the relationship between the morphology of articular fossa including the articular eminence, which was evaluated by reconstructed CT images, and the occurrence of habitual luxation.

Materials and methods: A case-control study was designed. The case group consisted of 10 patients (2 males, 8 females, mean age; 49 years old). All patients complained of habitual luxation and were treated between 2004 and 2008. "Habitual" was defined as a history of luxation at least two or more. Three patients complained a luxation during the mid phase to end phase of mouth closing. Patients with a history of mandibular tumors, inflammation, trauma or sagittal split ramus osteotomy (SSRO) were excluded from analysis. An age-matched control group was constituted of 19 patients (3 males, 16 females, mean age; 42 years old) with healthy temporomandibular joint (TMJ) confirmed by clinical history, MRI and CT. CT examination was performed by multi-slice CT scanner. On a CRT monitor, horizontal and vertical linear distances were measured between the deepest point of the fossa and the lowest point of the articular eminence on reconstructed sagittal CT image, and between the deepest point of the fossa and the lowest point of the temporal bone on reconstructed coronal CT image, respectively. Four measurements were obtained for each TMJ. Mann-Whitney U-test and cluster analysis were also performed. A significant difference was defined as a p-value less than 0.05.

Results: The case group showed characteristic morphology of the articular fossa. Significant differences between two groups were detected only for vertical linear distances between the deepest point of the fossa and the lowest of the articular eminence on reconstructed sagittal CT image (p<0.01). The linear distances of the cases were larger than those of controls. The case group was divided into three groups as follow, 1) normal morphology of the articular fossa, 2) developed morphology of articular eminence, and 3) wrapping morphology of the temporal bone to the mandibular condyle.

Conclusion: These findings suggested that the morphology of the articular fossa, in particular the downward development of the articular eminence and the lateral development of the temporal bone might be factors promoting habitual luxation. Detailed evaluation of articular fossa morphology on reconstructed CT images would be important for diagnosis and for planning surgical treatments in patients with habitual luxation.

Diagnostic accuracy of micro-computed tomography for osseous abnormalities in the rat temporomandibular joint condyle

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Purposes: To investigate the diagnostic accuracy of *in vivo* micro-computed tomography (micro-CT) for osseous abnormalities of the rat temporomandibular joint (TMJ) condyle, using macroscopic observations as the 'gold standard'.

Materials and methods: A 30 TMJ arthritis model was prepared by injecting inflammatory complete Freund's adjuvant (CFA) into one side of the TMJ cavities of rats. The TMJ condyles were then imaged using micro-CT (R_mCT, Rigaku, Tokyo, Japan). The samples were macroscopically evaluated for osseous abnormalities, including erosions, osteophytes, flattening, and concavity. The micro-CT images were independently assessed for abnormalities using the same criteria. Image in three planes were produced using the Micro-XYZ technique with the micro-CT equipment. The performance of the micro-CT equipment was investigated for rat condyles.

Results: According to the macroscopic observations, 26 of the 60 rat condyles showed osseous abnormalities. The Micro-XYZ images detected abnormalities in 25 of the condyles. The condyle diagnostic accuracy of micro-CT was 0.98, the sensitivity was 0.96, and the specificity was 1.0.

Conclusions: Good diagnostic results were obtained using micro-CT. It is therefore an effective technique for the evaluation of osseous abnormalities in the rat TMJ condyle.

Accuracy rate of clinical diagnosis of disc displacement without reduction using MRI

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Introduction & aim: Internal derangement (ID) of TMJ is accepted after muscle disorders as the most common type of temporomandibular disorders and includes: all disorders related to incoordination and dislocation of disc and condyle. Anterior disc displacement without reduction or closed lock will happen if the disc or condyle displace severely or if the disc traps in the space in front of the condyle accompanied with reduction in maximum mouth Opening. The purpose of this study was to test the reliability of the clinical diagnosis of disc displacement without reduction (closed lock) as compared with magnetic resonance imaging "Gold standard" .

Method and material: The cross sectional study comprised 10 patients reffered to Dental school of Mashhad university with the symptoms of ID, who were assigned a clinical diagnosis of disc displacement without reduction.Sagital and coronal MR images were obtained with 0.5 Tesla magnetic resonance system, with the jaw in closed and maximom opening position subsequently to establish. the corresponding diagnosis of disc-condyle relationship.The data analysis included kappa statistic and calculation of predictive value, sensitivity.

Results: Over all diagnostic agreement for disc displacement without reduction was 0.22 with a corresponding kappa value. The predictive value for clinical diagnosis of disc displacement without reduction was 20% , the sensitivity Was 100% .

Conclusion: The result suggest clinical diagnostic criteria for disc displacement without reduction to be insufficient reliable. Patients assigned clinical TMJ-related diagnosis of disc displacement without redaction may need to be supplemented by evidence from MRI to determine the functional disc – condyle relationship

Key word: MRI,TMJ, Anterior disc displacement without reduction, Clinical diagnosis

Quantification of Temporomandibular Joint Disk Displacement Using MR Imaging

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Purposes: To develop a quantifying measure of the temporomandibular joint (TMJ) disk position on magnetic resonance images and to assess the position of TMJ disk.

Materials and methods: The MR images of 150 TMJs in 20 healthy TMJ volunteers and 55 patients with TMJ disorders were evaluated. The parasagittal slice of TMJ both closed and opened mouth were analyzed. Anatomical landmarks of TMJ including anterior and posterior edge of TMJ disk were defined. The line from the lowest point of articular eminence to the point of posterior glenoid tubercle was used as the reference line and was mapped on XY-axis dimensions for individual anatomical compensation. To compensate for the different magnification of each MR image and for individual variation of the condyle and fossa size, the Magnification Index and the Joint space Index were calculated. All these points were defined and measured the distance by using the Area Manager Professional Lite Program version 1.0, 2005.

Results: There was a significant difference in the posterior position of TMJ disk between volunteer joints and symptomatic anterior disk displacement with reduction (ADDR) joints in closed mouth position. Between volunteer joints and symptomatic anterior disk displacement without reduction (ADD) joints, both anterior and posterior position of symptomatic ADD joints were found to be positioned anteroinferiorly in closed mouth position. Moreover, both anterior and posterior positions of disk were also different between symptomatic ADD and symptomatic ADDR in closed mouth position. There was a significant difference in posterior position of TMJ disk in opened mouth position between volunteer joints and symptomatic ADDR joints, and also significant difference was found between volunteer joints and symptomatic ADD joints. For the condylar position, the significant difference was found between volunteer joints and symptomatic ADDR joints, and also between volunteer joints and symptomatic ADD joints in only opened mouth position. However, the significant difference of anterior and posterior positions of TMJ disk, and condylar position between symptomatic and asymptomatic ADDR joints were not shown in both closed and open position, and not shown between symptomatic and asymptomatic ADD joints as well.

Conclusion: We proposed that our new quantification measure system would favorably represent TMJ disc positions. In this preliminary study, the quantification analysis revealed that there was no difference in disc position between symptomatic and symptomatic joints of ADDR and ADD, respectively. Disk positions can be quantified by this new quantification analysis in clinical TMJ studies.

Study of relationship between lymphadenopathy and joint effusion in temporomandibular disorders

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Purposes: Joint effusion in patient with temporomandibular disorders, it is studied with relationship to various phenomena such as joint pain, disk displacement, and marrow signal abnormality. However, there is no report concerning the relationship between joint effusion and lymphadenopathy in the head and neck region. The purpose of this study was to examine the relationship between cervical lymphadenopathy and occurrence of joint effusion in patients with temporomandibular disorders.

Materials and methods: The subjects of this study were 133 patients (37 male, 96 female; age range 7-77 years, mean age 28.9 years) who underwent STIR axial MR imaging for suspected temporomandibular disorders in the Nihon University School of Dentistry Dental Hospital at Matsudo from August 1, 2002 to June 20, 2003. MR imaging was performed with a 0.5 Tesla superconductive MR unit (TOSHIBA FLEXART; Tokyo, Japan) with a TMJ surface coil and a neck coil. The imaging protocol included SE proton-density-weighted and T2-weighted sagittal scans and STIR axial scans. Joint effusion was evaluated by the grading system with classification of categories of "minimal fluid", "moderate fluid", "marked fluid" and "extensive fluid" on SE T2-weighted sagittal images. On STIR axial images, the number of cervical lymph nodes and their short axis diameter were observed on a workstation. The results about lymph nodes were classified into a "no fluid" and "minimal fluid or greater" groups and they were studied comparatively at a significance level of $p<0.01$ with regard to the number of observed lymph nodes and mean short axis diameter of them. Using fluid classification as the criterion variable and the number and lymph node short axis diameter as explanatory variables, we calculated correlation coefficients at the significance level of $p<0.01$. These analyses were therefore performed in two groups divided by age: age 30 years and below and age 31 years and above.

Results: In the age 30 and younger group, there were no significant differences between "no fluid" and "minimal fluid or greater" groups for all lymph nodes. In the age 31 and older group, significant differences were observed for number and short axis diameter of spinal accessory nodes and for occurrence of Rouviere's lymph nodes. The "minimal fluid or greater" group demonstrated significantly more spinal accessory nodes and Rouviere's lymph nodes versus the "no fluid" group. In the age 30 and younger group, there was a slight significant correlation with the number of spinal accessory nodes. In the age 31 and older group, there was a slight significant correlation with the number and short axis diameter of spinal accessory nodes and the occurrence of Rouviere's lymph nodes. As TMJ fluid classification increased, occurrence of spinal accessory nodes and Rouviere's lymph nodes on images increased.

Conclusion: It is suggested that occurrence of joint effusion in patients with temporomandibular disorders promote the incidence of spinal accessory nodes and Rouviere's lymph nodes.

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Observations of the Incisive Canal and the Surrounding Bone with Cone Beam Computed Tomography image

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Purposes: Implant surgery in the anterior maxilla is often challenging because the functional, aesthetic and phonetic demands are not easily appreciated due to the possible anatomical limitations. Following loss of the incisors, absorption of the alveolar bone represents one of the major anatomical limitations mentioned above, in addition to the location of the incisive canal at the palatal zone of the incisor region.It is necessary to recognize the three-dimensional (3-D) form and its position relative to the surrounding structures, the architecture of the alveolar bone surrounding the incisive canal and changes in the morphology of the incisor-related alveolar can be performed. Using sets of edentulous and dentate patients from the general American population, the present study was designed to assess the morphology of the incisive canal and surrounding bone using CBCT imaging.
Materials and methods: One hundred twenty-two patients' data were adopted in this study. They were divided into two categories: the dentate group and the edentulous group. The median palatine suture and the anterior nasal spine (ANS) were recognized as points of reference and the palatal plane was recognized as reference plane, and then the sagittal images in the midline were acquired. The coronal image was formed by the plane along the course of the canal. With the ten measuring points from sagittal image and the four measuring points from coronal image, located around the incisive canal and the surrounding bone, changes of positions were measured and analyzed.
Results: The bone quantity of alveolar bone in the incisor region was greatly reduced from the alveolar ridge and labial surface in the edentulous group. It was confirmed that there was also influence on the bone posterior to the incisive canal because a vertical position of the incisive foramen had been superior in the edentulous group. The angle of the incisive canal was significant difference between the edentulous group and the dentate group.
Conclusions: Cawood et al. reported that basal bone does not change its shape significantly, whereas the alveolar bone changes its shape significantly in both the horizontal and vertical axes and bone loss of anterior maxilla is vertical and horizontal (from the labial aspect). In this study, their results were reconfirmed. Moreover, it was confirmed that the palate around and especially posterior to the incisive foramen showed resorption. The horizontal bone reduction from the labial side, and the vertical bone reduction from the alveolar crest were conspicuous, therefore the angle of the anterior alveolar bone changes after the loss of teeth. The nondestructive assessment of the incisive canals and surrounding bone with a high resolution CBCT demonstrated two typical shapes for the presence or absence of the incisors. These findings illustrate the importance of radiographic imaging evaluation before implant surgery.

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A study to identify the location of mental foramen in a selected Bangladeshi population by panoramic radiograph.

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Purpose: Knowledge of the position of the mental foramen is important both for administering regional anaesthesia and as well as performing surgical procedures in the mental region of the mandible. The aim of this study is to determine the most common position, shape and appearance of the mental foramen in a selected Bangladeshi population and to compare the results with those reported for other populations.
Materials and methods: One hundred and forty three (143) panoramic radiographs of Bangladeshi patients were selected from the records of dental patients attending a dental clinic in Dhaka. To avoid any radiological confusion of the exact localization of mental region, radiographs with mixed dentition, missing teeth between lower right first molar and lower left first molar, any radiolucent or radio opaque lesion in the lower arch were excluded. Radiographs were analyzed according to patient's age, gender, and also on the basis of the anterior-posterior and superior-inferior position mental foramina, including its shape, appearance and symmetry.
Results: There were 143 cases (286 sides) with a female-to-male ratio of 1:1.55 and mean age of 37.80 years. The most frequent anterior-posterior position was in line with the longitudinal axis of the mandibular second premolar (49.5%) followed by a location between the mandibular first and second premolars (33.6%). The anterior-posterior position was symmetrical in 62.9% cases. The majority of foramina were irregular in shape, and the most frequent appearance was continuous type. Accessory mental foramina were seen in 17.5% of the cases.
Conclusion: The position of mental foramen on panoramic radiographs in this selected group of Bangladeshi population is most commonly below and in line with longitudinal axes of the mandibular second premolar teeth and the most frequent appearance was continuous type.

Appearance of lingual foramina in the canine/premolar region of the mandible with CBCT images

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Purposes: Surgical complications can arise during implant installation when the mandibular lingual cortex of the interforaminal region is perforated, resulting in a severe hemorrhage in the floor of the mouth. The present study was performed to investigate the variations of the lingual foramina (LF) and its bony canals in the canine/premolar region of the mandible (LLF: lateral lingual foramina), using cone beam CT (CBCT) images.

Materials and methods: Sixty-six dry Japanese mandibles were used in this study. The age and gender distributions of the mandibles were unknown. CBCT images (voxel size 0.1 mm) of canine/premolar region were acquired. The menton (Me) and gonions (Go) of the dry mandibles were placed parallel to the floor and the plane was regarded as the standard mandibular plane. The followings were studied: 1) The frequency of LLFs; 2) The distance between the midpoint of the foramina and the mandibular plane; 3) The vertical and horizontal angulation of the lateral lingual canal (LLC). Additionally, to identify the vessels, six cadaver mandibles were dissected.

Results: At least one LF was observed in 46 (69.7 %) mandibles; 22 (33.3 %) unilaterally, and 24 (36.4 %) bilaterally. Total number of LLFs was 85. The average height of LLF from the mandibular plane was 3.8 mm (SD 1.6 mm), and 9.9 mm inferior from the mental foramen. The mean vertical angle of the bony canal from the inferior mandibular plane was 28.9 degrees, and mean horizontal angle from the tangential surface of the cortex was 21.9 degrees. Symmetrical LFs were recognized in twelve mandibles. Four of six cadaver mandibles represented LLF; two had LLF bilaterally. In all LLFs, the submental arteries diverging from facial arteries were identified.

Conclusions: Although the LF around the median region of the mandible is widely recognized, the LFs in the canine/premolar region are not well known. In this study, LLFs were observed frequently in about 2/3 of all mandibles. Also, it was revealed that the submental artery ran through the LLF in the cadaver study. The LLC runs slightly upward on the inside of the mandible. The anastomosis of the LLC and the incisive blanch of mandibular canal was suggested. It is thought that the possible injury of the vessels and the consecutive complication during implant surgery could be reduced by recognizing LF in the canine/premolar region of the mandible in the preoperative radiographs. It seems that the recognition of LLFs is critical for implant surgery for interforaminal region.

