RESEARCH

Computed tomography appearance of mandibular para-radicular third molar radiolucencies

J Dalton^{*,1}, M Mahoney² and N Savage¹

¹*School of Dentistry, The University of Queensland, Australia;* ²*Queensland Diagnostic Imaging, Brisbane Private Hospital, Australia*

Objectives: Mandibular para-radicular third molar radiolucencies (MPRs) were first described in 2004 by Bohay et al (Bohay RN, Mara TW, Sawula KW, Lapointe HJ. A preliminary radiographic study of mandibular para-radicular third molar radiolucencies. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004; **98**: 97–101) as a well-defined oval radiolucency surrounded by a thin sclerotic border located immediately distal to the mandibular third molar roots. Bohay et al's analysis was undertaken using panoramic radiographs. The purpose of this study was to confirm Bohay et al's findings on panoramic radiographs and to identify and document the appearance of MPRs on cross-sectional CT. **Methods:** Panoramic films and CT images of the lower third molar regions from 143 patients were reviewed.

Results: MPR was identified on panoramic film in 12 patients with a total of 14 MPRs. A number of factors were recorded from panoramic films and CT.

Conclusions: This study confirmed the findings of Bohay et al and concluded that the relative lucent appearance on panoramic radiographs can be explained by the presence of one or a combination of factors: (i) an area of decreased density in trabecular bone, (ii) thinning of the inner surface of the buccal cortex, (iii) thinning of the inner surface of the lingual cortex or (iv) a depression in the external surface of the lingual cortex.

Dentomaxillofacial Radiology (2011) **40**, 47–52. doi: 10.1259/dmfr/16606307

Keywords: mandibular para-radicular third molar radiolucency; computed tomography

Introduction

Mandibular para-radicular third molar radiolucencies (MPRs) were first described in 2004 by Bohay et al¹ as a well-defined oval radiolucency surrounded by a thin sclerotic border located just distal to the mandibular third molar roots. Bohay et al reported a frequency of 7.8% and a female to male ratio of 2.6:1.0. The mean age was 24.3 years (range 18–88 years). Six cases were bilateral; all were female. Bohay et al found no history of swelling or infection in cases of MPRs. There was no visible communication between the radiolucency and the oral cavity, periodontal ligament (PDL) space or follicle on panoramic radiographs. The lamina dura and PDL space were also unaffected. Bohay et al distinguished MPRs from other lucencies near the

lower third molars, such as the paradental cyst, pericoronitis, Stafne cyst, periapical inflammatory pathology and pathology of the dental follicle.¹

Bohay et al's analysis of MPRs was undertaken on panoramic radiographs. As with all plain film radiography, panoramic radiographs provide only a two-dimensional view. Many studies have highlighted that projection geometry, focal plane shape, horizontal and vertical magnification factors and patient positioning errors all affect the ability of panoramic radiographs to provide accurate measurements.^{2,3} The accuracy and reproducibility of CT is well documented^{4–6} and accordingly CT is recommended as the modality of choice when evaluating odontogenic cysts and other mandibular lesions.⁷ The purpose of this study was to confirm Bohay et al's findings on panoramic radiographs and to identify and describe MPRs on CT. This will aid in defining MPRs as a normal anatomical variant, pathology or merely a radiographic shadow.

*Correspondence to: Jacqueline Dalton, The University of Queensland, School of Dentistry, Queensland, Australia; E-mail: dalton.jacqui@gmail.com
Received 18 September 2009; revised 9 December 2009; accepted 16 December 2009

Materials and methods

Cases with both a panoramic radiograph and a subsequent CT image of the lower third molar area were gathered over a 24 month period from a private radiology practice. The research was approved by the institutional ethics committee. All cases were collected in a de-identified coded form.

Patients with radiolucencies in the third molar regions related to inflammatory periapical lesions, endodontic-periodontic lesions, advanced pericoronitis, paradental cysts or follicular pathology were excluded from the study. Cases with panoramic radiographs showing gross patient positioning errors were also excluded. Patients with an MPR visible on panoramic film were selected. In total, 143 patients (286 sides) with both panoramic and CT films were collected. From these, 12 patients with 14 MPRs were identified.

