Oral Radiol (2014) 30:53–63
DOI 10.1007/s11282-013-0139-z

ORIGINAL ARTICLE

Retrospective comparison of the frequency, distribution, and radiographic features of osteosclerosis of the jaws between Taiwanese and American cohorts using cone-beam computed tomography

Chia-Hui Chen · Chien-Kuo Wang · Li-Min Lin · Yao-Der Huang · James R. Geist · Yuk-Kwan Chen

Received: 5 February 2013 / Accepted: 1 April 2013 / Published online: 9 May 2013

Abstract
Objectives The aim of this study was to retrospectively compare the frequency, distribution, and radiographic features of osteosclerosis of the jaws between Taiwanese and American cohorts using cone-beam computed tomography.
Methods Our study comprised 400 Taiwanese and 400 American subjects. A three-dimensional model was used to measure the volume and mesial–distal distance (MDD) of the osteosclerotic lesions. A cross-sectional view was used to measure the top–bottom distance (TBD), buccal–lingual distance (BLD), and whether the lesions contacted the buccal and/or lingual cortical bone or adhered to root apices. The MDD and TBD were also measured on a panoramic reformatted view, which was used to classify the side, shape, and tooth site. The axial view was evaluated to categorize the osteosclerotic lesions as homogeneous or heterogeneous.
Results There was a significant difference in the frequency of osteosclerosis between the Taiwanese and American cohorts, as well as significant differences between these two cohorts in the measurements of volume, BLD, and MDD. No significant differences between males and females were found in either cohort. In the Taiwanese cohort the highest prevalence of osteosclerotic lesions (38 %) was found in subjects aged 40–49 years, while in the American cohort the highest prevalence (36 %) was found in subjects aged 30–39 and ≥60 years.
Conclusions The findings of our study may be of valuable clinical relevance to dental practitioners, since osteosclerosis of the jaws may have a significant impact on the osseointegration of dental implants.

Keywords Cone-beam computed tomography · Osteosclerosis · Taiwanese · Americans

C.-H. Chen and C.-K. Wang contributed equally to the work presented in this paper.

C.-H. Chen · L.-M. Lin · Y.-K. Chen
School of Dentistry, College of Dental Medicine, Kaohsiung Medical University, 100 Shih-Chuan 1st Road, Kaohsiung 80708, Taiwan

C.-K. Wang
College of Medicine, National Cheng Kung University, 138 Sheng Li Road, Tainan 70428, Taiwan

L.-M. Lin · Y.-K. Chen
Division of Oral Pathology and Maxillofacial Radiology, Kaohsiung Medical University Chung-Ho Memorial Hospital, 100 Shih-Chuan 1st Road, Kaohsiung 80708, Taiwan

L.-M. Lin · Y.-K. Chen (✉)
Oral and Maxillofacial Imaging Center, Kaohsiung Medical University, 100 Shih-Chuan 1st Road, Kaohsiung 80708, Taiwan
e-mail: yukkwa@kmu.edu.tw

Y.-D. Huang
Department of Dentistry, National Taiwan University Hospital, No. 1, Changde Street, Zhongzheng District, Taipei City 10048, Taiwan

J. R. Geist (✉)
School of Dentistry, University of Detroit Mercy, 2700 Martin Luther King Jr. Blvd, Detroit, MI 48208-2576, USA
e-mail: geistjr@udmercy.edu

Introduction

Osteosclerosis typically presents as an asymptomatic lesion that corresponds to dense bone without inflammatory, dysplastic, or neoplastic features on radiographic and histologic examinations [1–4]. Abnormally dense bone and bone thickening are commonly observed in these lesions, and the condition can be found in many bones, including the jaws. On radiographic evaluation, osteosclerosis of the jaws appears as a lesion of uniform radiopacity, with sharp margins and increased density [5, 6], comparable to the lesions occurring in other bones [7]. Although several possible etiologic factors have been suggested, including root fragments, reactive bone deposition [8], and intraosseous anatomic variations [2], the exact factors causing osteosclerosis of the jaws remain uncertain. A number of researchers have suggested possible differences in the prevalence of osteosclerosis between racial groups [8–11], but these variations are not completely understood.

Most previous studies on osteosclerosis of the jaws have been based on panoramic radiography [9–11], which presents the lesions in two-dimensional (2D) images. However, cone-beam computed tomography (CBCT) has been developed to generate detailed three-dimensional (3D) images of dentomaxillofacial structures [12, 13]. Application of the appropriate CBCT imaging techniques can identify the exact locations and characteristics of osteosclerotic lesions of the jaws. To our knowledge, osteosclerosis of the jaws has not been studied using CBCT imaging and, therefore, the aim of our study was to compare the age, sex, distribution, and various radiographic features of osteosclerosis of the jaws between Taiwanese and American cohorts using CBCT.

Materials and methods

Subjects

This was a retrospective analysis that was performed to evaluate two different groups of patients from 2009 to 2010 who underwent CBCT examinations. The Institutional Review Boards of the two institutions where the patients were examined approved the study. No specific inclusion and exclusion criteria based on medical conditions were applied.