Bifid mandibular canals: cone-beam CT evaluation

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Purposes: For surgical procedures involving the posterior mandible, it is important to be familiar with the incidence and configurations of the bifid mandibular canal. In particular, at the time of third molar extraction, complications including traumatic neuroma and paraesthesia, and unexpected bleeding may occur due to the damage to the accessory canal. There have been many systematic studies evaluating the bifid mandibular canal, all of which were based on panoramic images. To our knowledge, however, sectional imaging such as CT or cone-beam CT has not been used for this purpose. Against this background, this study evaluated the incidence and configurations of the bifid mandibular canal using cone-beam CT.

Materials and methods: Two hundred and fifty-two patients (301 sides of the mandible) who consulted our Dental Hospital for extraction of impacted mandibular third molars underwent cone-beam CT between October 2004 and September 2005 and were included in this study. Two oral radiologists evaluated the cone-beam CT images for the presence and configuration of the bifid mandibular canal. The patterns of bifurcation were classified into 4 types according to the classification by Nortje et al (Br J Oral Surg. 1977;15:55-63) as follows: Type I: Two canals originating from one foramen. Type II: A short supplemental upper canal extending to the second molar or third molar teeth. Type III: Two mandibular canals of equal dimension apparently arising from separate foramina in the mandibular ramus and joining together to form one canal in the molar region. Type IV: The supplemental canals arose in the retromolar pad region and joined with the main canals in the retromolar areas. The diameter of the accessory canal was classified into two: 1/2 or more and less than 1/2 of the diameter of the main mandibular canal.

Results: Of the 301 subjects, 47 (15.6%) demonstrated a bifid mandibular canal. They were Type I in 2, Type II in 40, Type III in 0, and Type IV in 5 cases. The incidence in our study (15.6%) was markedly higher than that in the previous reports using panoramic images. The diameter of the accessory canal was 1/2 or more of that of the main canal in 23, and less than 1/2 in 24 cases.

Conclusion: A bifid mandibular canal was found in 15.6% of the cases, and most were classified as Type II. Cone-beam CT could clearly demonstrate the bifid mandibular canal and was considered useful for evaluating the risk of damage to not only the main canal but also the accessory canal at the time of mandibular third molar extraction.

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Development and evaluation of 3D mandible shape model for Korean adults with normal occlusion

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Purposes: A three-dimensional(3D) statistical shape model of the mandible was developed using principal component analysis(PCA). It can be used as a template for individual treatment planning. To evaluate the developed mandible model, comparison between cephalometric parameters measured from the model and previous studies was performed.

Materials and methods: The subjects consisted of 23 males (mean age, 24.7 years) and 23 females(mean age, 26.0 years). The CT images of them were acquired from Seoul National University Dental Hospital. The two-dimensional DICOM images were input onto a PC and the mandible bone was segmented manually. After completing segmentation, the 3D surface model of each individual was reconstructed using a developed program. Then, to establish correspondence between different individual surfaces, the patch decomposition of the whole surface was performed and the parameterization of them was followed. After these procedures, the principal component analysis on this set of vectors yielded an averaged shape vector of all representatives contained in the training set. The averaged shape vector provided a statistical 3D shape model of the mandible. The 23 cephalometric parameters from the model and previous studies were compared, which were measured by two observers.

Results: The male an female 3D statistical shape models were created from 23 individual mandibles respectively. The measurements were greater in male than female except gonial angle.

Conclusion for Scientific Posters: Male and female 3D statistical shape models were created from each of individual mandible shapes. This 3D statistical shape model can be used in reconstruction of missing or malformed mandible structures. It can be also used as an initial template in 3D automatic segmentation.

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Usefulness of CT scan images for planning the bone cut for Intra-oral Vertical Ramus Osteotomy

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Purposes: To evaluate the usefulness of CT scan images for planning the bone cut of Intra-oral Vertical Ramus Osteotomy (IVRO).

Materials and methods: Five dried adult human cranium specimens that included the mandibles were prepared and panoramic radiographs and CT scan images of the mandibles were obtained. The length from the mandibular foramen to the posterior edge of the mandible was determined based on the panoramic radiographs, CT scan images, and actual measurement. The lengths obtained using the two imaging modalities were computed to the actual measured length. The differences between the true length and the lengths obtained using the CT scan images and the panoramic radiographs were analyzed statistically. In six patients with prognathism in whom IVRO was done based on preoperative panoramic radiographs only and in two patients with prognathism in whom IVRO was done based on preoperative CT scan images, the precision of the bone cut was evaluated using postoperative panoramic radiographs.

Results: In vitro, the difference between the length from the mandibular foramen to the posterior edge of the mandible measured on CT scan images and the actual measured length was significantly less than the difference between the length determined using panoramic radiographs and the actual measured length ($p < 0.0001$). In addition, no case had the CT length longer than the actual length, while all of the lengths determined using the panoramic radiographs were overestimated. In two patients, the safety margin (the length from the mandibular foramen to the bone cut) chosen based on CT scan images was shorter than the safety margin determined using panoramic radiographs only.

Conclusion: The present results show that CT scan images are clearly useful when planning IVRO to prevent an incorrect bone cut. Prior to IVRO, the length from the mandibular foramen to the posterior edge of the mandible should be evaluated using CT scan, in addition to panoramic radiographs.

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Evaluation of Secondary Bone Grafting for Alveolar Cleft Using CT

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Purposes: Secondary bone grafting into alveolar cleft plays an important role in the dental rehabilitation of patients with cleft lip, alveolus and/or palate. The objectives of bone grafting are to stabilize the upper dental arch, to give a bony support for the teeth, to support the lip and the nose, and to close the residual oronasal fistula. To keep the quality, i.e., the density, of bone bridge is important for orthodontic treatment and dental implants, along with managing the volume of bone bridge. The purpose of this study is to evaluate the qualitative changes of secondary grafted bone into alveolar cleft, using computed tomography (CT) images.

Materials and methods: Forty two patients with unilateral cleft lip and alveolus (UCLA) and 51 patients with unilateral cleft lip and palate (UCLP) were included in this study. Secondary bone grafting for alveolar cleft, using autogenous particulate cancellous bone and marrow of the iliac bone, were performed at Tohoku University Hospital between January 1998 and December 2005. Axial CT scans were taken 1 month and 6-8 months postoperatively. CT attenuation of grafted bone or bone bridge was measured with Hounsfield units on DICOM formatted images with the image analysis software Image J 1.40. The region of interest (ROI) was set as polygon area on each CT image from alveolar ridge to nasal floor and the mean of CT attenuation of grafted bone or inside bone bridge was calculated.

Results: Grafted bone 1 month postoperatively, which represented bone particle on CT, matured to bone bridge with cortical bone and trabecular structures at 6 month postoperatively. CT attenuation inside bone bridge was significantly low compared with grafted bone 1 month postoperatively both at patients with UCLA and UCLP.

Conclusion: CT attenuation of grafted bone inside decreased with maturation into bone bridge. Evaluation of bone bridge on CT is useful for orthodontic treatment and implants in patients with cleft lip, alveolus and/or palate.

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A genetic mode of regulation for the growth correlation of mandible and craniomaxilla in mice

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Background and Objective: A growth correlation of mandible and craniomaxilla is essential for the inheritance of morphology, behavior, and cranial function of a species. Previous genetic studies performed using laboratory mice have shown that the genetic background of mice influences the morphogenesis of mandible and maxilla. In these studies, complex quantitative trait loci (QTL) have been identified for the strain-specific variation of mandibular and maxillary shape in chromosomes 10 and 11 (Dohmoto *et al.*, 2002), and 12 (Oh *et al.*, 2007), respectively. However, although these studies provided genetic evidence for morphological regulation of the individual bone, little is known about the regulation of growth correlation between mandible and craniomaxilla. The aim of this study is to demonstrate a genetic mode of regulation for the growth correlation of mandible and craniomaxilla by using a murine genetic model.

Methods: To identify a genetic link of the morphological correlation of mandible and craniomaxilla, we analyzed genetically varied intercross F2 mice, which were generated from two different strains of mice, MRL/Mp.Fas^{lpr}-rpl/rpl (MRL/rpl) and C3H/HeJ.Fas^{lpr} (C3H/lpr). Morphological assessments for mandible and craniomaxilla were performed at 20 weeks of age using a new method, measurement indexes by which reflect the growth correlation of mandible and craniomaxilla. Briefly, width and length of mandibular and craniomaxilla were determined by a slide caliper for formalin-fixed, ethanol-dehydrated cranial specimen. A genome-wide genetic analysis for the morphological indexes of mandible and craniomaxilla obtained from 247 F_2 intercross mice was performed using WinQTL software with 96 microsatellite markers.

Results: The indexes of mandibular width represented marked, significant difference between male and female. However, the sex difference was not detected for the other indexes, mandibular length, maxillary width, and maxillary length. The morphological variation of maxillo-mandibular region (MMR), which was assessed by the ratio of the widths of madibule and maxillar bones, was observed in a strain-specific fashion, and among the F2 mice. Genome-wide screening by the QTL analysis showed significant linkages to several loci located in the vicinity of *D1Mit46* on chromosome (chr) 1, *D10Mit164* on chr 10, and *D11Mit263* on chr 11. The morphological variation of the MMR was largely dependent on the variation of mandibular width.

Conclusion: The murine genetic model indicates for the first time that the morphology of MMR is controlled under the polygenic mode of inheritance. Furthermore, our findings suggest that the genetic regulation largely reflect madibular morphogenesis. It may be interesting that either of IGFBP2 or 5 is a positional candidate for a genetic factor that affects the morphology of MMR.

A quantitative analysis of sonographic images of the salivary gland: A comparison between the sonographic findings and the sialographic findings

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Purposes: First, we evaluated whether the indices obtained by the quantitative analyses were useful for the differential diagnosis of the salivary glands affected with Sjögren's syndrome (SS). Next, we sought to determine which of these indices were most predictive of the salivary gland affected by SS, using a logistic regression analysis.

Materials and methods: Our study included 192 patients suspected of having SS. In 89 out of 192 patients, the sialography demonstrated abnormal findings $\geq$ Stage I (diffuse punctate shadows of less than 1 mm). Sonography was performed using a Sequoia 512 (Acuson, Mountain View, CA), using a linear transducer (15L8W). We performed 3 types of quantitative analyses (particle analysis, fBM model analysis, 2D-fractal analysis) on the US images. By a particle analysis of the binary image, we intended to detect the hypoechoic areas and the echogenic lines, which are characteristic findings for SS, and calculated two representative indices (ave-area, area ratio). By the fBM model analysis, we evaluated the complexity of the 2-dimensional distribution of the pixel values, therefore, we calculated the Hurst indices of the original image and the background subtracted images (Hurst-ori, Hurst-bs). By a 2D-fractal analysis, we evaluated the complexity of the boundary lines of the binary image, therefore, we calculated the fractal dimension (2D-FD). We entered these indices into a logistic regression analysis and evaluated which indices were useful predictors for detecting an abnormal sialographic stage. Moreover, we calculated the sensitivity, specificity, and accuracy of the determination of the abnormal sialographic stage with a probability obtained by a logistic regression analysis > 0.5.

Results: There were significant differences in all 5 indices of the Parotid gland (PG) between the normal gland and the abnormal gland. As the Rubin-Holt stage became more severe, both the Hurst-ori and 2D-FD became smaller. On the other hand, the Hurst-bs, ave-area, and area ratio became higher (Tukey-Kramer's HSD test). There were significant differences in 4 indices (ave-area, area ratio, Hurst-bs, 2D-FD) of the submandibular gland (SMG) between the normal gland and the abnormal gland. There was not a significant difference in the Hurst-ori between any stages. By logistic regression analyses, out of 5 indices of the PG, two indices obtained by the particle analysis (ave-area$_{PG}$, area ratio$_{PG}$) and the index obtained by the fBM model analysis (Hurst-ori$_{PG}$) were selected as useful predictors. 4 indices (ave-area$_{PG}$, area ratio$_{PG}$, Hurst-ori$_{PG}$, Hurst-bs$_{SMG}$) out of 10 indices of both PG and SMG were finally selected. The sensitivity, specificity, accuracy and Az value obtained by indices of the PG were 0.76, 0.87, 0.82 and 0.87, respectively. Those obtained by indices of both the PG and the SMG were 0.76, 0.89, 0.83 and 0.88, respectively, and those were closely similar to those by the indices of PG alone.

Conclusion: The US images strongly correlated with the sialographic stage and the quantitative analysis system has the possibility of clinical application for the detection of the abnormal sialographic findings.

Attempt for estimating parameters in the orofacial region by dynamic contrast-enhanced T1-weighted MRI

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Purposes: The objective of our study was to analyse the dynamic contrast-enhanced MRI using a pharmacokinetic model.
The first step was to make the accurate pre-contrast $T1_0$ map within an acceptable scan duration. Therefore, the first purpose was to validate the fast acquisition by Look-Locker (LL) sequence for the T1 map in vitro and in vivo.
The second step was to obtain T1 map during the dynamic sequence, based on the ratio of the signal intensities (SIs) during the dynamic study to those acquired before the contrast medium (CM) injection. Therefore, the second purpose was to calculate the concentration of CM obtained by the pre- $T1_0$ map and the change of the SIs during the dynamic scan and to estimate the kinetic parameters.

Materials and methods: 1. Validation of the fast acquisition by Look-Locker (LL) sequence (In vitro and In vivo). The LL method employs multiple radiofrequency pulses during the magnetization recovery to sample several time points and thereby track the recovery of magnetization. T_1 values by the LL sequence were compared with those by the Inversion Recovery (IR) sequence. In an *in vitro* study, we evaluated the T_1 maps of CM (Gd-DTPA-BMA) at different concentrations. In an *in vivo* study, we evaluated the T_1 maps of seven volunteers. **2.** Calculation of the concentration of the CM and the estimation of the kinetic parameters. The concentration of CM is calculated from the changes in T1 relaxation rate from the precontrast value, $T1_0$: $C = (1/T1 - 1/T1_0)/R1$ (1) Where the R1 is the longitudinal relaxivity of the CM. We calculated the concentration of CM during the dynamic study using equation (1). We applied the Toft and Kermode (TK) model and estimated the kinetic parameters such as the volume transfer constant K^{trans} (min^{-1}), the volume of etxravascular extracellular space per unit volume of the tissue (v_e) and so on. We performed the kinetic analyses in nine patients.

Results: 1.1 The T_1 measurements by the LL sequence were accurate (<7% error) for T_1 s between 200 ms and 1500 ms. For the slow-relaxing compartment (T_1>1500ms), the difference in the percentage between the T_1 values obtained by the IR-FSE sequence and those by LL sequence becomes larger. **1.2** In vivo study, there was a close correspondence between the *in vivo* T_1 measurements made with the LL sequences and those with IR-FSE sequence, therefore, the LL sequence was thus considered to be clinically useful for producing the T_1 map for soft tissue. **2** Using the LL sequence for pre-contrast T1 map and the dynamic sequence, we could obtain K^{trans}map and v_e map in the orofacial region. K^{trans}map and v_e were characteristic for the tissues and these were significantly higher in tumor than in normal tissues.

Conclusion: We validated the LL sequence for T1 mapping in orofacial region. Using LL sequence and dynamic sequence, we could estimate the kinetic parameters by TK model.

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Evaluation of blood flows in the sublingual gland by power Doppler imaging

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Purposes: The purpose of this study was to clarify the features on the ultrasonographic image of the sublingual gland, depiction characteristics of lingual artery, the relationship between the salivary secretion after acid stimulation and the change of blood flow of the sublingual artery as a indicator of the activity of the sublingual gland for the healthy individuals, and the value of intraoral ultrasonography.