The panoramic radiographs were taken on a variety of panoramic machines. CT scans were taken using a multislice spiral CT unit (Toshiba Aquilion, Toshiba Corporation, Tokyo, Japan) with 0.5 mm axial slices (pitch of 1.0 mm with 0.5 mm reconstruction interval). The scan volume began inferior to the mandible and extended superiorly to at least the middle of the ascending ramus. Exposure parameters were 135 kV and 60 mAs, and a low-frequency cut-off was employed in the reconstruction algorithm. All data were acquired in the axial plane without gantry tilt. Reformatted images were produced by CT technicians in corrected sagittal and coronal planes. Images were viewed on a Frenel light box (Frenel XR X-ray medical viewer, Frenel Lighting Industries, Salisbury, Australia) or a Toshiba personal computer. Measurements were made

with Mitutoyo Digimatic Calipers (Mitutoyo Corporation, Hampshire, UK) accurate to 0.01 mm or with an Efilm Lite software package (Merge Healthcare, Hartland, WI) accurate to 0.1 mm.

The following parameters were recorded by the author (JD) and confirmed by a specialist maxillofacial radiology colleague (MM):

1. gender of the patient (male or female);
2. age of the patient (in years); and
3. unilateral or bilateral occurrence.

From the panoramic radiograph the following were recorded:

1. side of the MPR (left or right);
2. impaction type of the mandibular third molar (fully erupted, mesioangular, distoangular, horizontally or vertically impacted) according to modified Winter analysis;⁸
3. relation of the MPR to the inferior alveolar canal (inferior, superior or superimposed);
4. the location of the MPR in relation to the roots of the third molar (apical half, coronal half or full length of the root);
5. distance of the MPR to the surface of the mandibular third molar root;
6. unilocular or multilocular;
7. shape (oval or round) (Figure 1a, b);
8. presence of a corticated margin (yes or no);
9. presence of internal trabeculation in the MPR (yes or no);
10. greatest height (in mm) of the MPR; and
11. greatest width (in mm) of the MPR.

a

b

Figure 1 (a) Oval mandibular para-radicular third molar radiolucencies (MPR); cropped panoramic radiograph. (b) Example of a round MPR (arrows); cropped panoramic radiograph

From the CT the following factors were recorded:

1. presence on CT (yes or no);
2. view in which the MPR was visible (sagittal, coronal or axial);
3. axial slice thickness (in mm);
4. sagittal slice thickness (in mm);
5. radiographic density of the MPR (denser than surrounding bone, less dense than surrounding bone or the same density as surrounding bone);
6. presence of thinning of the buccal cortex (yes or no);
7. presence of a corticated margin (yes or no);
8. presence of internal trabeculation in the MPR (yes or no);
9. presence of expansion (yes or no);
10. greatest height and width (in mm) of the MPR in the sagittal plane;
11. greatest length and width (in mm) of the MPR in the axial plane; and
12. description of the radiographic appearance of the MPR.

Results

The assessed patient pool was 143 cases (286 sides). 12 patients with 14 MPRs were identified; a frequency of 8.4%. Of the 12 patients, 8 were female (66.7%) and 4 were male (33.3%), giving a female to male ratio of 2:1. Age ranged from 22 to 52 years with a mean age of 32.1 years. Of the 12 patients, 8 had unilateral MPRs (66.7%). Two patients (16.7%) had bilateral MPRs: one male and one female. In the remaining two patients the contralateral lower third molar was missing and unilateral or bilateral occurrence could not be ascertained. 9 cases (64.3%) were on the left side and 5 cases (35.7%) were on the right. Of the 14 cases, 6 (42.9%) were associated with a mesioangular impacted mandibular third molar, 7 (50%) had a distoangular impacted mandibular third molar and the remaining

case was vertically impacted. All cases were unilocular in appearance.