Group 1 comprised 400 Taiwanese adults (244 males, 156 females) ranging in age from 20 to 84 years (average age 52.75 ± 12.55 years) (Table 1). For this group, we obtained 400 images of the maxilla ($n = 199$) and mandible ($n = 201$) for analysis. Group 2 comprised 400 Americans (223 males, 177 females) ranging in age from 20 to 88 years (mean age 46.94 ± 18.02 years) (Table 1). Images of both jaws were available for analysis for 28 of the 400 subjects in Group 2. Therefore, for Group 2, we had a total of 429 images of the maxilla ($n = 201$) and mandible ($n = 228$) for analysis. The patients in both groups were also classified into age levels as follows (Table 1): (1) 20–29 years, (2) 30–39 years, (3) 40–49 years, (4) 50–59 years, and (5) ≥60 years.

Table 1 Demographic data for osteosclerosis of the jaws in Group 1 (Taiwanese) and Group 2 (American) subjects

Variables	Group 1, *n* (%)	Group 2, *n* (%)
Sex		
Female	244 (61)	223 (56)
Male	156 (39)	117 (44)
Total	400 (100)	400 (100)
Jaw		
Mandible	201 (50)	228 (53)
Maxilla	199 (50)	201 (47)
Total	400 (100)	429 (100)
Age level[a]		
1	21 (5)	103 (24)
2	38 (10)	53 (12)
3	86 (22)	54 (13)
4	131 (33)	106 (25)
5	124 (31)	113 (26)
Total	400 (100)	400 (100)

Data are presented as the number with the percentage in parenthesis

[a] Age levels: (1) 20–29 years, (2) 30–39 years, (3) 40–49 years, (4) 50–59 years, (5) ≥60 years

CBCT system

Cone-beam computed tomography was performed at both institutions using an I-CAT® Cone Beam 3D Dental Imaging System (model 17–19; Imaging Sciences International, Hatfield, PA) set at the default parameters (120 kVp; 23.87 mAs; 6-cm field of view; 0.3- or 0.4-mm voxel size; medium sharpness filter) and measurement software (i-CATVision™ VisionQ ver. 1.8.1.10). The occlusal plane of each patient was set parallel to the floor base using a chin rest, and the acquired images were reconstructed into multiple-plane views (axial, panoramic, and cross-sectional) and 3D representations (Fig. 1). 3D modeling was performed by image processing software (Materialise Mimics ver. 10.01; Materialise Dental, Glen Burnie, MD). The CBCT units were calibrated at least once per week.

CBCT image analysis

3D model view

A 3D model of each osteosclerotic lesion was built from the axial, panoramic, and cross-sectional views (described

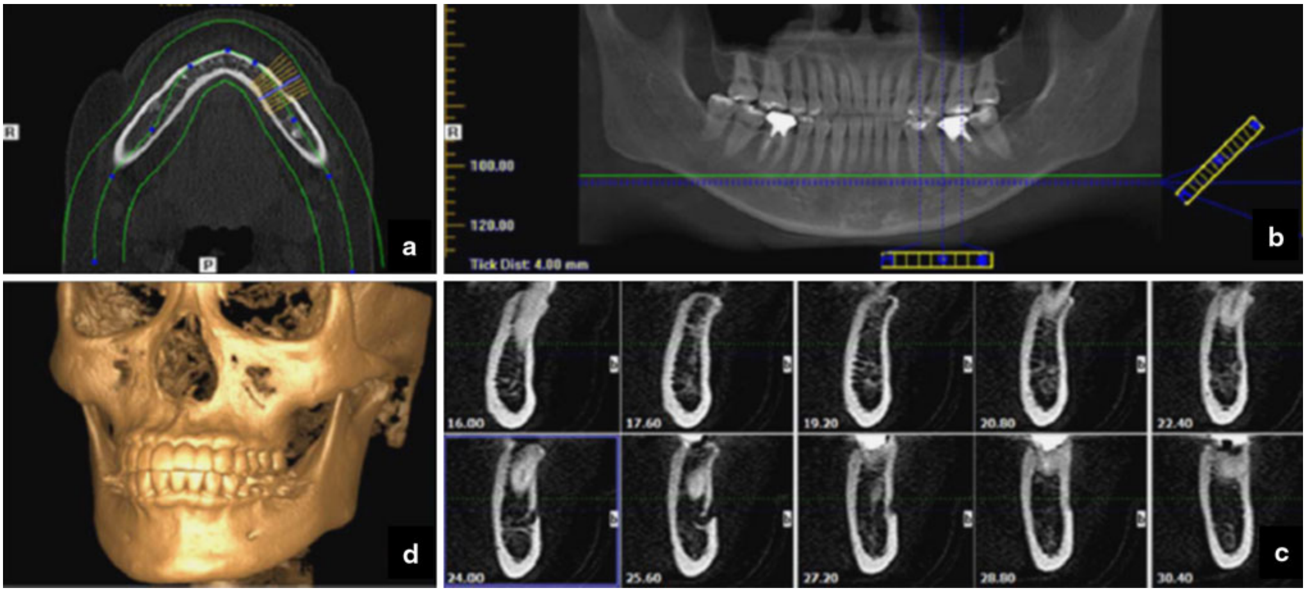


Fig. 1 Axial view (**a**), panoramic view (**b**), and cross-sectional view (**c**), and three-dimensional (3D) representation (**d**)