Materials and methods: The objects of this study were 20 sublingual glands of 10 male normal volunteers without any symptoms and the age ranged from 23 to 50 years old (Mean age was 36.1 years old). Intraoral ultrasonographic examinations were performed with a SSD-1700 (Aloka Co., Tokyo, Japan) equipped with convex scanning type small probe UST-995T-7.5. The blood flow around the sublingual gland was imaged by power Doppler method. The visualization of the sublingual artery, by which the sublingual gland is mainly nourished, were estimated. Furthermore, the maximum velocity, minimum velocity, average velocity and blood vessel resistance (Pulsatility Index, Resistance Index) were examined before and after citric acid stimulation, and analyzed the relationship between the salivary secretion after citric acid stimulation and the change of blood flow of the sublingual artery.

Results: All sublingual glands were visualized by intraoral ultrasonography of with the small probe. The average of the size of the sublingual gland was as follows: the antero-posterior diameter was 23.08±2.09mm, and the superior-inferior diameter was 9.81±2.33 mm. There was no laterality in size. The moderate correlation of right glands and left ones was observed in superior-inferior diameter (r=0.77). Regarding the ultrasonographic features of the sublingual gland, the shape was regular in 50%, the border was rough in 55%, the internal echo level was low in 100%, and the posterior echo was enhanced in 75%. The visualization of the artery was excellent in 85%. Concerning the blood flow change after the acid stimulation, the means of maximum velocities, minimum velocities and average velocities increased, and in contrast, pulsatility index and resistance index decreased. The correlation was not accepted between the change of salivary secretion before and after the acid stimulation and the change of blood flow of the sublingual artery.

Conclusion: Intraoral ultrasonography with the small probe enabled to evaluate the characteristic of the ultrasonographic image of the sublingual gland, depiction characteristics of sublingual artery, and therefore intraoral ultrasonography was valuable for the estimation of the sublingual gland.

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Evaluation of Normal Masseter Muscles on Ultrasonography

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Purposes: To test whether if ultrasonography could be used as a diagnostic criteria for evaluating masseter muscle by assessing internal echo intensity and morphological variability of masseter muscle using ultrasonography.

Materials and methods: 50 young participants (25 male and 25 female) who had full dentition without any pathologic condition were chosen. Sonographic examinations were done with real time ultrasound equipment on 3 locations, all running parallel to the reference line of ala-tragus line. On each location, the thickness and the area of the masseter muscle were measured at rest and maximum contraction. Then, masseter muscle was divided into 4 types based on its visibility and width of the internal echogenic intensity. All data were statistically analyzed by paired t-test and χ^2 test.

Results: 1. There were significant statistical differences between the left and right greatest thickness of the masseter within the female group($p<0.05$). 2. Comparing between genders, there were significant differences in left greatest thickness of masseter muscle. 3. The part with least masseter muscle thickness at rest, have shown greater change in thickness at maximum contraction. 4. Depending on locations, the internal echogenic intensity of the masseter muscle were different. However, it was not significant statistically.

Conclusion: Study result carefully suggests ultrasonography as a helpful diagnostic criteria for pathophysiologic and anatomic evaluation of masseter muscle, because it was successful in showing the changes of muscles thickness with contraction and the internal echogenic intensity with locations within the masseter muscles.

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Computer-based Kinetic Analysis of Retropharyngeal Wall in Head and Neck Cancer Patients during Swallowing

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Purposes: We performed a computer-based kinetic analysis of retropharyngeal wall using video-fluorography (VF) in head and neck cancer patients before and after surgery.

Materials and methods: We performed VF tests (using samples with contrast medium) before and after surgery on 14 head and neck cancer patients who underwent the surgical treatment. On each frame of VF profiles stored in a computer, we plotted the points representing the front side of the second, third, and fourth cervical vertebrae and the retropharyngeal wall points just in front of them using two-dimensional video measurement software. Thereafter, we measured the thickness of the retropharyngeal wall for each frame and determine the time when the thickness was greatest at each point. For the evaluation of dysphagia level, we quantified the remaining contrast media in the epiglottic vallecula or the piriform fossa and the aspiration amount based on the VF images.

Results: Prior to surgery, all patients showed a "normal pattern" where the thickest point in the retropharyngeal wall was initially observed at the second vertebra and moved sequentially from the second to the fourth vertebra. After surgery, however, several patients showed an "abnormal pattern" where irregular movements of the retropharyngeal wall were observed. Comparing the dysphagia scores after surgery between two groups, there was a significant difference. While the scores of the normal pattern group were low, the scores of the abnormal pattern group were high.

Conclusion: Computational analysis of the VF videos enabled us to evaluate the motions of the retropharyngeal wall along the time axis. A change in the kinetic pattern of the retropharyngeal wall cause by surgery can substantially be related to dysphagia.

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A case of mandibular ossifying fibroma showed an increased FDG uptake in the FDG-PET/CT

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Purpose: Ossifying fibroma (OF) of jaws is usually found in the third to fifth decade of life. OF is sometimes detected in the second decade and the juvenile form primarily occurs in the maxilla. The treatment of OF is usually curettage, however, OF has high recurrence rate when removed incompletely, suggesting a necessary of radiographic follow-up. In diagnostic imaging, OF is well known to show a typical appearance on panoramic radiogram and/or CT image, and show a marked increased uptake in bone scintigram. However, little is known about the glucose avidity of OF depicted by 18F-fluoro-2-deoxy-glucose-positron emission tomography (FDG-PET)/CT. The purpose of this case report is to demonstrate the findings on various images of OF including FDG-PET/CT.

Case: The patient was 18-year-old female and presented to our hospital with a complaint of left mandibular unerupted second premolar. She had a painless swelling in the left mandibular body. Radiographic examination revealed a radiopaque lesion in the left mandibular body on the panoramic X-ray photograph and an expansile radiopaque mass including the impacted second premolar on CT imaging. The margin of the mass was well-defined and surrounded by radiolucent zone. The lesion shows low signal intensity on T1-weighted MR image and T2-weighted MR image. Contrast-enhanced T1-weighted image with fat-suppression detected a mass with slight heterogenouse enhancement in the central region and enhancing margin. On FDG-PET/CT imaging, the left mandibular body showed a doughnut-shaped high uptake (standardized uptake value (SUV) max: 4.02). Bone scintigram with ^{99m}Tc-labelled methylene diphosphonate (^{99m}Tc-MDP) depicted a high accumulation in the same region. The lesion was surgically removed completely and the histopathologic diagnosis was ossifying fibroma.

Conclusion: We report a case of ossifying fibroma showed an increased uptake in the FDG-PET/CT. could be also considered as a differential diagnosis of mass lesions showedby high uptake on FDG-PET/CT. Ossifying fibroma might be characterized by high uptake on FDG-PET/CT imaging.

Solitary Plasmacytoma in the Mandible

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Solitary plasmacytoma of bone is found in the bone without any other evidence of plasma cell neoplasm. This condition may develop multiple myeloma at a later time. A 43-year-old male visited a local dental clinic for complaining pain and swelling on the left mandible. His panoramic radiograph showed an area of radiolucency with ill-defined margin. The radiolucency lesion involved the teeth #34-36 and the teeth were mobile and lost their lamina dura. The patient was referred to our dental school hospital after #35 and #36 were extracted at the local dental clinic. The medical CT and the dental cone beam CT images of the left mandible showed a 2.6 cm x 1.8 cm soft tissue mass of bony destruction without corticated border. Bone Scan with 99m-Tc-HDP showed increased uptake on the left mandible without any other bone involvement. Laboratory results revealed increased Ig G and B2-microglobulin but no Bence-Johns protein. Biopsy showed plasma cells in the soft tissue mass and infiltration of the plasma cells into the surrounding bone. Immunochemical stain showed positive reaction against kappa light chain. Final diagnosis was solitary plasmacytoma and surgical /chemical treatment were done. Oral manifestation may be the initial signs of plasma cell neoplasms as in this case, thus awareness of signs and symptoms these tumors of the dentist is important for diagnosis and patient management.

Mandibular brown tumor in renal osteodystrophy

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Purpose: Brown tumor is an uncommon disease but it is a serious complication of renal osteodystrophy. We report a case of brown tumor, which occurred in a 35-year-old woman with chronic renal failure, who has been treated with hemodialysis for 14 years.

Material and method: A 35-year-old woman who has been treated with hemodialysis for 14 years was referred to Seoul National University Dental Hospital concerning a progressive mandibular swelling of 3-month duration. She denied any other regional symptoms. Upon initial examination, a non-tender hard mass was found on the lingual side of the mandible, from the left central incisor to second premolar.

Results: Standard panoramic radiograph showed generally decreased bone mineral density, loss of lamina dura, and thin cortical plates. Computed tomography (CT) revealed multiple expansile lesions with heterogeneous attenuation in the anterior mandible, as well as generalized trabecular alteration with homogeneous sclerosis, and thinning or obliteration of cortical plates. Excision of the mandibular lesion and curettage of the affected bone were performed, and the excised mass was sent for biopsy. Biopsy from the lesion demonstrated central giant cell lesion; the brown tumor.

Conclusion: The brown tumor can show multiple expansile lesions with generalized trabecular alteration and thinned cortical plates. A periodic imaging examination is recommended to detect the possibility of brown tumor in renal osteodystrophy patients.

A case of a primary hyperparathyroidism with multiple brown tumors

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Purposes: To present the development of a brown tumor in the jaws as definite features of a primary hyperparathyroidism (HPT).

Materials and methods: 50-year-old female visited the Chonbuk National Uinversity Dental Hospital with a chief complaint (CC) of tooth mobility of the left mandibular molars. She had had a non-painful gingival swelling, bleeding at the CC site and gradual weight loss during the last 6 months. She has taken medicine for chronic renal failure of unclear etiology, knee joint pain for several months. Intraoral examination revealed firm and non-tender swelling of the left mandibular posterior alveolus. The plain radiographs showed multiple well-defined multilocular radiolucent lesions at the left posterior mandible and the left anterior maxilla, partial loss of lamina dura and osteoporotic change of both jaws. CT scans demonstrated low attenuated lesions with soft tissue mass and perforation of the cortical plate at the left posterior mandible and the left anterior maxilla, and the heterogeneous mass at right thyroid lobe consistent with parathyroid adenoma. Intraoral biopsy specimens revealed the typical features of a giant cell lesion with fibrovascular stroma and multinucleated giant cells of osteoclastic type. Blood test showed hypercalcemia (total calcium 13.6 mg/dl), hypophosphatemia (2.1 mg/dl), and elevated alkaline phosphatase level (1044 IU/L).

Results: The final diagnosis was a primary HPT with multiple brown tumors. The surgical treatment was done, and there was no recurrence after 6 months.

Conclusion: Usually brown tumor is diagnosed at the terminal stage of HPT. Differential diagnosis should be done from central giant cell lesions, ameloblastoma, anurysmal bone cyst radiographically. The final diagnosis should be confirmed by the endocrinologic and clinical examination of the patient as well as the correct radiographic diagnosis.

A Case of Malignant Lymphoma in the Sublingual Space

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Introduction: A favorite site of malignant lymphoma is head and neck, but it is rare to occur in oral cavity. We experienced a case of malignant lymphama in the sublingual space

Case Report: A 72-years-ole woman was referred to our hospital, complaining of the swelling of oral floor that she had first noticed 3 weeks earlier. It gradually enlarged to oral cavity. Oral examination showed a painless skin-colored with clear boundaries mass on the left side of the oral floor. That was elastic and hard. Coronal ultrasound showed solid well-delined hypoechoic mass in the left side of the sublingual space. Power Doppler ultrasound showed chaotic intralesional blood flow.Axial and coronal enhanced CT image showed that the lesion had a smooth margin and round form and enhanced homogenously. 67Ga-citrate scintigraphy showed intensity uptake in the lesion. A biopsy was performed, and the pathological diagnosis was a suspected diffuse large B-cell lymphoma arising in the sublingual gland.

Rhabdomyosarcoma of the tongue base and its recurrence with multiple lymph node metastases

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Purpose: Rhabdomyosarcoma is an aggressive and fast-growing malignant tumor dominantly arising in the region of head and neck in children. However, oral cavity involvement is not common and metastasis to lymph nodes is extremely rare. We report a case of rhabdomyosarcoma of the tongue which recurred with multiple lymph node metastases two months after the first operation.

Materials and methods: A 37 year-old woman, complaining of muffled voice and dysphagia, was referred to Seoul National University Dental Hospital in February 2007, with MRI, PET/CT, and the histopathologic diagnosis of rhabdomyosarcoma through an incisional biopsy. The intraoral examination showed that the oropharynx was nearly obstructed by a large mass of the tongue base.

Results: MRI and additionally performed contrast enhanced CT revealed a large, heterogeneously enhancing mass of the tongue base. Distant metastasis or lymph node metastasis was not observed on PET/CT. Although the management of the tumor had been planned via a multidisciplinary approach with induction chemotherapy to shrink the margins prior to definitive surgical resection, the surgery was undertaken first owing to an emergency bleeding incidence. Tumorectomy including glossectomy, total laryngectomy, intraoral reconstruction with rectus abdominis muscle free flap transfer, and permanent tracheostomy were performed. Chemotherapy was subsequently implemented. Two months after the first operation, right neck node enlargement was noticed on the follow-up examination and contrast enhanced CT was taken to reveal the recurrence of rhabdomyosarcoma with multiple lymph node metastases. A heterogeneously enhancing soft tissue swelling was seen at the pharyngeal area adjacent to the lower part of the posterior margin of the operation site and extended inferiorly along the esophagus. A recurrent lesion was observed superior to the tongue base, in the medial pterygoid muscle adjacent to the right pharyngeal wall. In particular, the lingual cortex of the right mandibular ramus was destructed and the invasion into the marrow was observed. Multiple lymph node metastases were seen on the levels I, II, and III of the right neck, and on the lateral retropharyngeal lymph node. Thereafter, although anti-cancer therapy was carried out, bleeding had repeatedly occurred and the mass was continuously growing, so the chemotherapy was stopped and only supportive care and pain control were sustained. Finally, the patient was hopelessly discharged in January 2008.

Conclusion: By the time rhabdomyosarcoma is noticed, the patients may already have a large mass of tumor for the reason of a fast-growing tendency of rhabdomyosarcoma and a delayed medical consultation. As in the present case, rhabdomyosarcoma has an unfavorable prognosis with a possibility of a rapid recurrence and lymph node metastasis. Therefore, careful follow-up examination, as well as early detection and diagnosis, is important.

Sub-classification of Warthin's tumor by Tc-99m-Sialoscintigraphy

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Purposes: It is well known that Warthin's tumor shows a marked accumulation with Tc-99m- sialoscintigraphy and Warthin's tumor is sub-classified into four types according to the ratio of the epithelial component to lymphoid stroma (Seifert, et al). It is also well known that the accumulation of Tc-99m is found in the epithelial component of Warthin's tumor. In this study, the correlation between the accumulation and the ratio of the epithelial component to lymphoid stroma was estimated and the evaluation of the usefulness of Tc-99m-sialoscintigraphy for the sub-classification of Warthin's tumor was performed.

Materials and methods: Nine cases with Warthin's tumor were five women and four men. The age ranged from 51 to 73 years, and the duration from onset was 1 to 23 years. All cases had a swelling of the parotid region, but maintained a good salivation. No case had any other symptoms such as pain, dry mouth. All tumors were located in the lower surface-lobe of the parotid gland. The sizes of tumors were measured when they were extirpated surgically. Sialoscintigraphy was performed with Tc-99m using a gamma camera using an ultra-high-resolution collimator. Immediately after injection of Tc-99m, 20-second scintiscans were made continuously for 50 minutes. A taste stimulation with ascorbic acid was done 30 minutes after injection to evaluate the excretory function of the salivary gland. A 20-second scintiscan was recorded as a frame data, and 150 frames were obtained. On each frame, regions of interest (ROI) covering the parotid glands and the tumor were used to recognize the accumulation of Tc-99m in parotid glands, the excretion of the saliva, and the accumulation and retention of Tc-99m in the tumor. Another one ROI was added in the forehead region as a background of radioactivity. The obtained frame data (radioactive count) were used to make a "Time activity curve (function curve)". The radioactive indexes were calculated by dividing the radioactive count in the tumor by the product of the radioactive count in the background and the tumor volume. Nine cases underwent a surgical extirpation of tumor and the sizes of tumors were measured. Tumors were submitted to a histopathological examination. The specimens were stained with hematoxyline and eosin by a usual method to estimate the ratio of epithelial component to lymphoid stroma. Tumors were sub-classified into 4 types by the ratio (the typical cystadenoma; subtype-1, stroma-poor cystadenoma; subtype-2, strome-rich cystadenoma; subtype-3, and others; subtype-4).