On panoramic radiograph, 11 of the 14 MPRs observed were separated from the third molar by the PDL space and lamina dura. In the remaining three cases, no PDL or lamina dura could be seen. On panoramic radiographs 71.4% of MPRs (10 cases) were superimposed over the inferior alveolar canal (IAC) and the remaining 28.6% (4 cases) were completely superior to the canal and, with the exception of 2 cases, all had a corticated margin. Ten cases were round in shape and four were oval. Five cases were located adjacent to the apical half of the third molar root, two adjacent to the coronal half, five ran the entire length of the root and two were adjacent to the middle of the root. The width on panoramic radiograph ranged from 2.62 to 12.9 mm (mean 5.90 mm) and height ranged from 2.3 to 9.67 mm (mean 6.24 mm).

All except one case were identifiable on CT. Cases were visible in 0.5 mm slices and 1 mm slices. All cases could be seen in the axial plane and five cases were identifiable in all three planes. Seven cases were identifiable in the sagittal plane (Figure 2a, b) and eight cases were identifiable in the coronal plane.

Of the 13 cases identifiable on CT, 10 appeared less dense than the surrounding bone (76.9%). Three had the same density as surrounding bone. Of the 13 cases visible on CT, 11 had some thinning of the cortical plate in the area of the MPR. One case had no cortical thinning and no axial images were available in one case. 7 of the MPRs had a corticated margin visible on CT and 12 cases had faint internal trabeculations in the MPR seen on CT. No expansion of the area was seen in any case, nor was root resorption seen.

On CT, in the sagittal plane, height was measured as 2.26 to 9.0 mm (mean 5.85 mm) and width as between 2.0 and 8.0 mm (mean 4.7 mm). In the axial plane, length (mesial – distal) was measured as 3.0 to 6.75 mm (mean 4.97 mm) and width (buccolingually) as between 1.58 and 6.0 mm (mean 2.82 mm).

Figure 2 (a) Cropped sagittal CT from Case 10 showing a mandibular para-radicular third molar radiolucency (MPR) on CT sagittal view (arrows); note the MPR is well corticated. (b) Cropped sagittal CT from Case 1 showing an MPR as seen on a CT sagittal view (arrows); note the MPR is well corticated

Discussion

This study has shown that MPRs are clearly identified on CT in one or a combination of ways:

1. an area of decreased density in trabecular bone (Figure 3a);
2. thinning of the inner surface of the buccal cortex (Figure 3b);
3. thinning of the inner surface of the lingual cortex (Figure 3c); and

4. a depression in the external surface of the lingual cortex (Figure 3d).

The relative lucent appearance on panoramic radiograph is explained by the presence of one or more of these factors, which results in either less dense or thick bone. Every case that was identifiable on CT had one of these factors. Of the 13 cases visible on CT, 11 showed thinning of the cortical plate in the area of the MPR. Ten cases had less dense trabecular bone in the region of the MPR than the surrounding bone and one case

a

b

c

d

Figures 3. The four factors that can form a para-radicular third molar radiolucency (MPR). (a) The first factor; arrow indicates an area of decreased density in trabecular bone (axial CT from Case 14); (b) The second factor; thinning of the inner surface of the buccal cortex in the location of the MPR is indicated with arrows (cropped axial CT of Case 12); (c) The third factor; arrow shows thinning of the inner surface of the lingual cortex. The cortical outline of the MPR is highlighted with arrow heads (cropped axial CT from Case 13); (d) The fourth factor; arrow indicates thinning of the outer surface of the lingual cortex in the region of the MPR (cropped left coronal CT from Case 6)

had a depression in the external surface of the lingual cortex in the region of the MPR. MPRs do not relate to the IAC. 28.6% of cases were located completely superior to the canal on panoramic radiographs, and on CT all cases were independent of the canal.