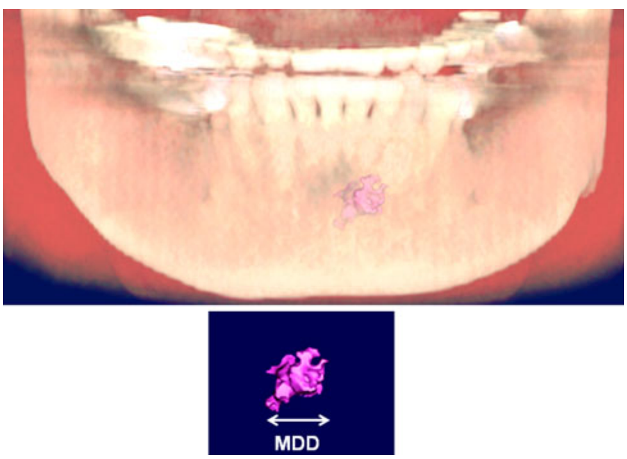


Fig. 2 Three-dimensional reconstruction and resulting volume as well as measurement of the mesial–distal distance (*MDD*) of a representative mandibular osteosclerotic lesion

below) using the threshold setting (bone density scale range 350–1,500 HU). Volumetric measurements were calculated for each lesion in a free-hand manner using the automatic function of the Mimics software (Materialise NV, Leuven, Belgium). The mesial–distal distance (MDD) of each lesion was also measured (Fig. 2).

Cross-sectional view

A cross-sectional view perpendicular to the mandibular dental arch (Fig. 3a) was used to measure: (1) the top–bottom distance (TBD), and (2) the buccal–lingual distance (BLD). The cross-sectional image also showed whether the lesion contacted the inner surface of the buccal and/or lingual cortical bone or adhered to the root apex (Fig. 3b–e).

Panoramic view

The MDD and TBD of each lesion were also measured from a panoramic view reconstructed from the CBCT data (Fig. 4). The panoramic view was further used to classify the side (left or right), shape (circular, oval, or irregular) (Fig. 5), and location with respect to the tooth site(s).

Axial view

The axial view was used to categorize each lesion into homogeneous (HO) or heterogeneous (HE) type (Fig. 6).

Measurements

All measurements were made independently by two examiners (C-H. Chen and Y-K. Chen), both of whom have at least 10 years of experience in acquiring and interpreting CBCT scans. When there was disagreement between the two examiners, an agreement was reached by mutual discussion. Comparisons between the patients in Group 1 and Group 2 were analyzed by the χ^2-test for the frequency of osteosclerosis and by a two-sample t test for all measurements, with the results denoted as mean ± standard deviation. Pearson's correlation coefficients were used to compare the MDD and TBD measurements obtained from the CBCT and panoramic reconstructed images. All statistical assessments were two-sided, and significance was accepted for values of $P < 0.05$. All statistical analyses

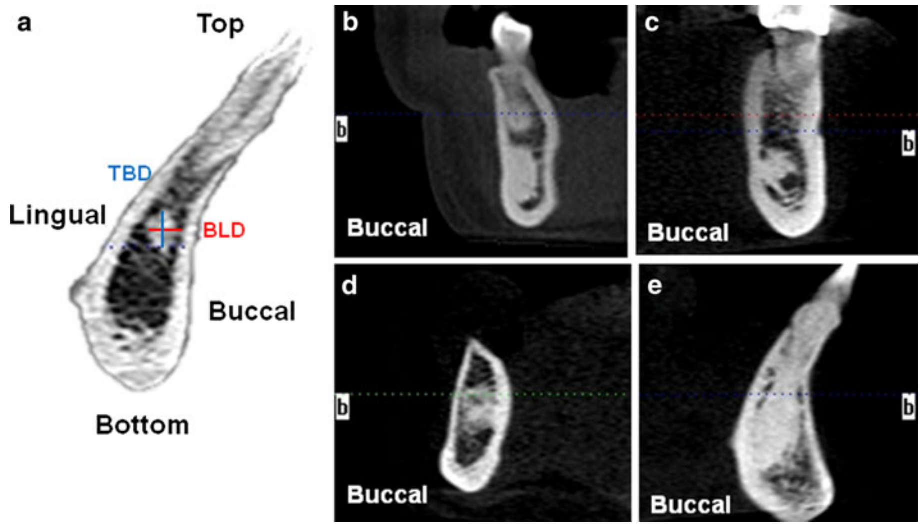


Fig. 3 Cross-sectional view reconstructed from cone-beam computed tomography (CBCT) data to measure the top–bottom distance (*TBD*) and buccal–lingual distance (*BLD*) of a representative mandibular osteosclerotic lesion (**a**) and to determine whether the lesion contacts the inner surface of the buccal (**b**), lingual (**c**), or both buccal and lingual (**d**) cortical bone, or adheres to the root apex (**e**)

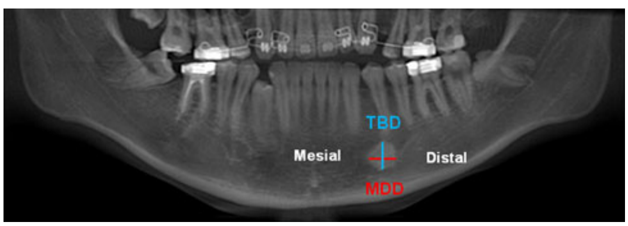


Fig. 4 Panoramic view reconstructed from cone-beam computed tomography data to measure the MDD and TBD of a representative mandibular osteosclerotic lesion

were performed using SPSS ver.15.0 statistical software (SPSS, Chicago, IL).