Results: Sialoscintigraphic and histopathological findings showed a good correlation. Tumors with a large amount of epithelial component (subtype-1 and subtype-2) showed a large radioactive index and a hot accumulation of Tc-99m. On the other hand, Tumors with a poor amount of epithelial component (subtype-3) revealed a small radioactive index and a poor accumulation of Tc-99m.

Conclusion: Sialoscintigraphic manifestations mainly depended on the amount of epithelial component of Warthin's tumor. The good correlation between the sialoscintigraphic and histopathological results indicated a usefulness of Tc-99m-sialoscintigraphy for the sub-classification of Warthin's tumor.

Correlation between the incidence of central nodal necrosis in neck node metastasis and the degree of differentiation in oral squamous cell carcinoma

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Purposes: Correctly diagnosing relatively smaller metastatic lymph node is important for determining the prognosis of patients with oral squamous cell carcinoma (SCC). The use of computed tomography (CT) scanning continues to be the best diagnostic methods for pre-operative detection of metastatic neck disease. However, few studies to date have reported on the use of CT scanning for identifying the components of central nodal necrosis (CNN) in metastatic lymph nodes in patients with oral SCC and no studies have identified the factors that influence changes in metastatic lymph node density on CT scans. Therefore, the purpose of this study was to investigate the incidence of CNN in the cervical lymph nodes of patients with SCC and the factors that influence the formation of CNN.

Materials and methods: Lymph nodes shown as CNN on CT films in 107 lymph nodes from 27 patients with oral SCC were selected. Lymph nodes with CNN on CT films were compared with the pathological findings of lymph nodes on specimens. We compared many kinds of factors influencing the formation of CNN, including the differentiated type, with the incidence of CNN. The degree of differentiation was classified as well differentiated, moderately differentiated, or poorly differentiated, according to the World Health Organization (WHO) pathological grading system. The mode of invasion to the lymph nodes was classified as grade 1, grade 2, grade 3, grade 4-C, or grade 4-D as described by Yamamoto et al, according to the pattern of tumor cell invasion at the tumor-host interface. The extent of invasion into the lymph nodes (spread) was also classified as stage I, stage II, stage III or stage IV, as described by Honma.

Results: Significant relationships were found between the incidence of CNN in matastatic lymph nodes and the presence of well-differentiated SCC and the presence of keratinization in tumor cells. No relationship was found between the mode or the extent of invasion to the lymph nodes and the incidence of CNN in metastatic lymph nodes.

Conclusion: Important result in our study is the significant relationship between the extent of SCC differentiation in lymph nodes and the incidence of CNN in metastatic lymph nodes. The results indicated that if a patient had SCC with low- grade differentiation, CNN in small lymph nodes would be difficult to detect on CT scan. Therefore, noting changes in lymph node density in the absence of CNN on CT scans is necessary in case the primary tumor is low grade SCC. We proposed that lymph nodes of heterogeneous density on CT scans should be diagnosed as metastasis in patients with moderately differentiated or undifferentiated SCC in the primary sites. Furthermore, in the present study, metastatic lymph nodes without density changes on CT scan were present in cases with stage II and stage III in the moderate differentiated type of SCC. We physicians must still recognize the limitation of using CT scanning to diagnose metastatic lymph nodes in patients with oral SCC.

MR Imaging Characteristics of Cervical Metastatic Lymph Nodes

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Purposes: The use of magnetic resonance (MR) imaging for the detection of the metastatic lymph nodes has become widespread. The size of the lymph node and abnormality of internal architecture, including necrosis have been used for criteria for metastatic cervical lymph nodes. In general, criteria for diagnosis of necrosis on MR images is considered to be detection of hyperintense area on T2-weighted MR images and/or focal defect on contrast-enhanced T1-weighted MR images. A recent report described the performance of MR imaging in detecting necrosis in metastatic cervical lymph node was equivalent to that of CT. MR images with surface coil and smaller matrix have potential to improve the detection of detailed architectures of metastatic lymph nodes. The apparent diffusion coefficient (ADC) values on diffusion-weighted images were useful determinants in discriminating metastatic lymph nodes benign nodes in patients with head and neck cancer. On the other hand, the recently introduced concept of "diffusion weighted whole body imaging with background body signal suppression (DWIBS)" is an valuable tool to identify lymph nodes. However, it is still unknown characteristics of metastatic lymph nodes on DWIBS image. Therefore, the aim of this study was the aim of this study was to compare with MR images and histopathological architecture and to characterize the MR signal intensity of cervical metastatic lymph nodes of patients with oral squamous cell carcinoma.

Materials and methods: Ninety eight cervical lymph nodes (19 metastatic and 79 benign nodes) from 20 patients with oral squamous cell carcinoma underwent MR before neck dissection. On nonenhanced T1- and T2-weighted MR images and DWIBS images, the signal intensity of internal architecture of lymph node was assessed. On contrast-enhanced T1-weighted MR images the presence or absence of focal defect in lymph nodes were assessed. On histopathological views, focal necrosis, keratinization, and fibrous tissue in metastatic lymph nodes and adipose tissue, follicular hyperplasia, sinus histiocytosis, hyperemia, and focal hemorrhaging in benign lymph nodes were assessed. MR findings were compared with histopathological findings.

Results: 1) Six (31.6%) of 19 metastatic lymph nodes contain hyperintense and 6 (31.6%) of 19 metastatic lymph nodes contain isointense on T2-weighted MR images. 2) In metastatic lymph node, hyperintnse areas on T2-weighted MR images were corresponded to cystic degeneration, marked keratinization with histolysis / detachment. Isointense areas were corresponded to marked keratinization. Keratinization presented different signal intensity on T2-weighted MR images by degree of histolysis. 3) Thirteen (68.4%) of 19 metastatic lymph nodes showed heterogeneous appearance on DWIBS images.

Conclusion: Cystic degeneration and marked keratinization in metastatic lymph nodes may depict on T2-weighted MR images and contrast-enhanced T1-weighted MR images. Tumor cells without necrosis were not characteristic on MR images.

Hypervascularity in cervical lymph nodes of oral cancer patients on power Doppler US

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Purposes: Power Doppler ultrasonography (Power Doppler US) is useful for assess cervical lymph nodes metastasis of oral cancer patients. On power Doppler US metastatic lymph nodes were reported to usually show peripheral vascularity that runs along periphery nodes, with perforating branches into lymph nodes, because blood vessels within the nodes are compressed by tumor cells, which grow and spread and replace a large portion of the lymph node. However, this vascular pattern is presented when tumor occupies a large portion of node. Therefore, these criteria may not help to diagnose small metastatic lymph nodes. Then, we aimed blood vessels within nodes increase by angiogenesis at early stage of tumor cell implantation in nodes, and speculated hypervascular pattern on Power Doppler US was presented in small metastatic lymph nodes. The purpose of this study was to evaluate whether hypervascular pattern on Power Doppler US was feature of small metastatic lymph node.

Materials and methods: The subjects were 22 patients with oral squamous cell carcinoma, who underwent neck dissection. A total of 305 lymph nodes were confirmed by histopathological examination. In these 305 lymph nodes, 247 lymph nodes measuring 6 mm or less in short axis on US images were evaluated in this study. Power Doppler US imagings were performed by using 10.0MHz liner transducer, flow rate scale 0.013m/sec. DICOM data of Power Doppler US images were analyzed with Image J and Adobe Photoshop on PC (Windows XP). Contour of lymph nodes were traced manually and measured the area of lymph node. Then, Blood vessels within lymph nodes were extracted using Photoshop and measured the area of vascularity. Vascular / lymph node area ration was calculated. 50% and more than area ration was defined as hypervascular pattern.

Results: 11 (30.6%) of metastatic lymph nodes were classified into hypervascular pattern, 25(69.4%) of reactive lymph node into hypervascular pattern. In each lymph node group, 4 of 7 metastatic lymph node presented hypervascula pattern and 3 of 7 reactive lymph nodes in submental group (Level IA), 1of 7 metastatic lymph nodes and 6 of 7 reactive lymph nodes in sybmandibular group (level IB), 4 of 6 metastatic lymph nodes and 2 of 6 reactive lymph nodes in upper jugular group (level II), 4of 7 metastatic lymph nodes and 3 of 4 reactive lymph nodes in middle jugular group (level III), and 0 of 6 metastatic lymph nodes and 6 of 6 reactive lymph nodes in lower jugular group (level IV).

Conclusion: Hypervascular pattern is useful power Doppler US findings for detecting small metastatic lymph node in level IA, II and III.

Clinical significance of Real-time Tissue Elastography in the evaluation of cervical lymph node metastases in patients with oral cancer

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Purposes: Ultrasonography is an alternative method of diagnostic imaging of cervical lymph node metastases in patients with oral cancer. Currently, ultrasonographic analysis has been evaluated based on the size of lymph node using B-mode imaging and blood flow analysis using Doppler method. It is well known that some diseases, such as cancer, lead to a change of tissue hardness. The reconstruction of tissue elasticity provides the sonographer with important additional information which can be applied for the diagnosis of these diseases. Conventional diagnostic imaging methods could not demonstrate the objective images of tissue elasticity of cervical lymph node metastases in oral cancer. EUB-8500 with the newly innovated technology "Real-time Tissue Elastography" enable to display the tissue elasticity. The real-time tissue elastography suggests the possibility that it is reflecting the pathological tissue characterization in cervical lymph node metastases in oral cancer. Therefore, we studied its clinical usefulness in diagnosing cervical lymph node metastases in oral cancer using an ultrasound diagnostic system equipped with the real-time tissue elastographic function.

Materials and methods: Fifteen patients with oral cancer were enrolled in this study. The patients consisted of 4 males and 11 females, and age ranged from 20 to 87 years with mean age of 65.3 years. All patients gave informed consent for participation in this study. Conventional ultrasonography and real-time tissue elastography were performed in every patient. Ultrasonogram before surgery was compared to the histopathological specimen obtained after surgery. Based on Tsukuba Elastography Score, we classified real-time tissue elastographic images of lymph node in five patterns, and the patterns above category 3 were recognized as metastases. The hardness of lymph node was shown as patterns of colors, from red, yellow, green to blue. Red being the softest and blue hardest gradually. Furthermore, we considered that lymph nodes as non-metastatic when no metastatic findings were observed within the follow-up period of one year or more.

Results: A total number of 26 nodes were examined with real-time tissue elastography. Malignant lymph nodes were pattern 3, 4, or 5. Non malignant lymph nodes were pattern 1, or 2. The differences of tissue elasticity between malignant lymph nodes and non malignant lymph nodes were extracted clearly. Precision of diagnosis was as follows; sensitivity of 92%, specificity of 86%, accuracy of 88%, PPV of 85% and NPV of 92%, respectively. Additionally, metastatic lymph nodes with a minimal axial diameter of 0.5cm could be detected accurately by real-time tissue elastography.

Conclusion: Real-time tissue elastography is a promising method which allows characterization and differentiation of benign and malignant lymph nodes with a high sensitivity, specificity and accuracy, offering complementary information added to conventional ultrasonographic imaging.

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Detectability of cervical lymph nodes on CT: Comparison of tile and stack mode images on the PACS monitor

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Purposes: Picture archiving and communication system (PACS) offer another image display format, stack mode, in which CT images are effectively stacked on top of one another on the PACS monitor. The purpose of this study was to compare CT image interpretation using PACS tile and stack modes with respect to observer performance for the detection of cervical lymph nodes.

Materials and methods: We used 10 subjects (7 males and 3 females, 40-78 years old; mean age 60.4 years) who were selected from patients admitted to the Kyushu university hospital with oral cancer and underwent radical neck dissection between May 2007 and August 2008. CT examinations were performed on MDCT scanners, Aquilion (Toshiba MedicalSystems, Tokyo, Japan). Scanning parameters in this study were detector configuration, 4 x 3.0, slice thickness, 3.0 or 5.0mm, table speed, 9.0mm/rotaion, and matrix, 512 x 512. Five radiologists interpreted the distribution of cervical lymph nodes on CT images using the two interpretation modes independently and were asked to record the location and the number of the lymph nodes in each subject. Regional lymph node was divided into five divisions, submental, submandibular, upper, meddle and lower neck. Correct location of the lymph node was confirmed by the result of pathologic findings after surgery. All reviewers were acquainted with the use of PACS (SYNAPSE; FUJI FILM, Japan).

Results: Average of detection rate of five divisions, submental, submandibular, upper, meddle and lower neck were 11.1%, 76.7%, 78.6%, 57.3%, 38.9% in the tile mode image, while 27.8%, 90.0%, 90.5%, 65.6%, 88.9% in the stack mode image, respectively. Total detection rate of the lymph nodes were 61.4% in the tile mode image and 81.2% in the stack mode image. Detectability of the cervical lymph nodes in the stack mode image was higher than that of the tile mode image, especially in the lower neck division.

Conclusion: The stack image is preferable than the tile image in interpreting lymph nodes on the PACS monitor.

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Comparison of PET and US imaging findings in metastatic lymph nodes of head and neck cancer

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Purpose: Recently, Positron Emission Tomography (PET) reported usefulness is used in diagnosis of head and neck malignant tumor. The other side, it is necessary for diagnosis as a morphological examination that Computed Tomography (CT), Magnetic Resonances Images (MRI) and Ultra Sonic (US) are used according to routine. In diagnosis of metastatic lymph node of head and neck tumor, US examination is frequently used because US modality is not damaged and is reappearance, US modality is comparatively simple. As a result, it is necessary that we are thinking of cause and basement of diagnosis used to US with the other modality again. We compare PET and/or US results with pathological diagnosis, and have experienced of False Positive (FP) or False Negative (FN) cases in PET and/or US examination. Consequently, we report to investigate of metastatic lymph node in head and neck cancer in attention to FP and FN cases of PET and/or US examination.

Object and Method: 18 cases that were performed neck dissection were the targets. In addition, we had performed US and PET examination in the same time nearly and a period of preoperative state.

Results: 14/18 cases were positive in pathological diagnosis. Both PET and Pathological results were in accord of 11/18 cases, True Positive (TP) case was 10/11 cases, True Negative (TF) was 1/11, FP was 3/7 and FN was 4/7 in PET findings. US results were agreed with pathological diagnosis about 14/18 cases. TP case was 13/14 cases, TN was 1/14, FP was 2/4 and FN was 2/4 in US findings. And so, the case that both PET and US results were not agreed with pathological diagnosis was 3 cases, FP case was 2/3 cases, FF case was 1/3 case.

Conclusion: Though, it is several reported to PET and US examination of metastatic lymph node in head and neck cancer, we have disagreement case between PET and US findings. As a result, it is suggested that we must synthetically diagnose of metastatic lymph node in head and neck cancer by several modality including CT and MRI.

Sentinel Lymph Node Biopsy in Oral Cancer

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Purposes: Metastases to cervical lymph nodes are the most significant prognostic factor for patients with oral cancer. We studied whether the sentinel lymph node concept is applicable to oral cancer.

Materials and methods: Subjects were 21 cases diagnosing squamous cell carcimoma histopathollogically and undergoing primary resection between November 2006 and August 2008. The day before surgery, they were injected with ^{99m}Tc-tin colloid or ^{99m}Tc-phytate surrounding primary site for tracers and lymphoscintigraphy were done. They were injected with blue dye surrounding primary site and intraoperative identification by gamma probe were done to detect sentinel lymph nodes and sentinel lymph node biopsy underwent. We investigated the detection of metastasis in sentinel lymph node by intraoperative rapid diagnosis with frozen section and H-E stain histopathollogically.