All cases except one were identified on CT in the axial plane and this was independent of slice thickness; however, visibility in the sagittal and coronal planes may be dependent upon slice thickness of the reformatted images and placement of the corrected slices. 12 cases were corticated on panoramic film, but only 7 of the MPRs had a corticated margin visible on CT. Thin corticated boundaries may have been present but beyond the resolution of the CT machine.

This study recorded a number of important factors from panoramic radiographs that were not included in Bohay *et al*'s original study: occurrence on the left or right side and impaction type of the lower third molar. This study found that 64.3% occurred on the left side and 35.7% on the right. 42.9% were associated with a mesioangular impacted lower third molar, 50% of cases had a distoangular impacted lower third molar and the remaining case was vertically impacted. All MPRs in this study were adjacent to unerupted or impacted teeth. No cases have been identified adjacent to fully erupted teeth.

This study had similar findings to Bohay *et al* on panoramic radiographs. Bohay *et al*¹ reported an incidence of 7.8%, which is similar to this study's finding of 8.4%. A female preponderance with female to male ratio of 2:1 was found. Similarly, Bohay *et al* reported a higher incidence in females and a ratio of 2.6:1. The MPRs were found over a wide age range (22–52 years) with a mean of 32.1 years, which concurs with Bohay *et al*'s findings of 18–88 years with mean of 24.3 years.¹ A higher incidence in this age group is expected, as this age group has a high presentation for pain and imaging of the wisdom teeth.

MPRs were found to occur unilaterally in 66.7% of patients in this study. Two patients had bilateral occurrence (16.7%), one male and the other female. In two patients, however, unilateral or bilateral occurrence could not be ascertained owing to a missing contralateral lower third molar. Bohay *et al* found a lower bilateral incidence of 9.4% and all cases were female;¹ however, Bohay *et al*'s article does not state if contralateral teeth were missing and if these cases were then considered unilateral. All cases were unilocular, as were all cases in Bohay's study. On panoramic views, 11 of the 14 cases observed were separated from the third molar by the PDL space and lamina dura. This confirmed Bohay *et al*'s findings. In the remaining three cases, no PDL space or lamina dura could be seen. This may have been because of patient rotation or poor panoramic resolution. On panoramic radiographs, the majority of MPRs (71.4%) were superimposed over the IAC. None were positioned inferior to the canal. All MPRs except for two cases had a corticated margin visible on panoramic radiographs. This is consistent

with Bohay *et al*'s findings. Ten cases were round in shape and four cases had an oval shape on panoramic film. This is different to Bohay *et al*'s findings; however, that article did not define what was considered round or oval. Both Bohay *et al*'s study and this study found that the MPR can be located anywhere along the lower third molar root. The mean width on panoramic radiograph was 5.90 mm and mean height was 6.24 mm. Bohay *et al* reported a size of 9 ± 3.2 mm,¹ but did not indicate in which dimension.

The presence of MPRs on CT reinforces that MPRs are "real" and not merely a radiographic shadow behind a tooth of high density and absorption. None of the MPRs seen on CT related to a depression in the buccal cortex. This confirms Bohay *et al*'s suggestion that MPRs are not the buccal depression described by Kocsis *et al*.⁹ MPRs are unlikely to be a pathology because no expansion or root resorption was seen in any case on CT. It seems likely that MPRs resolve after extraction; in clinical experience no case has been seen without a lower third molar present and no MPR-like lucencies have been documented on post-extraction radiographs. It is the opinion of several maxillofacial surgeons that there is increased intra- and post-operative bleeding during extraction of third molars with MPRs, although no studies have been published in the literature to support this. Increased bleeding could suggest a marrow space or vascular malformation. Marrow spaces or focal osteoporotic bone marrow defects can be described as asymptomatic radiolucencies mainly in the molar region of the mandible.^{10–12} Vascular malformations are primarily lytic lesions with variable expansion and lattice-like coarse trabeculations.¹³ The MPRs resulting from areas of decreased density in trabecular bone (76.9%) and thinning of the inner surface of the cortex could indeed be a large marrow space or vascular space. The cortical outline seen on CT and panoramic radiograph would then be the trabecular boundary of the large marrow space. The MPRs that are seen on CT as a depression in the lingual cortex could be considered normal anatomical variations.