Results

As shown in Table 2, there were 45 (11 %) and 22 (5 %) osteosclerotic lesions in Groups 1 and 2, respectively. The χ^2-analysis demonstrated a significant difference in the frequency of osteosclerosis between the two groups ($\chi^2 = 10.595$, $P = 0.0011$) (Table 2). The frequencies of the locations of the osteosclerotic lesions with respect to the tooth sites between Group 1 and Group 2 are shown in Table 2 and Fig. 7a, b. In Group 1, the most frequently involved tooth sites were the left mandibular first molar (13 %) and right mandibular second premolar (13 %) (Fig. 7a). In Group 2, the most commonly involved tooth site was the right mandibular first molar (23 %), followed by the left mandibular second molar (15 %) (Fig. 7b). In both Group 1 and Group 2, the most frequently involved location was the mandibular posterior region (69 and 77 %, respectively), followed by the mandibular anterior region (22 and 18 %, respectively). There was no significant difference in the frequency of osteosclerosis by site in the jaws between the Taiwanese and American groups ($\chi^2 = 2.900$, $P = 0.5746$) (Table 2).

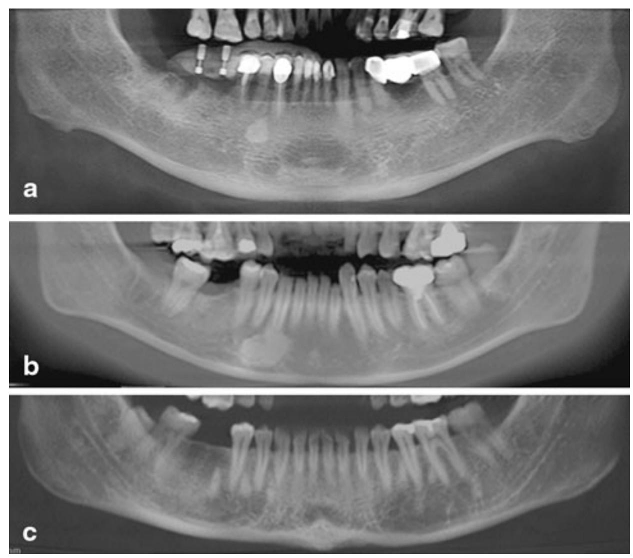


Fig. 5 Panoramic view reconstructed from CBCT data to classify the different shapes of osteosclerotic lesions as circular (**a**), oval (**b**), or irregular (**c**)

The frequencies of osteosclerosis in Group 1 females and males were 10 % (20/200) and 13 % (25/200), respectively, while those in Group 2 females and males were 5 % (13/247) and 5 % (9/182), respectively (Table 3). There were no significant differences between the frequencies in males and females for either Group 1 ($\chi^2 = 0.627$, $P = 0.4284$) or Group 2 ($\chi^2 = 0.022$, $P = 0.8825$) (Table 3).

As shown in Table 3, in Group 1 the greatest percentage of patients with osteosclerosis was found in the age range of 40–49 years (20 %, 17/86), followed by the age range of 30–39 years (13 %, 5/38). No significant difference was detected for the frequency of osteosclerosis based on age

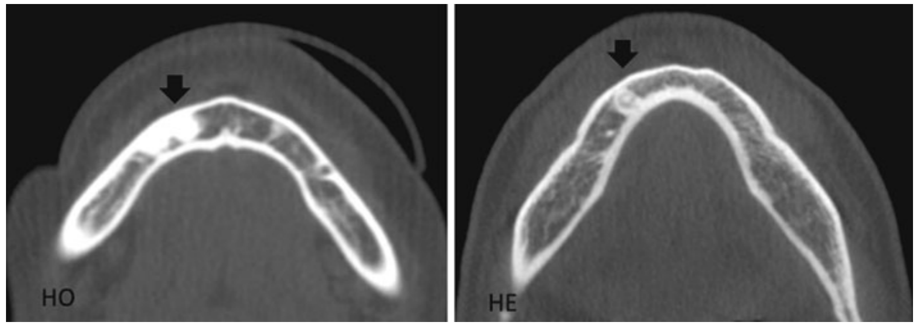


Fig. 6 Axial views reconstructed from CBCT data to show representative homogeneous (*HO*, *arrow*) and heterogeneous (*HE*, *arrow*) types of osteosclerotic lesions

Table 2 Comparison of the frequency of osteosclerotic lesions and the frequency according to the sites in the jaws in Group 1 (Taiwanese) and Group 2 (American) subjects

Variables	Group 1, *n* (%)	Group 2, *n* (%)	χ^2	*P*
Osteosclerosis				
Without osteosclerosis	355 (89)	407 (95)	10.595	0.0011*
With osteosclerosis	45 (11)	22 (5)		
Total	400 (100)	429 (100)		
Site				
Mandible				
Incisor and canine areas	10 (22)	4 (18)	2.900	0.5746
Incisor and canine areas to premolar and molar regions	1 (2)	1 (5)		
Premolar and molar regions	31 (69)	17 (77)		
Maxilla				
Incisor and canine areas to premolar and molar regions	1 (2)	0 (0)		
Premolar and molar regions	2 (4)	0 (0)		
Total	45 (100)	22 (100)		