Results: Sentinel lymph nodes were identified in every cases by lymphoscintigraphy and gamma probe. One to four sentinel lymph nodes were identified in each case. Both intraoperative rapid diagnosis with frozen section and H-E stain of sentinel lymph node identified metastasis in 3 of 16 cases diagnosing node-negative clinically. Metastasis were identified sentinel lymph node and no metastasis were identified other regional lymph nodes in 3 of 5 cases diagnosing node-positive clinically. No metastasis to sentinel lymph node was present in 2 cases.

Conclusion: The results suggest the usefulness of the sentinel lymph node concept in oral cancer.

Prospective study on hypoxic image in osteomyelitis of mandible using PET with 18F-Fluoromisonidazole

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Hypoxia is a common characteristic feature of solid tumors that causes the failure to achieve local control using radiotherapy. This is due to increased radioresistance of hypoxic cells. During the period of '80, as hypoxic region of solid tumor induces limitation against the effectiveness of radiation therapy and chemotherapy, Misonidazole had been applied to Radiotherapy as build up agent for hypoxic tumor cells. Usefulness of hypoxic region image of tumor is obvious and has been reported in many way especially head and neck tumor. 18F-Fluoromisonidazole (18F-FMISO) Positron Emission Tomography (PET) is a noninvasive imaging technique that can assist in the identification of intratumor hypoxic region. Osteomyelitis of mandible is one of the major infective diseases, which also contain the hypoxic region. It is well known that prognosis of osteomyelitis is depending on blood supply and the diagnostic image of that hypoxic region is required for the evaluation of patient outcome.

Case Report: A case of 80 years old Japanese male visited to Hokkaido University Hospital. Sapporo, Japan on April 2008,with the complain of pain in the right mandible. His previous medical history was suffering from osteoporosis and for that reason he was medicated Bisphosphonate, 5mg/day from May 2003 and then Steroid 1mg/day since 2004.In Hokkaido university hospital various diagnostic images confirmed that he was suffering from chronic osteomyelitis. He underwent 20Fr of hyperbaric oxygen therapy (HBO) preoperatively and then the surgical operation (sequestrectomy) was performed. Postoperatively again 10Fr of HBO was given. Two months later of operation affected area was covered by normal mucosa and having no complain. We will present pre and post therapeutic OPG, bone scintigram, FDG-PET images and 18-F-Fluoro-misonidazole PET images. Pre-HBO 18-F-Fluoromisonidazole images show slight accumulation in right mandible region, hyper accumulation in arterial region and moderate accumulation in left mandible. It showed that accumulation level must be depending on the stage of inflammation. Slight accumulation in right mandible meant well vasculization of the region and predicted good prognosis of the therapy. Hyper accumulation in arterial region of the mandible had periodontal inflammation with discharging of pus.PET with 18F-Fluoromisonidazole (18F-FMISO-PET) is a non-invasive method to measure the hypoxia within the tumor area. We analyzed the changes of FMISO uptake before and after the treatment and administration of HBO in a case of hypoxic region of chronic osteomyelitis.

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Sonographic appearance of lingual abscess -Report of 2 cases-

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Purposes: The diagnosis of lingual abscess may not always be clinically apparent. Such patients are frequently referred for sonography because of insufficient CT examinations with metal artifacts. The purpose of this study was to document the sonographic features of lingual abscesses.

Materials and methods: Two patients with lingual abscess had sonography in their initial imaging examinations. Inflammatoy lesion of the tonguewas suspected clinically in both patients on the basis of findings, that is, swelling and tenderness of the tongue. Sonography was performed to confirm inflammation, to try to find a cause and to reveal an extent into the tongue. Both patients were treated by antibiotics and became free of symptoms in several days. Fish bone was removed in a patient during his antibiotic treatment.

Results: Lingual abscess was revealed as a hypoechoic area with ill-defined diffuse margin. A hyperechoic thin rod was found in the area in both patients. Hypoechoic areas were found to spread around the rod. Posterior enhancement of the lesions and posterior attenuation behind the rods was seen. Slightly increased flow on power Doppler sonography was found.

Conclusion: In both patients fish bone which was revealed as a hyperechoic rod was considered a cause of lingual abscess. The characteristic sonographic feature is a hypoechoic area with ill-defined margin in the tongue that shows slightly increased flow on power Doppler examination.

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Dynamic contrast-enhanced magnetic resonance imaging for estimating tumor proliferation and microvessel density of oral squamous cell carcinoma

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Purposes: Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI), which produces functional images, not only aid diagnosis but also provide measures that relate to histological assessments of vascular density, providing a noninvasive method for measuring angiogenesis. A relationship between tumor angiogenesis and tumor growth or metastasis has been reported in oral squamous cell carcinoma (oral SCC). In addition, it has been clarified that proliferating cell nuclear antigen (PCNA), which is related to cell proliferative activity, and CD34, the most reproducible endothelial cell marker, and so on, are related with the growth and metastasis of cancers such as oral SCC, breast cancer, and hepatocellular carcinoma. Several studies have reported that the cell proliferating activity of tumors was estimated immunohistochemically by this PCNA antibody and compared with DCE-MRI, and that the PCNA labeling index of tumor was significantly correlated with DCE-MRI parameters. In the present study, after tumor resection, the tumor cell proliferation estimated by PCNA and microvessel density (MVD) estimated by CD34 were determined using immunohistochemical stains on available specimens to correlate with DCE-MRI enhancement parameters.

Materials and methods: Twenty-eight T2 and T3 patients with primary oral SCC underwent DCE-MRI using three-dimensional fast imaging with a steady-state precession sequence. Tumor cell proliferation and MVD of all surgical specimens were evaluated using immunohistochemical staining with the antibody for proliferating cell nuclear antigen (PCNA) and CD34. Regression analysis was used to statistically analyze the relationship between the PCNA labeling index and MVD and three DCE-MRI parameters: maximum CI (CI-max), maximum CI gain (CI-gain) and the CI-gain / CI-max ratio). Statistical analysis of the relationships between the CI-gain, the CI-max, and the CI-gain/ CI-max ratio, and PCNA labeling index and MVD was carried out using Kaleida Graph software (for Windows, Version 4.0, Synergy Software ,USA). These relationships were assessed by simple regression analysis. P values of <0.05 were considered significant.

Results: The mean CI-max was 2.56 ± 0.86 (range, 1.24–5.00). The mean CI-gain was 1.61 ± 0.58 (range, 0.49–2.84). The mean CI-gain/CI-max ratio was 65.0 ± 18.7 (range, 35.8–100). PCNA and CD34 expression was present in all pathological specimens. The mean PCNA labeling index was 40.9 ± 12.4 (range, 22.2–62.09). The mean MVD was 94.9 ± 36.9 (range, 41–207). The PCNA labeling index showed no significant correlation with the CI-max ($P=0.513$, $r=0.129$). However, the PCNA labeling index showed a significant positive correlation with CI-gain and the CI-gain/CI-max ratio ($P=0.0473$, $r=0.378$ and $P=0.0012$, $r=0.581$ respectively). In addition, MVD showed no significant correlation with the CI-max ($P=0.401$, $r=0.165$). MVD showed a significant positive correlation with CI-gain and CI-gain/CI-max ratio ($P=0.00821$, $r=0.490$ and $P =0.00141$, $r=0.574$, respectively). The PCNA labeling index showed no significant correlation with the MVD ($P= 0.661$, $r=0.0867$).

Conclusion: The assessment of DCE-MRI parameters may provide valuable information for tumor cell proliferation and MVD of patients with oral cancer as non-invasive methods.

Mitochondrial Signal Lacking Manganese Superoxide Dismutase Failed to Prevent Apoptosis by X-irradiation in a Human Hepatocellular Carcinoma Cell Line, HLE

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Experiments were performed to examine importance of mitochondrial generated ROS in X-irradiated human hepatocellular carcinoma cell line, HLE. We previously reported that the potential role of mitochondrial manganese superoxide dismutase (MnSOD) in protective activity to irradiation by analyzing the cell viability by a colony-formation assay, and by detecting apoptosis in stably human MnSOD gene-transfected stable clones of HLE (*Cancer Res. 61:5382-5388, 2001*). The results showed that overexpression of MnSOD reduced the levels of reactive oxygen species (ROS) in the mitochondria, intracellular phospholipid peroxidation product (4-Hydroxy-2-nonenal; HNE), and prevented apoptosis. The results suggested that MnSOD might play an important role in protecting cells against radiation-induced apoptosis by controlling the generation of mitochondrial ROS and intracellular lipid peroxidation. In this study, we further examined whether MnSOD is necessarily present in mitochondria to have a function. Normal human MnSOD, and MnSOD without a mitochondrial targeting signal (MTS) were transfected transiently to HLE cells, and reactive oxygen species (ROS), lipid peroxidation, and apoptosis were examined as a function of time following 18.8 Gy X-irradiation. Our results showed X-irradiation increased in ROS, HNE, and apoptosis. Authentic MnSOD protected against these processes and apoptosis, but MnSOD lacking MTS could not. These results suggest that only when MnSOD is located in mitochondria is it efficient in protecting against cellular injuries by X-irradiation, and they also indicate that mitochondria are primary sites of X-ray-induced cellular oxidative injuries.

Expression of MMP13 in chondroblast cells and rat tibiae after exposure to accelerated carbon ions

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Purpose: We had reported that the cartilage volume within the trabeculae in the secondary spongiosa in rat tibiae was increased after carbon ion irradiation. We believe that carbon ion irradiation might cause suppression of matrix metalloproteinase 13 (MMP-13), and then cartilages remain in thicker trabeculae. The purpose of this study is to analyze the effect of carbon ion irradiation for MMP-13 after irradiation and the effect of irradiation for endochondral ossification.

Materials and methods: We conducted the following two experiments *in vitro* and *in vivo*. Cultured chondroblast cells ATDC5 had been irradiated with 2, 4, and 6 Gy of carbon ions. We assessed the induction of MMP-13 mRNA expression in culture system. RNA was harvested from the irradiated and control ATDC5 cells in time course. In animal study, carbon ion irradiated to a single dose of 15 Gy of radiation to the proximal metaphysis of the tibia. The localization of MMP-13 and the angiogenic activity in the primary spongiosa of carbon ion irradiated rat tibiae were also examined 30 days after irradiation.

Results: Expression of MMP13 mRNA in carbon ion irradiated cells was much less than that in non-irradiated control cells. Carbon ion irradiation induced the thick trabeculae and the remained cartilage inside the trabeculae was observed. Immunoreactivity of various intensities was detected on trabeculae surface in non irradiated rats; On the contrary, MMP-13 was detected inside the trabeculae in carbon ion irradiated rats. A lot of blood vessels invaded into the cartilage in non irradiated rats', but invasions of blood vessels in calcified cartilage were hardly observed in carbon ion irradiated rats.

Conclusion: These results suggest that carbon ion irradiation suppress production of MMP13, thus allowing the cartilage matrix to remain in the trabeculae. Suppression of MMP13 mRNA expression in carbon ion irradiated ATDC5 might reflect a localized decrease in the rate of matrix turnover of carbon ion irradiated rats compared to that observed in non irradiated rats. However, conditional inactivation of MMP13 in carbon ion irradiated cartilage obstructs matrix degradation and vascularization of the hypertrophic cartilage.

Numerical Simulation on the Mechanical Responses of Endodontically Treated Tooth/implant-supported System under Different Periodontal Supports and Load Conditions

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Purposes: Structure strength is a major complication for endodontically treated teeth that is usually restored with post and core to recover its function. While endodontically treated tooth is splinted to an implant in edentulous region for some clinical situations, complex biomechanical aspects of an endodontically treated tooth/implant-supported system are derived from the dissimilar mobility between the osseointegrated implant and the tooth, and the weak structure strength of endodontically abutment tooth. Significant problems such as: loss of osseointegration, abutment screw loosening, prosthesis fracture and adhesive interface debonding between tooth and post arise due to the high bending moment caused by the cantilever effect, especially for the case of compromised periodontal support (not enough post length in alveolar bone). The aim of this study was to investigate the biomechanical aspects for endodontically treated tooth/implant-supported system with normal and compromised periodontal supports under axial and lateral loading conditions using non-linear finite element (FE) approach.

Materials and methods: Geometries and section contours of alveolar bone, abutment tooth and prosthesis were acquired from computed tomography (CT) and Micro-CT to construct the individual solid models firstly, and generated two solid models of splinted systems with two levels of periodontal support (distance from crown tip to alveolar bone: distance from alveolar bone to post base=1:1 and 2:1) containing a Frialit-2 implant at first molar splinted to the endodontically treated second premolar in CAD systems. Solid models were then imported to the finite element (FE) package to generate corresponding FE mesh models, non-linear simulated approach by using contact element to simulate the interface adaptation within the implant system to calculate the detailed mechanical responses under system receiving axial and oblique (45°) loads. ANOVA was used to test for relative importance of the investigated factors and main effects for each level of the two investigated factors (periodontal supports and loading conditions) in terms of the stress values were performed.

Results: The simulated results indicated that stress values in the implant, alveolar bone, prosthesis and adhesive cement between post and remaining dentin increased significantly for splinted system with receiving oblique load and in compromised periodontal support situation. The factor of periodontal support was a major issue more than loading condition affecting the stress values in adhesive cement. The unfavorable stress for system with compromised periodontal support increased the risk of adhesive interface de-bonding between post and tooth might and induce the post loosening frequently.

Conclusion: Occlusal adjustments need to perform to reduce lateral load for decreasing the stress distribution in different components (bone, adhesive cement, prosthesis and implant) of the splinted system. Treatment for the endodontically tooth/implant splinted system should pay attention to the high risk of post loosening in compromised periodontal support.

Application of Micro-ct and Finite element analysis on an immediate-load implant with maxillary sinus augmentation

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Purposes: Immediate-load implants with maxillary sinus augmentation are becoming more and more popular in clinics nowadays. However, most studies on the maxillary sinus augmentations and immediate-load implants are still dependent on the clinical experiences rather than scientific-based data. Therefore, there is no general consensus of how a grafted material could predominately influence the stability and bone stress distribution of an immediate-load implant. The purpose of this research is to combine the technologies of micro-computer tomography (micro-CT) analysis and three dimensional (3D) non-linear finite element (FE) simulations to investigate the effect of an immediate-load implant with maxillary sinus augmentation by using autogenous bone as grated material.

Materials and methods: This research was divided into two portions to be completed within the one-year span. Firstly, after 5 to 6 months of the maturation of healing period a cylindrical biopsy of grafted bone was taken at fixture locations and analyzed by the micro-CT (Skyscan1076 micro-CT system; SkyScan, Aartselaar, Belgium) with 17.8 μm of resolution of micro-ct images to study the (1) percent bone volume BV/TV, (2) bone surface density BS/TV, (3) trabecular thickness Tb.Th, (4) trabecular number Tb.N, (5) trabecular pattern factor Tb.Pf and (6) degree of anisotropy DA. The grafted bone will be compared to ones placed with other various grafted materials in maxillary sinus. At the second stage, according to Stoppie N's study [1], the relationship between Young's modulus (y) and BV/TV (x) has been obtained as $y=0.3405x^{1.9672}$. The material properties of grafted bone can be calculated and imported to the 3D computer models with an anatomic human maxillary bone and implant created by CT images of human dry skull, CAD (computer aided design) technology (SolidWorks 2006; Solidworks co., Concord, MA, USA)) and FE software (Ansys; Swanson Analysis Inc., Huston, PA, USA). Then the non-linear contact analysis will be carried out to analyze the sliding distance between implant and bone and the stress at bone around the implant.