Thus, this study confirmed and extended the findings of Bohay *et al* and concluded that an MPR is a well defined corticated, oval or round lucency that is located adjacent to any part of the root of an impacted lower third molar seen on a panoramic radiograph. MPRs are always superimposed over the IAC or located superior to the IAC on panoramic radiographs, never inferior to it. They are separated from the lower third molar by the PDL space and lamina dura. The relative lucent appearance on panoramic radiograph can be explained by the presence of one or a combination of decreased density in trabecular bone, thinning of the inner surface of the buccal cortex, thinned inner surface of the lingual cortex or a depression in the external surface of the lingual cortex.

It is important for practitioners to recognize MPRs and other pathologies of the lower third molars to allow appropriate management or referral for

surgical treatment and further imaging, as required. If an MPR is noted on a panoramic radiograph then further imaging is not required as MPRs cannot

be considered pathology, but the possibility of a large marrow space and increased bleeding could be considered.

References

1. Bohay RN, Mara TW, Sawula KW, Lapointe HJ. A preliminary radiographic study of mandibular para-radicular third molar radiolucencies. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004; **98**: 97–101.
2. Catic A, Celebic A, Valentic-Peruzovic M, Catovic A, Jerolimov V, Muretic I. Evaluation of the precision of dimensional measurements of the mandible on panoramic radiographs. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1998; **86**: 242–248.
3. McKee IW, Glover KE, Williamson PC, Lam EW, Heo G, Major PW. The effect of vertical and horizontal head positioning in panoramic radiography on mesiodistal tooth angulations. *Angle Orthod* 2001; **71**: 442–451.
4. Bodner L, Bar-Ziv J, Kaffe I. CT of cystic jaw lesions. *J Comput Assist Tomogr* 1994; **18**: 22–26.
5. Vannier MW, Hildebolt CF, Conover G, Knapp RH, Yokoyama-Crothers N, Wang G. Three-dimensional dental imaging by spiral CT. A progress report. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1997; **84**: 561–570.
6. Waitzman AA, Posnick JC, Armstrong DC, Pron GE. Craniofacial skeletal measurements based on computed tomography: Part I. Accuracy and reproducibility. *Cleft Palate Craniofac J* 1992; **29**: 112–117.
7. Abrahams JJ, Oliverio PJ. Odontogenic cysts: improved imaging with a dental CT software program. *AJNR Am J Neuroradiol* 1993; **14**: 367–374.
8. Quek SL, Tay CK, Tay KH, Toh SL, Lim KC. Pattern of third molar impaction in a Singapore Chinese population: a retrospective radiographic survey. *Int J Oral Maxillofac Surg* 2003; **32**: 548–552.
9. Kocsis GS, Marcsik A, Mann RW. Idiopathic bone cavity on the posterior buccal surface of the mandible. *Oral Surg Oral Med Oral Pathol* 1992; **73**: 123–126.
10. Barker BF, Jensen JL, Howell FV. Focal osteoporotic bone marrow defects of the jaws. An analysis of 197 new cases. *Oral Surg Oral Med Oral Pathol* 1974; **38**: 404–413.
11. Cheng NC, Lai DM, Hsie MH, Liao SL, Chen YB. Intraosseous hemangiomas of the facial bone. *Plast Reconstr Surg* 2006; **117**: 2366–2372.
12. Schneider LC, Mesa ML, Fraenkel D. Osteoporotic bone marrow defect: radiographic features and pathogenic factors. *Oral Surg Oral Med Oral Pathol* 1988; **65**: 127–129.
13. Vargel I, Cil BE, Kiratli P, Akinci D, Erk Y. Hereditary intraosseous vascular malformation of the craniofacial region: imaging findings. *Br J Radiol* 2004; **77**: 197–203.