Data are presented as the number with the percentage in parenthesis

* Significant difference at $P < 0.05$

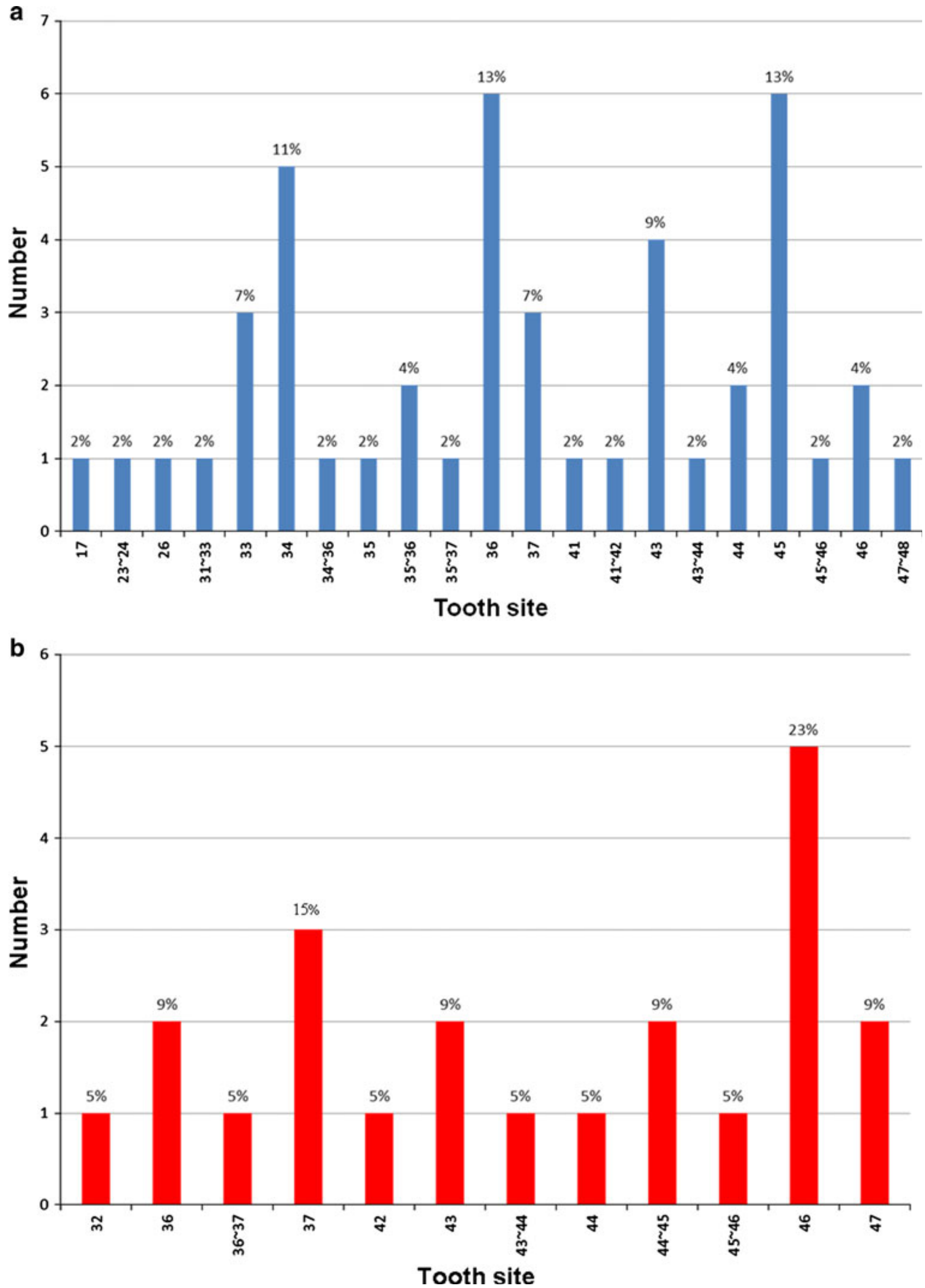
level ($\chi^2 = 8.277$, $P = 0.0819$). In Group 2, the greatest percentage of patients with lesions was noted in the age range of 30–39 years (15 %, 8/53), followed by the age range of ≥60 years (7 %, 8/113). In contrast to Group 1, there was a significant difference in the frequency of osteosclerosis between the age levels in Group 2 ($\chi^2 = 15.500$, $P = 0.0038$).

As also shown in Table 3, the frequencies of osteosclerosis in the mandible and maxilla were 21 % (42/201) and 11 % (3/199), respectively, in Group 1 and 10 % (22/228) and 0 %, respectively, in Group 2. There were significant differences in the frequency between the jaws for both Group 1 ($\chi^2 = 44.193$, $P < 0.0001$) and Group 2 ($\chi^2 = 28.859$, $P < 0.0001$). Moreover, in comparisons of the data on side (left or right), shape (circular, oval, or irregular), contact site (apex, buccal, lingual, or buccal and lingual cortex), tooth site, and nature of radiopacity (HO or HE) within Group 1 and Group 2, only differences between the HO and HE patterns in both Group 1 and Group 2 were significant, with HO patterns being much more common than HE patterns in both groups.

As shown in Table 4, the mean MDD measurements of the osteosclerotic lesions were 6.32 mm on panoramic reconstructed radiographs and 5.93 mm on CBCT 3D images in both Group 1 and Group 2. The mean TBD measurements were 7.37 mm on panoramic radiographs and 6.73 mm on cross-sectional CBCT images. The mean MDD and TBD measurements on panoramic radiographs were noted to be approximately 1.1-fold (6.32/5.93 for MDD; 7.37/6.73 for TBD) longer than the measurements on CBCT images. The Pearson's correlation coefficients showed highly significant linear correlations between the CBCT and panoramic images for both MDD ($R = 0.98$; $P < 0.0001$) and TBD ($R = 0.98$; $P < 0.0001$).