Results: The 3D data of micro-CT of grafted bone including BV/TV, BS/TV, Tb.Th, Tb.N Tb.Pf and DA influenced by patients' age and donated sites of autogenous bone (iliac and tibia). The mean value of BV/TV of autogenous bone is 25.56 (SD 2.84). According to the equations of $y=0.3405x^{1.9672}$, the value of Young's modulus of grafted bone was calculated as 199.72 MPa and imported to the FE model to achieve the computer simulation. The sliding distance is lower than 100 μm, which might explain the clinical observation that employing the immediate loading treatment can lead to osseointegration. However, the concentrated stresses were yielded in the buccal site of cortical bone. These outcomes showed that the use of immediate-load implant might induce the disproportionate strain distribution in bone, which cause a high risk of surrounding bone loss due to disuse atrophy or overloading resorption.

Conclusion: The results of this research provide practical information for clinicians to predict the primary implant stability and surrounding bone stresses of immediate- load implant with maxillary sinus augmentation.
Reference: [1] Stoppie N et al. Int J Oral Maxillofac Implants 2007;22:436-445

Development and Clinical Application of Self-Curing Acrylic Resin Containing Radiopaque Filler for Dental Implant Treatment

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Purposes: Recently, the conception of top-down implant treatment has been proposed in order to estimate the final restoration in dental implant treatment. For this purpose, a diagnostic stent is used in presurgical imaging. However, there has not been an appropriate consideration given to the computed tomography (CT) value of the materials used to construct the crown restoration of diagnostic stent. In this investigation, a self-curing acrylic resin with radiopaque filler considered CT value was developed and clinically applied.

Materials and methods: Filler material with 4 levels of radiopacity was added to self-curing resin. Cylinder phantoms measuring 5 mm, 10 mm, 15 mm and 20 mm in diameter and 5 mm in length were produced using each self-curing acrylic resin, and CT scans was performed with a multislice helical CT unit (HiSpeed NX/I Pro, GE Yokogawa Medical Systems, Tokyo, Japan). A circular region of interest (ROI) was set at 80% of diameter in the center of 5 contiguous axial imagesof each cylinder phantom, and CT values in the ROI were measured using software supplied with the CT unit. In clinical practice, a diagnostic stent produced using the radiopaque acrylic resin was applied and then imaging studies with panoramic radiography, multi-slice CT, and dental cone-beam CT (3DX, Morita Co., Kyoto, Japan and Arphard VEGA, Asahi Roentgen Ind Co., Kyoto, Japan) were performed.

Results: The mean CT values of the phantom measuring 5 mm in diameter were 7.9×10^2, 1.48×10^3, 2.57×10^3, and 3.14×10^3, and those of the phantom measuring 20 mm was 7.4×10^2, 1.40×10^3, 2.21×10^3, and 2.61×10^3, in descending order.

Conclusion: The self-curing acrylic resin with radiopaque filler, in which CT value was close to that of enamel was developed and could be applied to panoramic radiography, multi-slice CT and dental cone-beam CT for presurgical imaging in dental implant treatment.

Biomechanical Interactions in Tooth-implant Supported Fixed Partial Dentures with Variations in the Number of Splinted Teeth and Connector Type: A Finite Element Analysis

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Purposes: A controversy emerged regarding whether implants should be connected to natural teeth in anatomically limited areas or self-supporting. When splinting the implant and tooth is a rational alternative in some clinical situations, the dissimilar mobility patterns of the osseointegrated implant and natural teeth make the biomechanical behavior of the entire system complicated. Consensus regarding the proper connector designs and number of splinting teeth in implant-teeth splinting systems have not been attained to improve the different degrees of mobility between the implant and tooth.

Materials and methods: Section contours of alveolar bone, abutment tooth and prosthesis were acquired from computed tomography (CT) and Micro-CT to construct the individual solid models and generated the splinted systems containing a Frialit-2 implant at second molar splinted to the first and second premolars in CAD system. Solid models were then imported to the finite element (FE) package to generate corresponding FE mesh models, non-linear simulated approach by using contact element to simulate the interface adaptation within the implant system and non-rigid connector function to calculate the detailed mechanical responses under system receiving six different loads. The main effects for each level of the three investigated factors (loading condition, number of splinted teeth, and connector type) in terms of the stress values and dissimilar mobility of the natural teeth and implant were computed for all models.

Results: The results indicated that load condition was the main factor affecting the stress developed in the implant, bone and prosthesis when comparing the type of connector and the number of splinted teeth. The stress values were significantly reduced in centric or lateral contact situations once the occlusal forces on the pontic were decreased. However, the prosthesis stress for the non-rigid connections was increased more than 3.4-fold relative to the rigid connections. Moreover, the average tooth-to-implant displacement ratios (RTID) with a non-rigid connection were obviously larger than those for rigid connections under axial loading forces. Adding an extra tooth to support a three-unit tooth-implant FPD only exploited its function when the prosthesis withstood lateral occlusal forces.

Conclusion: The load condition is the main factor affecting stress distribution in different components (bone, prosthesis and implant) of tooth-implant supported FPDs. Minimizing the occlusal loading force on the pontic area through selective grinding procedures could reduce the stress values obviously. A non-rigid connector may more efficiently compensate for the dissimilar mobility between the implant and natural teeth under axial loading forces but at the risk of increasing unfavourable stresses in the prosthesis.

Comparison of CBCT and conventional CT images for assessment of implant sites

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Purposes: To compare measurements from CBCT with those from conventional CT for assessment of implant sites.
Materials and methods: 20 patients (50 sites) with surgical stents containing markers for the assessment of implant sites were imaged using conventional CT (HiSpeed Advantage®, GE Medical, NY, USA). Axial images were reconstructed by conventional DentaScan® (GE Medical, NY, USA) and OnDemand 3D® (Cybermed Co., Seoul, KOREA) used in CBCT, respectively. Conventional image measurements were corrected for known magnification. Alveolar height and width above the mandibular canal were measured from the cross-sectional image at the marked area. Two observers measured three times from each cross-sectional image. Differences between the measurements were evaluated statistically.
Results: There is no significant difference between the measurements from CBCT and those from conventional CT (p>0.05). There is no significant difference in inter- or intra-observer readings.
Conclusion: Measurements from CBCT are similar to those from conventional CT. Thus, CBCT may replace conventional CT for assessment of implant sites.

Evaluation of MR Image artifacts caused by orthodontic appliances on the basis of innovative standard test method

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Purposes: In the magnet resonance image (MRI) scanning of head and neck regions, metallic artifact caused by dental metallic materials often distorts diagnostic images. In particular, orthodontic appliances sometimes produce large artifacts, which distort temporomandibular joint (TMJ) and brain images. And in general, an orthodontic appliance is replaced by another as the treatment stage is going on. So this time, we focused on the metallic artifacts of various orthodontic appliances. And to our knowledge, this is the first time to evaluate those kinds of artifacts using the standard test method proposed by the American Society for Testing and Materials (ASTM) in 2001. The aim of this study was to measure the MRI artifacts of orthodontic appliances and to evaluate the effect toward diagnostic images.
Materials and methods: We prepared typical seven orthodontic appliances as the test specimens, such as five archwires of 0.018-inch nickel titanium (NiTi), 0.017 x 0.019-inch NiTi, 0.018-inch stainless steel (SS), 0.017 x 0.019-inch SS, 0.019 x 0.025-inch SS and two multibracket appliances consisting of 6 and 12 SS brackets disposed on the arch of acrylic resin teeth. In scanning, each of specimens was placed at the center of the glass box the size of 16 centimeters square and depth filled with $CuSO_4$ solution. Artifacts were measured after scanning with spin-echo (SE) and gradient-echo (GRE) pulse sequence at 1.5T MR scanner (Signa LX, General Electric, Milwaukee, WI, USA). After complete shimming, axial, coronal and sagittal scanning were sequentially done without and with a specimen. In addition to that, another scanning for each was done with readout and phase-encode directions swapped. Those sets of scanning were applied for the six different orientations per a specimen. Analysis of DICOMs was done using free software on Windows XP®.
Results: With the definition shown by ASTM, the extent of metallic artifacts of orthodontic appliances can be depicted objectively and calculated almost automatically. In comparison with the same alloy, the larger a diameter of an archwire is, the larger an artifact becomes. And with GRE sequence, every specimen made larger artifact on MRIs than with SE sequence. In comparison with the two multibracket appliances, artifact of 12 was larger than of 6 brackets. And among orthodontic appliances, artifact of multibracket was much larger than any of archwires. These may suggest that the size of metallic artifact affected by the amount of ferromagnetic material not by the shape of a specimen. As for orientation of an object, artifact was smallest when an apex of orthodontic appliance was heading for static magnetic field.
Conclusion: The size of metallic artifact varies according to the sort of orthodontic appliances. In other words, the quality of diagnostic MRI may depend in which stage the orthodontic treatment is. As long as the multibracket appliance is most influential, the extent of metallic artifact may reach the TMJ as well as the whole oral cavity. And it may also effective in diminishing metallic artifact to displace an archwire from brackets or to remove SS brackets from molar teeth.

Metallic artifacts caused by dental metal prostheses on PET images obtained using two types of PET/CT scanners: A phantom study

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Purposes: Compared to the conventional attenuation correction method utilizing a transmission source, positron emission tomography / computed tomography (PET/CT), a CT-based attenuation correction method, tends to generate metallic artifacts. However, detailed PET/CT findings regarding the artifacts caused by dental metal prostheses have been rarely reported. The purpose of this study was to investigate the effects of CT artifacts caused by dental metal prostheses on PET images obtained using two types of PET/CT scanners.

Materials and methods: In this phantom study, the PET emission scan was performed at 2.54 kBq/g in a background of the 2-deoxy-2-[^{18}F] fluoro-D-glucose (^{18}F-FDG) activity, corresponding to the injection of a clinically standard dose of ^{18}F-FDG. This value was determined because 3.7 kBq/g was injected in a clinical study and the PET emission scan was performed at 60 minutes following ^{18}F-FDG injection. A dental arch cast composed of epoxy resin was fixed in a cylindrical water-bath phantom with a diameter of 20 cm. A spherical phantom of 16 mm in diameter positioned in the vicinity of the dental arch cast was used to simulate a tumor. To simulate the tumor imaging conditions, the ratio of ^{18}F-FDG radioactivity concentration of the spherical phantom to that of the water-bath phantom was set at 2.5. A dental bridge composed of a gold-silver-palladium alloy and covering from the first premolar to the second molar on the right mandibular side was prepared. A spherical phantom was set in the white artifact area on the CT images (site A), in a slightly remote area from the white artifact (site B), and in a black artifact area (site C). A PET/CT scan was then performed with and without the metal bridge at each simulated tumor site, and the artifactual influence was evaluated on the axial attenuation-corrected PET images, in which the simulated tumor produced the strongest accumulation. Measurements were performed using two PET/CT scanners (Gemini GLX 16; Philips Medical Systems, Markham, Ontario, Canada, and Discovery ST Elite; GE Medical Systems, Waukesha, Wisconsin, USA). These scanners were named scanners 1 and 2, respectively. The influence of the metal bridge on the attenuation-corrected PET images was evaluated using the change rate of the SUVmean, with and without the metal bridge at each simulated tumor site.

Results: At site A, the change rate of the SUVmean, showed an overestimation (scanner 1: +8.2%, and scanner 2: +3.3%). At site B, it also showed an overestimation (scanner 1: +3.5%, and scanner 2: +4.1%). However, at site C, it showed an underestimation (scanner 1: -25.8%, and scanner 2: -29.5%).

Conclusion: Careful interpretation of the underestimated area on the attenuation-corrected PET images corresponded to the black artifactual areas on the CT images caused by dental metal prostheses in the oral cavity is needed. Both attenuation-corrected and non-attenuation corrected PET images need to be reviewed to avoid metallic artifacts caused by them.

Accuracy of Intra-oral Radiography, Multi-detector Helical CT and Limited Cone Beam CT for the Detection of Horizontal Tooth Root Fracture

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Purposes: To compare the accuracy of intraoral radiography, multi detect helical CT (MDHCT; slice thickness: 0.63 and 1.25 mm) and limited cone beam X-ray CT (LCBCT) for the detection of horizontal tooth root fracture.

Materials and methods: Twenty-eight maxillary anterior teeth (bilateral first and second incisors) in seven beagle dogs were extracted with local anesthesia under sodium pentobarbital anesthesia. All crowns of the extracted teeth were cut down to approximately 2 mm from the cement enamel junction. All roots were labio-lingually ditched from the surface to the middle of the root using a tapered diamond bar. Using this guide groove, the root fracture in single horizontal plane was experimentally induced using a flat head screw-driver in 13 randomly selected teeth. The fragments were thoroughly held together and glued in their respective original positions using strong glue. All extracted teeth with and without fracture were replaced into their original sockets and were fixed using dental adhesive. After sacrificing the dogs, all teeth were excised with surrounding maxillary bone and soft tissues. The width of the fracture line was measured using a micro-CT device, and then the specimens were examined by the above-mentioned four kinds of radiographies. Intraoral radiographies were obtained using standardized x-ray exposure (65 kV, 20 mA, 0.1 s, focus-film distance, 40 cm) using bisecting technique with a conventional dental film. Axial scan images of MDHCT with six lined detectors were taken using standard conditions (130 kV, 80 mAs). The slice thicknesses were set up in two ways: (1) 0.63 mm using detector collimation 0.5 mm, and (2) 1.25 mm using detector collimation 1.0 mm. Each image was reconstructed to a 0.2 mm interval image. The LCBCT imaging produced a cylindrical area (40-mm height, 41-mm diameter) was obtained using a standardized exposure of 60 kV, 4 mA, 13.3 s, and with a slice thickness of 0.1 mm. The intraoral radiographs were observed on a light-box, and the reconstructed coronal images obtained by MDHCT and LCBCT were observed on a monitor. Diagnosis of root fracture was based on direct visualization of radiolucent line in each image by six dental radiologists.

Results: The actual width of the fracture line was 0.243 ± 0.069 mm. Inter-observer agreement in LCBCT was higher than those in other three radiographs. LCBCT showed the highest sensitivity, negative predictive value, and diagnostic accuracy (true positives + true negatives) for detection of the fracture line, followed by MDHCT (slice thickness: 0.63 mm); no significant difference was noted between MDHCT (slice thickness: 1.25 mm) and intraoral radiography. No significant difference was found in specificity or positive predictive values among the four methods.

Conclusion: LCBCT is considered more useful than other three radiographies as the diagnostic imaging of the horizontal tooth root fracture.

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Accuracy of linear measurements obtained by a newly developed cone beam CT

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Purposes: The aim of this study was to determine the accuracy of measuring linear distances obtained with a newly developed cone beam CT (CBCT) device with a single detector CT (SDCT) system.

Materials and methods: Measurements of length were taken using volumetric data from two imaging systems and were compared with physical measures using a caliper applied to one human adult skull. CB scans were obtained with a newly developed CBCT device with a scan volume of 16 x 16 x 14 cm. Conventional CT scans for comparison were performed with a helical SDCT scanner. To determine distance accuracy, 19 measurements were performed on radiopaque markers on a dry human skull. Landmarks were identified with gutta percha points embedded at 8 cranial and 6 mandibular landmarks and the linear measurements were taken with a precision digital caliper.

Results: Mean absolute measurement error(AME) for linear distances was 0.23 ± 0.06 mm for the CBCT device and 0.23 ± 0.12 mm for the SDCT device ($P = 0.97$ in paired t test). The average absolute percentage error (APE) was 0.28 ± 0.13 % and 0.26 ± 0.15 %, respectively ($P = 0.65$ in paired t test). The volumetric data rendered with both imaging systems provided highly accurate data compared with the gold standard of physical measures directly from the skulls, with less than 1%.

Conclusion: The difference between the imaging modes was statistically not significant for linear distance estimations. The CBCT scans proved almost same in linear measurements as the SDCT. The results indicate that the evaluated CBCT device provides satisfactory accuracy about linear measurements.

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Validity and Correspondence of Parallax Technique and Occlusal Cross-Sectional Technique for Localizing Impacted Teeth

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Purpose: To evaluate the validity and correspondence between the parallax technique and occlusal cross– sectional technique for localizing impacted teeth.

Materials and methods: Occlusal cross-sectional and parallax radiographs of 45 impacted teeth were interpreted for tooth localization. The impacted teeth were mesiodens, upper canine, and posterior teeth except third molars. Agreement and disagreement between both techniques were recorded. Agreement between the position of the teeth at the surgical procedure (gold standard), and on the radiograph were compared. If there was disagreement between those film interpretations, then conventional, cross-sectional tomography was applied. The Chi square test was used to analyze the validity and correspondence between both radiographic techniques and the gold standard. The effects of different positions of the impacted teeth on the radiographs from each technique were also analyzed.

Results: Eighty-nine percent of film interpretations from parallax and occlusal cross-sectional techniques agreed with each other. Eleven percent were different, and conventional, cross-sectional tomography was used for these cases in order to give a conclusive film interpretation. Statistical analysis showed medium level correlation between each technique and the gold standard. However, the parallax technique tended to give a better prediction in the upper anterior region.

Conclusions: Both parallax and occlusal cross-sectional techniques are useful for tooth localization, but in the upper anterior region, the parallax technique shows better prediction and is recommended as the first choice. More advanced imaging modalities such as tomography is recommended if the location could not be determined by the first two techniques.

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A Comparative Measurement Between Films and Digital Images in Endodontics

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Purpose: To compare the length, from a tooth apex to the tip of an endodontic file, measured from films and from digital images using a Kodak RVG intra-oral sensor.

Materials and methods: Thirty-three extracted maxillary molar teeth, each with a No. 8 endodontic file in one of their mesio-buccal or disto-buccal root canals, were radiographed, replicating the process of root length measurement. The distances from the tips of the files, inserted short of the apical foramina, to the root apices ranged from 0 to 2 mm. The radiographs of the teeth were made using two image receptors. One was F-speed, Insight Kodak No. 2 film and the other was the Kodak RVG 5000 intra-oral sensor. The digital images were saved after enhancement by a sharpness filter. Four oral radiologists measured, twice each, the length from the tooth apex to the tip of the endodontic file from all images. A digital caliper with a magnifying glass was used to measure the images on the films, whereas the digital images on a computer monitor were measured using software accompanying the sensor. The observers, at their discretion, were allowed to use some tools from the software to enhance the images. In addition, the observers were asked to rate their satisfaction with the clarity of the images on both films and digital radiographs, in consequence of their measurement. The measurement from the film and the digital images were statistically compared and the satisfaction and agreement of the observers in the image measurement were analysed.

Results: There was no significant difference between the films and the digital images in comparing the distances between the tips of endodontic files and root apices. (Paired samples test; *P-value = 0.742*). However, the satisfaction of all observers with the measurements from the digital images was superior to those from the films (Wilcoxon signed ranks test; *P-value < 0.01*). Both intra- and inter-observer agreement in the measurement from the digital images were higher than those from the films.

Conclusions: Using film as the silver standard commonly used in clinical practice, the digital images recorded by the Kodak RVG 5000 intra-oral sensor was comparable to those recorded by films for endodontic measurement. With the image enhancement capability of the computer software, the larger image on the computer monitor, and an easier method of measurement, the digital images gave higher satisfaction in measurement for the observers. The Kodak RVG 5000 intra-oral sensor can be used effectively in endodontic measurement.

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The value of panoramic radiography for assessing maxillary sinus inflammation

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Purposes: To evaluate the value of panoramic radiography for diagnosing maxillary sinus inflammation.

Materials and methods: A total of 214 maxillary sinuses from 114 panoramic radiographs were assessed in this study. Two independent experienced oral radiologists evaluated the images in random order for sinus inflammation. Using Cone beam CT images as a gold standard, the sensitivity and specificity of panoramic radiography were calculated and the inter- and intraobserver agreement for panoramic interpretation were obtained.

Results: The mean sensitivity and specificity of panoramic radiography were 81.0% and 85.6%, respectively. The weighted kappa for the inter- and intraobserver agreement of panoramic radiography was 0.56 and 0.60, respectively.

Conclusion: The diagnostic ability of panoramic radiography for maxillary sinus inflammation was reasonably accurate and can be used for screening. However, additional examinations should be considered in patients with potentially significant pathology.

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Image quality evaluation of intraoral digital imaging system, YCR-21XG

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Purposes: The aims of this study were to evaluate visual image quality of intraoral digital imaging system YCR-21XG by observer performance test.

Materials and methods: An aluminum block of 12 steps, with 7 holes in each step, was covered by an acrylic block. This phantom was radiographed using YCR-21XG and Digora Optime with various exposure times. All images were displayed to 7 observers. The change in the average number of perceptible holes from all steps in the two systems was plotted against exposure and compared with each other.

Results: The maximum number of perceptible holes of YCR-21XG was almost similar to that of Digora Optime. Exposure levels of the two systems where maximum observer performance is obtained were also similar to each other. In low exposure level, however, detectability in the YCR-21X was lower than that of the Digora Optime.

Conclusion: Observer performance using this system was similar to that with Digora Optime in image quality evaluation. However, further improvement may be required in the detectability in low exposure level.

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Development and assessment of a computer program to teach intraoral radiography

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Purposes: We have developed a training system for intraoral radiography based on virtual reality technique without radiation exposure. However, the system is fixed in a room, many students cannot use it simultaneously. Therefore, we developed a software to simulate intraoral radiography as a stand alone program. This program can be used anywhere, if there is a PC. The aim of this study was to introduce this program and evaluate its usefulness by student questionare.

Materials and methods: A data set of dried skull maxilla scanned with a multi detector CT was used. A simulation program made with Visual C++.NET (Microsoft Inc) can reconstruct an image in arbitrary positioning of a film and an indicator cone on the computer display. User decides a position and an orientation of them with a mouse interface. Students in the fifth grade used this program in a multimedia room at the same time and evaluated the operability and understanding level of the technique by comparing it with a conventional lecture.

Results: Students more than 60% felt the operation of the program difficult, though some of them understood the method of operating the program. Some students found that it was easy to understand projection geometry in arbitrary positioning of a film and an indicator cone by using this program, compared with the lecture only.

Conclusion: In this program, the process of positioning and reconstructing image are separated. This non user-friendly interface might have lead to the low evaluation scores for the operability and understanding. In addition, the students' inexperience of taking actual radiography might have influenced the result. We are going to improve the program and to evaluate it in a clinical training term.

Simulator to allow dental school undergraduate students to undergo pre-practical training in intraoral radiographic technique without using x-rays

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Purpose: The purpose of this study was to develop a simulator that does not use x-rays to enable dental school undergraduate students to undergo pre-clinical training in intraoral radiographic techniques.

Materials and methods: The simulator consists of 3 major components. The first is a manikin with an oral cavity in which a dental film can be set. The second is a mobile model dental x-ray unit with no parts that actually generate x-rays. The third is the case of a real intraoral solid-state x-ray sensor. Each of these components contains an electromagnetic sensor from which data are obtained. Three-dimensional positional relationships among the manikin, the cone of the x-ray unit and the intraoral sensor are obtained using a 6 degree-of-freedom electromagnetic motion tracking system. One transmitter and 2 receivers are fixed on each of the 3 components. According to captured data on the position of the 3 components, an intraoral radiographic image is calculated by the PC and displayed on a monitor. The calculation is based on a Ray-sum algorithm using the volume data for a dry skull obtained by CT scanning. The tooth and surrounding structures of the manikin, which is made of plaster, are also constructed using the CT volume data.

Results and Discussions: The simulator reproduced intraoral radiographic images accurately, corresponding to position employed. Our final goal is to further improve this system so as to allow objective evaluation of user skill. This study was supported by a Grant-in-aid for University Reform under a support program for distinctive university education by the Japanese Ministry of EducationÅACulture, Sports, Science and Technology.

Interactive ICT system for informed consent of oral radiology

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Purpose: Many patients have a fear from damaging effects of x-ray. Many patients have a worry about radiography. Sometimes some patients have a wrong knowledge from newspaper or television. We must be able to explain about the methods of radiography and the safety and risk of x-ray. We used to explain for patients with a pamphlet or leaflet before radiography at radiography room. However, this intelligible explanation is very difficult for most patients to understand. The purpose of this study is to make the new explanation system with ICT (Information and Communication Technology) for taking informed consent of oral radiography.

Material and Methods: Our explanation system was produced using HTML, MPEG and FLASH. We used FLASH CS3 for Macintosh (Adobe Inc.) and a Power MAC G5 (Apple Computer Inc.) to develop this system. We incorporated all contents in a laptop personal computer, and thought that we would show a patient this system in side of radiology room. We used our system for fifty patients before x-ray examination. We did questionnaire on our system for these patients. Contents of Questions as follows. 1) Have you understood the explanation by our PC? 2) Do you think that the explanation by animation and movie is necessary of other examinations?

Results: Contents of our system are as follows. 1) Bisecting technique, Paralleling technique and panoramic radiography: patients can see about the method of those examinations by Flash and movies. Those movies superimposed original animations of head position, teeth position, finger placement and etc. 2) Safety of the X-ray: We compared the natural radiation and the x-ray dose of examinations. Then we build animation into those results. 3) Almost of these patients replied that our system was useful for understanding the methods of radiography and the safety and risk of x-ray, comparing favorably with the conventional explanation.

Conclusions: It is considered that our system is useful when we take informed consent of oral radiography from patients.

Maxillo-Facial Skin Dose in procedure of Simulation and Verification with CT-Simulation and MV-CT

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Introduction: In recent improvement of technology and computer science were widely applied in medical science, and it significant cause good result in cancer treatment. Although the treatments become more sophisticate to the patient and the patients will get more radiation exposure. In this study we will show the skin dose of face during the procedure of CT simulation and the procedure of IGRT with MV-CT.

Materials and methods: TLD-100 chip was placed on the tip of nose, bilateral upper eye lids and upper lip of the human phantom. The procedure of the exposure were arranged as the patient in CT simulation in 85 cm large hole gantry CT Scanner and IGRT with MV-CT. The manipulation of the TLD was as the stander process.

Results: Skin dose of each region are as follows

	R't eye	L't eye	nose	Upper lip	
MV-CT	1.012	0.861	0.876	1.079	(cGy)
KV-CT	1.907	2.182	1.737	1.923	(cGy)

Effective Dose of Panoramic Radiography Using Optically Stimulated Luminescence (OSL) Dosimeter

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Purposes: The purpose of the study was to determine the adaptation of optically stimulated luminescence (OSL) dosimeter in measuring the absorbed dose of organ/tissue in diagnostic radiography, and to measure the dose in panoramic radiography using a Rando phantom.

Materials and methods: The OSL of aluminum oxide was fabricated to be able to insert into the hole dug in the Rando phantom, in shape of thin small sheet. The OSL dosimeter response was examined in the dependency on angle and energy of diagnostic X-ray beams. The OSL sheet in a capsule to shield a light was irradiated in free air with the incident X-ray ranged from 0 to 90 degrees and with the X-ray effective energy between 27 and 51 keV at the tube voltage from 50 to 120 kV. The absorbed dose of two panoramic machines (Hyper-X from Asahi Roentgen Corp, operated at 78kV, 10mA and PC-1000 from Pancorp, at 80kV, 6mA) was then measured.

Results: The dependency of the angle was ranged between 0.95 and 1.10, and the energy dependency was 38% in 50-120kV. The effective dose (2007 ICRP) calculated from absorbed dose was 11 micro Sv for a Hyper X and 7 micro Sv for PC-1000. These values were well coincident to the previous reports.

Conclusion: The OSL of aluminum oxide dosimeter can be used for the measurement of diagnostic X-ray machine.

Initial values of local diagnostic reference levels in computed tomography for dental implant planning

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Purpose: To establish initial values of local diagnostic reference levels (LDRLs) in order to promote optimization in computed tomography (CT) for dental implant planning, we surveyed the exposure factors and evaluated computed tomography dose indexes (CTDIs) weighted and dose-length products (DLPs) at two dental university hospitals of A and B in Japan.

Materials and methods: Utilizing exposure records, we randomly extracted 160 patients from October 2004 to February 2005 in A and 548 patients from May 2004 to March 2007 in B. During the survey the HiSpeed QX/i (GE/Yokogawa Medical Systems, Japan) scanner in A was operated at 120/140 kV, 76 mAs/rotation with a slice thickness of 1.25 (0.625 x 2) mm; the Asteion Model TSX-021A (Toshiba Medicals, Japan) scanner in B was operated at 120 kV, 113 mAs/rotation with a slice thickness of 1.0 mm. The spiral scans in A and B were commonly performed with a pitch factor of 1. The CT doses of the CTDIs and DLPs were measured using a calibrated dosimeter, model 9015 (Radcal, US) with a pencil ionization chamber, model 10X5-3CT inserted into a standard PMMA cylindrical head phantom, model 20CT-6.

Results and conclusions: The average weighted CTDIs were 28 mGy in A and 46 mGy in B, respectively; the average DLPs for a single upper/lower jaw and for both jaws were 140 and 250 mGy cm in A, and 180 and 360 mGy cm in B, respectively. Regarding the initial values of the LDRLs derived from the third quartiles of these CT doses, we recommend using the weighted CTDI of 35/46 mGy in A or B and common DLPs of 180/360 mGy for a single jaw or both jaws in A and B. To assure patient doses are as low as reasonably achievable, the exposure factors of CT for dental implant planning must be set at a tube voltage from 120 to 140 kV and a current-exposure time product below 110 mAs/rotation with a pitch factor above 1.

A survey of patient dose in intraoral and panoramic radiography at general dental offices

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Purpose: To promote optimization of radiation protection for patients in intraoral and panoramic radiography, we surveyed doses for standard adult patients at general dental offices in Tokyo-bay area and compared the doses with the diagnostic reference levels (DRLs) recommended in UK.

Materials and methods: We measured patient entrance doses (PEDs) in intraoral radiography with an optically stimulated luminescence (OSL) dosimeter, and dose-width products (DWPs) in panoramic radiography with an array of thermo-luminescent dosimeter (TLD) tips. Reading values of the OSL dosimeter and the TLD were calibrated using Radiation Monitor 9015 (Radcal) with the ionization chambers of 10X5-6M and 10X5-3CT, which were calibrated by the Japan Quality Assurance Organization.

Results and discussions: The PEDs for the same radiographic region were different with a factor of 100 among 28 offices. The offices, which used x-ray beams of adequate quality and higher speed films than D-speed with adequate film processing or digital x-ray sensors such as an imaging plate (IP) and a charge-coupled device (CCD), showed low PEDs. The PEDs for mandibular molar region were less than 4.0 mGy of the DRL. The offices with the PEDs more than 4.0 mGy used D-speed films and old x-ray units which generated x-ray beams of soft quality. The offices with the PEDs more than 10 mGy might obtain radiographs with over-exposure and under-developing procedure. The DWPs were different with a factor of 15 among 23 offices. The offices, which used x-ray beams generated at adequate tube voltage and film/screen systems with higher relative speed than 400, showed the DWPs less than 65 mGy mm of the DRL. Some of the offices, which used digital CCD systems, did not show the DWPs less than the DRL. The offices with the DWPs more than 65 mGy mm used film/screen systems with lower relative speed than 250 and old panoramic units with full-wave rectification. The offices with the DWPs more than 100 mGy mm used wider x-ray beams than 10 mm at a full width at a half maximum in a dose profile. The offices with the DWPs more than 200 mGy mm should check a slit alignment of the panoramic units.

Conclusions: The patient doses were less than the DRLs in 54% and 57% of the surveyed dental offices for intraoral radiography and panoramic radiography, respectively. The patient dose exceeding the DRLs should be improved without preventing the diagnostic purpose.