As shown in Table 5, the mean volumes of the osteosclerotic lesions were 403.37 (range 18.82–2547.67) mm^3 for Group 1 and 159.80 (range 28.97–645.41) mm^3 for Group 2. The two-sample *t* test analysis showed a significant difference in the mean volume of the lesions between the two groups ($P = 0.036$). The mean TBDs for Group 1 and Group 2 were 7.11 (range 2.43–18.97) mm and 5.95 (range 3.20–9.87) mm, respectively. This difference was not significant ($P = 0.1237$). The mean BLDs for Group 1 and Group 2 were 6.00 (range 2.40–11.21) mm and 4.99 (range 2.28–9.38) mm, respectively; these measurements differed significantly ($P = 0.0419$). The mean MDD

Fig. 7 Frequencies of locations of osteosclerotic lesions of the jaws with respect to tooth sites in Group 1 (Taiwanese) (**a**) and Group 2 (American) (**b**)



measurements were 6.58 (range 2.56–19.10) mm in Group 1 and 4.60 (range 1.69–7.12) mm in Group 2; these measurements were also significantly different ($P = 0.0134$).

Comparisons of the frequency, distribution, and various radiographic features of the osteosclerotic lesions between Group 1 and Group 2 are listed in Table 6. The χ^2-analysis showed no significant differences between the two groups in terms of the predilection for males versus females ($\chi^2 = 1.273$, $P = 0.2592$) or prevalence in the mandible versus the maxilla ($\chi^2 = 2.456$, $P = 0.117$). In contrast, a significant difference for the age level of patients with osteosclerotic lesions was demonstrated between Group 1 and Group 2 subjects ($\chi^2 = 14.454$, $P = 0.006$). Most lesions (38 %) in Group 1 were found in subjects aged 40–99 years, while most lesions in Group 2 were detected in patients aged 30–39 years and ≥60 years (36 % for each age level). No significant differences were found between Group 1 and Group 2 with respect to side (left or right), shape (circular, oval, or irregular), contact site (apex,

Table 3 Comparison of the frequency of osteosclerotic lesions of the jaws by sex, age level, jaw, side, shape, contact site, and nature of radiopacity within Group 1 (Taiwanese) and Group 2 (American) subjects

Osteosclerosis	Group 1				Group 2			
	Without osteosclerosis, *n* (%)	With osteosclerosis, *n* (%)	χ^2	*P*	Without osteosclerosis, *n* (%)	With osteosclerosis, *n* (%)	χ^2	*P*
Sex								
Female	180 (90)	20 (10)	0.63	0.428	234 (95)	13 (5)	0	0.8825
Male	175 (88)	25 (13)			173 (95)	9 (5)		
Age level[a]								
1	19 (90)	2 (10)	8.28	0.082	102 (99)	1 (1)	16	0.0038*
2	33 (87)	5 (13)			45 (85)	8 (15)		
3	69 (80)	17 (20)			53 (98)	1 (2)		
4	119 (91)	12 (9)			102 (96)	4 (4)		
5	115 (93)	9 (7)			105 (93)	8 (7)		
Jaw								
Mandible	159 (79)	42 (21)	44.2	<0.0001*	206 (90)	22 (10)	29	<0.0001*
Maxilla	196 (98)	3 (2)			201 (100)	0 (0)		
Side								
Left		25 (56)	0.36	0.551		7 (32)	2.2	0.1356
Right		20 (44)				15 (68)		
Shape								
Circular		18 (40)	0.93	0.627		5 (23)	1.2	0.5538
Oval		14 (31)				9 (41)		
Irregular		13 (29)				8 (36)		
Contact site								
Apical		7 (29)	0.67	0.881		1 (7)	3.9	0.2688
Buccal		5 (21)				6 (40)		
Buccal and lingual		5 (21)				3 (20)		
Lingual		7 (29)				5 (33)		
Nature of radiopacity								
Homogeneous		15 (33)	4.36	0.0369*		5 (23)	5.5	0.010*
Heterogeneous		30 (67)				17 (77)		

Data are presented as the number with the percentage in parenthesis

* Significant difference at $P < 0.05$

[a] Age levels: (1) 20–29 years, (2) 30–39 years, (3) 40–49 years, (4) 50–59 years, (5) ≥60 years

buccal, lingual, or buccal and lingual cortex), tooth site, and natures of radiopacity (HO or HE).

Discussion

The results of our study indicate that a few lesions, predominantly condensing osteitis, cemento-osseous dysplasia, and mature complex odontoma, should be included in the differential diagnosis of osteosclerosis of the jaws [1]. Differentiating condensing osteitis from osteosclerosis can be difficult, if not impossible, when the sclerotic lesion is located in an edentulous ridge and is not related to a specific tooth. If the sclerotic lesion neither contains a root tip nor surrounds the apex of an infected (or non-vital) tooth, the diagnosis of osteosclerosis is appropriate. If, however, a root tip can be observed within the sclerotic lesion, the diagnosis would be condensing osteitis. Consequently, sclerotic lesions attached to either a root tip or to a non-vital tooth were excluded from our study. Cemento-osseous dysplasia and mature complex odontoma can be diagnosed principally on the presence of radiolucent borders. Hence, sclerotic lesions containing a radiolucent rim were also not included in our analysis. Mature complex odontoma can be distinguished from osteosclerosis by its distinctive high radiopacity which reflects the inclusion of enamel within the lesion.