Changes in minor salivary gland secretion following medication of cevimeline in patients with Sjogren's syndrome

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Purpose: Sjogren's syndrome (SS) is generally known as an autonomic disease, which shows dry mouth and dry eye, because of exocrinopathies characterized by lymphocytic infiltration into exocrine glands, including salivary glands. A large number of agents to resolve dry mouth have been proposed, but few have obvious efficacy. Recently, it has been reported that cevimeline hydrochloride hydrate (cevimeline) improves the subjective perception of oral dryness, and increases whole saliva in SS. However, we often experienced in clinical process that oral dryness was improved nevertheless sustaining hyposalivation (diminution of whole saliva) in some patient after application of cevimaline. In these patients, the increase of flow rate of minor salivary glands (MSG) seem to be related in the improvement of oral dryness, since MSG exist in all areas of oral mouth. The purpose of this study was to examine the minor salivary flow rate following medication of cevimeline. and to observe following changes in dry mouth perception in patients with SS.

Subjects and Methods: Eight consecutive Japanese primary SS patients (6 female and 2 male) with a mean age of 66.5 ± 7.2 (range 53-75 years) treated with cevimaline for their dry mouth participated in this study. SS was diagnosed on the basis of the revised Japanese criteria for SS by the Committee on Sjogren's syndrome of the Ministry of Health and Welfare of Japan (1999). In all participants, whole saliva was severely diminishing. An informed consent was given from each subject, and the research program was approved by the Human Etgics Committee of Tohoku Unovrsity School of Dentistry. Secretions from lower labial minor salivary gland (LMSG) were detected and quantified using the iodine-starch filter paper method (Shoji et al., 2003), in each patient. Amount of whole stimulated saliva, which was stimulated by chewing gum, was measured. Subjective perception of oral dryness, difficulty in specking, eating and swallowing, and pain of oral mucosa were respectively measured using Visual Analogue Scale (VAS). These measurements were done at first arrival and each medical consultation day. Significance of difference in the pre- and post treatment was tested by Wilcoxon signed-rank test, or paired t-test. A difference of $p < 0.05$ was considered significant.

Results: After treatment of cevimelin, VAS score of subjective perception of oral dryness, difficulty in specking, eating and swallowing, and pain of oral mucosa were significantly reduced as compared with pre- treatment, indicating obvious improvement of patients' oral complaints. However, amount of whole stimulated saliva did not significantly increase and were still little even after treatment. On the other hand, salivary flow rate of LMSG significantly increased after cevimelin treatment.

Conclusion: Our results show that cevimeline increases MSG salivation even in SS patients with severe hyposalivation. The present findings suggest that decline of MSG salivation seem to be closely related to dry mouth perception, and that improvement of MSG salivation must be important to dry mouth treatment strategy.

Study of the diagnostic method for Sjogren syndrome using sialoscintigraphy

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Purposes: We studied how to improve the diagnostic accuracy for Sjogren syndrome using sialoscintigraphy.

Materials and methods: The subjects were 19 patients with Sjogren syndrome (4 male and 15 female, mean age 60.0 ± 13.4 years of age, 38 parotid glands and 38 submandibular glands). Thirty-seven controls with xerotomia (13 male and 24 female, mean age 60.0 ± 14.5 years of age, 74 parotid glands and 74 submandibular glands) were selected. The visual accumulated degree in sialoscintigraphy was evaluated as follows: absent, decrease, normal, and increase. Regarding the time activity curves for sialoscintigraphy, 2 parameters were calculated: stimulatory secretion ratio expressed the ratio of pre- to post- citrate stimulation counts on salivary glands (Rc), and the maximum storage ratio expressed the ratio of salivary counts to nasal counts (S/Nc). We evaluated Rc and S/Nc for comparison with our normal data as follows: decrease (lower than 1SD), normal (less than ± 1SD), increase (more than from 1SD to 2SD), excessive increase (higher than 2 SD).

Results: Evaluation of visual accumulation:1) when we diagnosed Sjogren syndrome to be absent of the visual accumulation in the parotid gland and/or the submandibular gland, the sensitivity was 65.7%, the specificity was 90.5%, and the accuracy was 82.1%. 2) When we diagnosed Sjogren syndrome to be absent of the visual accumulation in the parotid gland only, the sensitivity was 42.1%, the specificity was 95.9%, and the accuracy was 77.6%. 3) When we diagnosed Sjogren syndrome to be absent of the visual accumulation in the submandibular gland only, the sensitivity was 65.8%, the specificity was 91.9%, and the accuracy was 83.0%. Evaluation of Rc and S/Nc: 1) When we diagnosed Sjogren syndrome to evaluate the decrease of Rc and/or S/Nc in the parotid gland and/or the submandibular gland, the sensitivity was 66.2%, the specificity was 66.2%, and the accuracy was 66.1%. 2) When we diagnosed Sjogren syndrome to evaluate the decrease of Rc and/or S/Nc in the parotid gland only, the sensitivity was 66.2%, the specificity was 66.2%, and the accuracy was 66.1%. 3) When we diagnosed Sjogren syndrome to evaluate the decrease of Rc and/or S/Nc in the submandibular gland only, the sensitivity was 61.5%, the specificity was 80.8%, and the accuracy was 75.0%. Combined diagnosis: We diagnosed Sjogren syndrome to detect abnormal findings of several salivary glands in the visual accumulation. Next, we excluded the cases of excessive increase and increase from Sjogren syndrome in some salivary glands for evaluation of the S/Nc. Next, we didn't include the cases of excessive increase and increase from Sjogren syndrome in some submandibular glands for evaluation of Rc. In this combined diagnosis, the sensitivity was 89.5%, the specificity was 73.0%, and the accuracy was 78.6%.

Conclusion: We think that this combined diagnosis is useful to diagnose Sjogren syndrome using sialoscintigaphy.

Dynamic MR sialography for patients with Sjögren syndrome

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Purposes: To evaluate the clinical utility of dynamic magnetic resonance (MR) sialographic images as a diagnostic tool for patients with Sjögren syndrome.

Materials and methods: For standardized criteria of dynamic MR sialographic data, we recruited 30 volunteers. To get dynamic MR sialographic data from patients with Sjögren syndrome, we recruited 5 patients with definite Sjögren syndrome satisfying the present criteria. The dynamic MR sialographic images and data were acquired as acquisition of the optimal section using 2D-FASE sequencing (TR/TE: 6000/500) with single-section acquisition of thick sections was repeated every 30 seconds (acquisition time: 18 seconds; interval time: 12 seconds) before and after a few drops of 5% citric acid was placed on the tongue. Evaluation of the time-dependent alternation associated with citric acid stimulation of the area of the detectable parotid gland ducts was quantitatively measured using the scanner-computer analysis system. For each subject, a graph was drawn to demonstrate the relationship between the time course after citric acid stimulation and the changing ratio of the detectable area in the parotid gland ducts. The changing ratio was determined as follows: changing ratio = detectable area of parotid gland ducts/minimum detectable area. Student' t test was used to examine the differences between the volunteers' group and the patients' group. P values less than 0.05 were taken as indicating a statistically significant difference.

Results: On the representative dynamic MR sialographs of healthy volunteers, the main duct became clearer in a time-dependent fashion from immediately after citric acid stimulation until 30~60 seconds post-stimulation. Thereafter, the main duct became more obscure in a time-dependent manner. On the MR sialographs of patients with Sjögren syndrome, a small amount of atrophy of the parotid gland ducts was visible along its entire length, and diffuse areas of punctate high signal intensity 1 mm or less in diameter, so-called "apple-tree-like appearance", were distributed. Even post-citric acid stimulation, the findings mentioned above remained to be invariable. In addition, the difference in two functional parameters using the dynamic MR sialographic data was elucidated between the two groups. The maximum area of the detectable ducts in the group of patients is significantly smaller ($P<0.001$) than that in the group of volunteers. The changing ratio in the detectable ducts in the group of patients was significantly lower ($P=0.011$) than that in the group of volunteers.

Conclusion: Our study suggests that dynamic MR sialographic data in addition to MR sialographic images might be useful for the diagnosis of Sjögren syndrome.

Evaluation on changes of T2 values and ADCs of the Masseter muscle by Clenching

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Purpose: Our purpose of this study was to evaluate the change of T2 values and apparent diffusion coefficients (ADC) in masseter muscle (MM) by clenching.

Material and Methods: Fifteen healthy volunteers were examined. All volunteers gave informed consent and were considered in good health condition. All the examinations were performed on a 1.5T scanner (Intera Achieva; Philips Medical systems, Best, the Netherlands) utilizing a sensitivity encoding SENSE-NV-16coil. All examinations have been performed at rest, and afterwards during clenching. And then other 5-minute-rest examinations have been performed. To calculate T2, we used a spin-echo sequence; matrix=104×103; and total imaging time=3 min,28 s. TR was 2000 ms. Echo times were increased from 10 to 80ms in 10-ms interval. The signal intensities (SI) under various TEs were fitted to the equation SI=M exp (-TE/T2), where SI is the measured signal intensity, M is the steady state magnetization, and TE is the echo time. To calculate ADC, a single-shot, spin-echo, echo planner sequence were used with repetiton time(TR)=3500 ms; echo time(TE)=60 ms, spectral attenuated with inversion recovery (SPAIR) for fat suppression; reduction facto r of SENSE=2; matrix=104×103; NEX = 6; and total imaging time=4 min, 15 s. The motion-probing gradients (MPG) were applied separately along the posterior-to-anterior, right-to-left, and superior-to-inferior directions with b values of 0,300,and 600s/mm^2 at each direction. The ADC was calculated separated along each directions of the MPG for the evaluation of the anisotropic diffusion, therefore, we obtained the ADC-PA (anterior-posterior), ADC-LR (left-right) and ADC-SI (superior-inferior). We also calculated the ADC-iso for the mean diffusivity. The signal intensities (SI) under various b factors were fitted to the equation SI=M exp (-bD), where SI is the measured signal intensity, M is the steady state magnetization, and b is the strength of MPG, and D is the ADC. The regions of interest (ROI) were placed in each slice image of masseter muscle, and examined the change of ADC and T2value.

Results: 1. T2 value showed no significant difference between at rest and during clenching. 2. At rest, the ADC-SI was greater than either the ADC-R-L or the ADC-P-A, and it showed the anisotropic diffusion in the MM. The muscle fiber direction was roughly parallel to the superior to inferior direction in supine position; therefore, the primary eigenvector of the diffusion tensor might be also to the superior to inferior. 3. ADC-iso was significantly increased by clenching, and decreased after rest. The three ADCs for anisotropic diffusion were also significantly increased by clenching, and decreased after rest. These results might be attributed in the change of the blood flow, perfusion, muscle microstructure and so on. 4. The ratio of the increase of the ADC-SI between at rest and during clenching was significantly smaller than that of either the ADC-RL or the ADC-PA.

Conclusion: This research demonstrated the anisotropic diffusion in of MM and the increase of ADC by clenching. Therefore, ADC has a possibility of evaluation for bruxism.

Evaluation of masseter muscle contraction using Real-time tissue Elastography

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Purposes: The real-time tissue elastography is a newly developed technology, which may lead to the pathological tissue characterization. The aim of this study was to characterize the changes of muscle-related conditions induced by contraction using Pulse Doppler ultrasonography and real-time tissue elastography.

Materials and methods: Our study included 24 masseter muscles of 12 volunteers (7 men and 5 women, 27-55 years old; mean age 36.6 years) not affecting temporomandibular disorders. All ultrasonographic images were obtained using EUB-6500 (Hitachi Medical, Tokyo, Japan) with a 7-14MHz linear prove. Before and during clenching, Pulse Doppler ultrasonography of the facial artery and real-time elastography of the masseter muscle were performed. First, we measured both maximum and minimum value of the waveform (peak systolic and end diastolic velocity) using Pulse Doppler mode imaging. Second, we set two regions of interest, -superficial and deep portions-, in the masseter muscle. Elasticity score was measured in each portion. Next, we defined 'homogeneity rate' as S/D, where S is elasticity score of superficial portion and D is that of deep portion of the masseter muscle. Homogeneity rate was calculated in each case before and during clenching.

Results: The maximum and minimum velocities during clenching were significantly different from those before clenching ($P<0.05$). The maximum and minimum velocities during clenching were lager than those before clenching. For elasticity score, mean values of superficial and deep portion of masseter muscle were 1.73 and 1.47 respectively before clenching, while 1.15 and 0.23 during clenching. For homogeneity rate, in consequence, the mean value before clenching was 1.28 and that during clenching was 20.61 ($P<0.001$).

Conclusion: 1. Maximum and minimum velocities of blood flow were significantly higher during clenching than before clenching. 2. Homogeneity rate was significantly higher during clenching than before clenching. These two parameters may be useful to evaluate masseter muscle pathology.

Nocturnal Bruxism and Botulinum Toxin Effect on the Subjects with Masseteric Hypertrophy

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Purposes: To evaluate a relation of bruxism with clinical effects of botulinum toxin type A (BTX-A) injection in the subjects with the masseteric muscle hypertrophy

Materials and methods: 5 bruxers and 5 nonbruxers with bilateral masseter hypertrophy were participated in this study, After injecting 25 unit of BTX-A (Allergen Inc, Botox) into each masseter muscle, the thickness of masseter (Ms) and anterior temporalis (Ta) muscles was measured by ultrasonography and the maximum bite force was evaluated during a 9-month period. Self-estimation on the recovery of occlusal force during mastication was done as well.

Results: Regardless of presence of bruxism, all subjects showed significantly reduced Ms thickness ($p<0.001$) and maximum bite force at 1st molars ($p=0.027$) with their peak at 3 months after infection, which then started to return. No significant difference was observed in Ta thickness and the bite force at the central incisors. While self-estimated occlusal force was the least at 2 weeks after injection and then rapidly returned to the baseline level with full recovery at the time of 6 to 9 months after injection, the maximum bite force measured by bite force recorder did not recover the original value, particularly in the nonbruxer group.

Conclusion: It is assumed that nocturnal bruxism can influence recovery of atrophic masseter and decreased occlusal force due to BTX-A injection. These findings suggest a need of occlusal appliance to control bruxism or clenching habit for longer clinical effect of BTX-A injection.

Massage for the masseter and temporal muscles using the oral rehabilitation robot

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Purposes: This study was aimed to determine the suitable condition for masseter and temporal muscles massage using a specially fabricated robot named the "Waseda-Asahi Oral-Rehabilitation Robot No. 1 (WAO-1)", and to evaluate its effects on patients with TMJ dysfunction associated with myofascial pain.

Materials and methods: WAO-1 was composed by two 6-degree of freedom (DOF) arms with plungers attached at the end-effector. Massage was applied to the patient by controlling the force and position of the plunger (virtual compliance). Three massage pressures (1, 6 $\sim$ 8, and 10 N) were tested in twelve healthy volunteers. The maximum mouth opening was measured between the upper and lower incisors. All volunteers were asked to record subjective evaluations regarding comfortableness, warmth and ease of mouth opening using the visual analogue scale (VAS). The thickness and intramuscular appearances were evaluated using ultrasonography. After the determination of massage pressure, the robot was applied to some patients. The massage pressure applied started at 6 N and was increased gradually. One-minute massage was performed alternately for the masseter and temporal muscles and a treatment session consisted of seven repeated massages. This treatment was performed three times every two weeks. The maximum mouth opening was measured before and after massage together with subjective evaluations including pain.

Results: On subjective evaluation, most volunteers showed the highest VAS score for comfortableness at 6 $\sim$ 8 N, while the warmth and ease of mouth opening scores were the highest at 10 N. The VAS after massage was slightly related to muscle thickness. The maximum mouth opening increased and the pain decreased in all patients after treatment.

Conclusion: This robot appeared to be a potential tool for the treatment of TMJ dysfunction associated with myofascial pain.