The frequency of osteosclerotic lesions was significantly different between the Taiwanese and American cohorts enrolled in our study. This finding suggests that differences in prevalence may exist between races. Geist and Katz [8] found a significantly greater frequency of osteosclerosis among black patients compared with white patients in an American population. The overall prevalence of osteosclerosis in their patients (5.4 %) was lower than the percentages of affected patients in studies conducted in Japan by Kawai et al. (9.7 %) [9] and in Korea by Lee et al. (6.7 %) [14]. In our study, we found osteosclerosis in 11 % of Taiwanese patients compared with 5 % of American patients. Although the American cohort in our study was not stratified by race, it is possible that the largely white and black populations surveyed in North America may have a lower tendency to develop these lesions than Asian populations. Lee et al. [14] reported that there was a higher prevalence of osteosclerosis in females (6.89 %) than in males (6.45 %) in Korea. However, in our study, there were no significant differences in the frequencies of osteosclerosis by sex in either the Taiwanese or American cohorts, which is consistent with previous studies [9, 11, 16].

In most of the studies reported to date, the majority of osteosclerotic lesions occurred in the mandible [15, 16], which is consistent with our findings. Sisman et al. [17] reported that osteosclerotic lesions were detected more often in the mandible than in the maxilla, as also found in our study. Geist and Katz [8] reported that the frequency of osteosclerotic lesions was 11 % (12/112) in the maxilla; in contrast, Eversole et al. [1] reported that the frequency of osteosclerotic lesions in the maxilla was 0 % (0/41). In our study, there were no osteosclerotic lesions in the maxilla in the American cohort, while 7 % (3/45) of the lesions occurred in the maxilla in the Taiwanese cohort.

In our study, the most common sites of osteosclerotic lesions in the Taiwanese cohort were the mandibular second premolar and the mandibular first molar regions, whereas the most common site in the American cohort was the mandibular first molar region. These findings are consistent with those reported previously [8–10, 16]. Moreover, the frequency of osteosclerotic lesions in our American cohort was 5.1 % (22/429), which is comparable to the frequency of 5.4 % reported by Geist and Katz [8].

In terms of the nature of radiopacity, Yonetsu et al. [18] reported that CT examinations were performed in 11 patients with osteosclerotic lesions of the jaws, of which four lesions were of the HO type, two lesions were of the HE type, and the remaining five lesions were of the enostosis type. In our study, HO patterns were significantly more common than HE patterns in both the Taiwanese and American cohorts.

In terms of shape of the osteosclerotic lesions of the jaws, in our Taiwanese cohort 40 % of the lesions were circular, 31 % were oval, and 29 % were irregular; in the American cohort 23 % were circular, 36 % were oval, and 41 % were irregular. There were no significant differences in the outline within either group or between Group 1 and Group 2. Williams et al. [19] reported that the frequencies of different shapes of osteosclerotic lesions of the jaws were 32, 64, and 4 % for round, irregular, and U-shaped lesions, respectively. Their findings seem to suggest that round lesions are significantly more common than the other outlines.

Table 4 Correlations between the mesial–distal distance and top–bottom distance of the osteosclerotic lesions obtained from panoramic radiographs and cone-beam computerized tomography images in both Group 1 (Taiwanese) and Group 2 (American) subjects

Variables	Mean ± SD	Correlation	*P*
Pano MDD	6.32 ± 3.06	0.9818	<0.0001*
CBCT MDD	5.93 ± 3.12		
Pano TBD	7.37 ± 3.07	0.9788	<0.0001*
CBCT TBD	6.73 ± 2.90		

MDD mesial–distal distance, *TBD* top–bottom distance, *Pano* panoramic radiographs, *CBCT* cone-beam computerized tomography, *SD* standard deviation

* Significant difference between Pano images and CBCT images at $P < 0.05$

Table 5 Comparison of the measurements of volume, top–bottom distance, buccal–lingual distance, and mesial–distal distance of osteosclerotic lesions of the jaws between Group 1 (Taiwanese) and Group 2 (American) using cone-beam computerized tomography

CBCT parameter	Group	*n*	Mean ± SD	Lower 95 %	Upper 95 %	Minimum	Maximum	*P*
Volume	1	45	403.37 ± 523.9	245.97	560.77	18.82	2,547.67	0.036*
	2	22	159.8 ± 130.03	102.14	217.45	28.97	645.41	
TBD	1	45	7.11 ± 3.24	6.13	8.08	2.43	18.97	0.1237
	2	22	5.95 ± 1.84	5.13	6.76	3.2	9.87	
BLD	1	45	6 ± 1.98	5.41	6.6	2.4	11.21	0.0419*
	2	22	4.99 ± 1.64	4.26	5.71	2.28	9.38	
MDD	1	45	6.58 ± 3.5	5.53	7.63	2.56	19.1	0.0134*
	2	22	4.6 ± 1.45	3.96	5.24	1.69	7.12	

CBCT cone-beam computerized tomography, *BLD* buccal–lingual distance

* Significant difference between Group 1 and Group 2 at $P < 0.05$

Table 6 Comparison of the frequency, distribution, and various radiographic features of osteosclerotic lesions of the jaws between Group 1 (Taiwanese) and Group 2 (American) subjects

Osteosclerosis variable	Group 1, *n* (%)	Osteosclerosis variable	Group 2, *n* (%)	χ^2	*P*
Sex					
Female	20 (44)		13 (59)	1.273	0.2592
Male	25 (56)		9 (41)		
Total	45 (100)		22 (100)		
Jaw					
Mandible	42		22 (100)	2.456	0.117
Maxilla	3		0 (0)		
Total	45 (100)		22 (100)		
Age level[a]					
1	2 (4)		1 (5)	14.454	0.006*
2	5 (11)		8 (36)		
3	17 (38)		1 (5)		
4	12 (27)		4 (18)		
5	9 (20)		8 (36)		
Total	45 (100)		22 (100)		
Side					
Left	25 (56)		7 (32)	3.399	0.0652
Right	20 (44)		15 (68)		
Total	45 (100)		22 (100)		
Shape					
Circular	18 (40)		5 (23)	2.13	0.3447
Irregular	13 (29)		9 (41)		
Oval	14 (31)		8 (36)		
Total	45 (100)		22 (100)		
Contact site					
Apical	7 (29)		1 (7)	3.898	0.2727
Buccal	5 (21)		6 (40)		
Buccal and lingual	5 (21)		3 (20)		
Lingual	7 (29)		5 (33)		
Total	24 (100)		15 (100)		
Nature of radiopacity					
Heterogeneous	15 (33)		5 (23)	0.817	0.366
Homogeneous	30 (67)		17 (77)		
Total	45 (100)		22 (100)		
Tooth site		Tooth site			
1	1 (2)	2	2 (9)	26.647	0.0317
1–2	1 (2)	3	2 (9)		
1–3	1 (2)	3–4	1 (5)		
3	7 (16)	4	1 (5)		
3–4	2 (4)	4–5	2 (9)		
4	7 (16)	5–6	1 (5)		
4–6	1 (2)	6	7 (32)		
5	7 (16)	6–7	1 (5)		
5–6	3 (7)	7	5 (23)		
5–7	1 (2)	Total	22 (100)		
6	9 (20)				
7	4 (9)				
7–8	1 (2)				
Total	45 (100)				

Data are presented as the number with the percentage in parenthesis

* Significant difference between Group 1 and Group 2 at $P < 0.05$

[a] Age levels: (1) 20–29 years, (2) 30–39 years, (3) 40–49 years, (4) 50–59 years, (5) ≥60 years

In our study, most of the osteosclerotic lesions involved a single tooth site in both the Taiwanese and American cohorts. Interestingly, the osteosclerotic lesions involved up to three tooth sites in the Taiwanese cohort, but not in the American cohort. With respect to the various measurements of the lesions, we believe that the use of CBCT in our study provides more accurate data in several aspects compared with the 2D radiography used in previous studies [8, 11, 16]. First, in our study, the mean MDD and TBD measurements of the osteosclerotic lesions on the panoramic radiographs were approximately 1.1-fold larger than those on CBCT images. This discrepancy may be caused by the difference in the magnification factor of panoramic radiography.

Second, the jaw lesions could only be measured in two dimensions using periapical or panoramic radiography in previous studies [8, 11, 16]. In our study, using the 3D model from CBCT imaging we were able to evaluate the volumes of the osteosclerotic lesions. To our knowledge, this study is the first to determine the volumes of osteosclerotic lesions of the jaws. We discovered that the volume of the lesions in the Taiwanese cohort was significantly greater than that in the American cohort. In addition, the TBD and MDD measurements were significantly greater in Group 1 than in Group 2. These previously unreported findings, combined with the significantly greater prevalence of osteosclerosis in the Taiwanese cohort, suggest that the nature and possible causes of these lesions may differ between the two populations.

Third, the cross-sectional images show the relationships between osteosclerotic lesions and the buccal and lingual cortical bone as well as the apices of the teeth. These relationships cannot be demonstrated in 2D radiography. It is presently unknown whether implants positioned within osteosclerotic lesions will integrate with the bone to the same degree as implants placed in normal tissue. Knowledge of the buccal–lingual locations of osteosclerotic lesions in the jaws, obtained through cross-sectional imaging, may enable surgeons to avoid such lesions when placing implants—if future research indicates that osteosclerotic lesions are detrimental to the success of implant therapy. In our study, the osteosclerotic lesions were found to contact the buccal and/or lingual cortices and root apices with no significant predilection in either Group 1 or Group 2, or between the cohorts.

In conclusion, our results show that osteosclerosis of the jaws was significantly more common in our Taiwanese cohort than in our American cohort. The lesions in the Taiwan cohort had greater volumes as well as greater MDDs and BLDs. Lesions with HO patterns were significantly more common than those with HE patterns in both groups. While there was no predilection for the occurrence of lesions in any age range in the Taiwanese cohort, there was a significantly greater prevalence in the American cohort among patients aged 30–39 years and ≥60 years. Our findings confirm the results of previous studies that osteosclerosis is more commonly found in the posterior mandible, with no differences in frequency between the sides, and that there are no significant predilections for sex. 3D imaging may prove valuable in planning implant placement in patients with osteosclerosis.

Conflict of interest None.

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