RESEARCH

The relationship between idiopathic bone cavity and orthodontic tooth movement: analysis of 44 cases

I Velez^{*,1}, MA Siegel², SM Mintz³ and R Rolle⁴

¹Division of Oral and Maxillofacial Pathology, Department of Diagnostic Sciences, College of Dental Medicine, Nova Southeastern University, Fort Lauderdale, FL, USA; ²Department of Diagnostic Sciences, College of Dental Medicine, Nova Southeastern University, Fort Lauderdale, FL, USA; ³College of Dental Medicine, Nova Southeastern University, Fort Lauderdale, FL, USA; ⁴Department of Oral and Maxillofacial Surgery, College of Dental Medicine, Nova Southeastern University, Fort Lauderdale, FL, USA

Objectives: Idiopathic bone cavity (IBC), also named simple or traumatic bone cyst, is a common lesion of unknown cause. The mandible is a very common location, although it may occur in any bone of the body. The authors performed a retrospective analysis of 44 cases in order to assess the causation of this entity.

Methods: Each case was analysed by two of the authors (IV and SM) for medical and dental history, history of mandibular/maxillary trauma, clinical presentation, radiographic appearance, surgical findings and histopathology.

Results: This retrospective study suggested a possible relationship between IBCs and orthodontic treatment. This association was noted in 10/44 cases (22.73%). All of these cases were located in the mandible and were well-circumscribed radiolucencies. Evaluation of these cases disclosed that 6/44 (13.64%) demonstrated scalloping, and 3/44 (6.82%) revealed bony expansion. The age range of the patients evaluated was 9–74 years. None of these cases had a history of trauma or extractions in the area.

Conclusions: The findings of this retrospective study suggest an association between orthodontic treatment and the development of this IBC. This occurrence may be multifactorial; further research in the dental science is required.

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Introduction

Idiopathic bone cavity (IBC), also known as a simple or traumatic bone cyst, is a benign osseous lesion comprising an empty or semi-empty cavity within the bone. The term traumatic bone cyst is a misnomer as this entity is not usually associated with a traumatic event. Histopathologically, IBCs lack an epithelial lining and, therefore, cannot be classified as a cyst. Some patients have a history of trauma to the mandible; however, a higher incidence has not been reported in boxers or other individuals sustaining frequent trauma to the head and neck. IBC has not been induced in laboratory animals.

IBC is frequently found in the humerus and other long bones, but the orthopaedic literature does not accept the theory of a traumatic cause.

The literature is replete with hypotheses of the cause of IBCs. It has been suggested that an intraosseous blood clot produced by trauma breaks down and liquefies leaving an empty cavity;¹ but lesions that demonstrate progressive enlargement do not show evidence of continuous haemorrhage. Another theory is that there is an alteration in bone metabolism because of either biochemical or hormonal changes, resulting in osteolysis. This theory would explain the association between IBCs and florid cemento-osseous dysplasia (FCOD).

Relative to the craniofacial complex, it has been reported that the most common site for IBCs is the body of the mandible. The symphysis and ramus are also frequently involved. These lesions may be

*Correspondence to: Ines Velez, DDS, MS, Associate Professor and Director, Division of Oral and Maxillofacial Pathology, Department of Diagnostic Sciences, College of Dental Medicine, Nova Southeastern University, 3200 South University Drive, Fort Lauderdale, FL 33328-6962, USA; E-mail: ivelez@nova.edu

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unilateral or bilateral. At the time of diagnosis the patients range in age from 10 to 40 years. IBCs are usually an incidental radiographic finding. On rare occasions a slight swelling with cortical thinning, without perforation, may be found.²

Radiographically, the most common presentation of IBC is a radiolucent, unilocular, well-defined lesion, which may enlarge up to 10 cm in size. Occasionally, inter-radicular scalloping is evident which is highly suggestive, but not pathognomonic, of this entity. IBC may also appear as a multilocular well-defined radiolucency. Teeth associated with the lesion are vital, and usually do not show root resorption or displacement. The mandibular canal is not involved.

The differential diagnosis should include odontogenic keratocyst, central giant cell tumour, central haemangioma, ameloblastoma and/or odontogenic myxoma.² Following radiographic diagnosis, the affected area should be aspirated and surgically explored in order to obtain a specimen for definitive histopathological diagnosis. A large empty cavity or a closed space containing serosanguinous fluid is found during the surgical exploration. Unfortunately, the yield of the specimen for biopsy is minimal. The mandibular nerve is sometimes noted lying free within the cavity, but the position and cortices are unaffected. If a lesional lining is present within the specimen, it consists of a thin fibrovascular membrane and/or granulation-like tissue that may be intermixed with fragments of trabecular bone and scattered osteoclasts.

The clinical presentation at the time of the surgical exploration is almost pathognomonic for IBCs. The finding of an empty or semi-empty space will prompt surgical curettage of the lesional bony walls to initiate bleeding. Bleeding into the lesion subsequent to surgery or produced by curettage of the walls leads to organization of a clot and new bone formation. Healing and normal radiographic appearance is found within 6 months after the surgical exploration, and the prognosis is excellent.^{3,4} Spontaneous resolution has also been reported.⁵

Materials and methods

Two of the authors (IV and SM) analysed 44 IBC cases from the files of the Division of Oral and Maxillofacial Pathology at Nova Southeastern University. Inclusion criteria for these cases were the availability of a diagnostic panogram, clinical, radiographic and surgical description of the lesion and histopathology. Every case was also supported by medical and dental history and a history of trauma to the site. The following parameters were recorded: gender, age, race, reported symptoms, lesional expansion and displacement of teeth. Any history of trauma in the area, association with orthodontic treatment or other concurrent bony conditions such as FCOD were recorded. These results were compared with the incidence of orthodontic

treatment in a control group with age-matched (9–20 years) and gender-matched (male-to-female ratio 1:1) patients selected randomly from patients' records at the College of Dental Medicine, Nova Southeastern University. From this sample, the rate of orthodontic treatment was determined. Radiographic manifestations were analysed according to the location and number of lesions; size, shape, circumscription, cortication, scalloping and relationship to other dental structures; displacement of teeth and nerve canal; and resorption of the roots. The independent evaluations between the two observers were virtually identical.

Results

Based on this series of cases, IBCs may present at any age (range 9–74 years), but are most common in young people. The median age was 18 years and the mean age was 26 years. There is a predilection for female patients, 28/44 (63%), and the oldest patients in this series were female (75% of the patients were older than 35 years). In this series, 33/44 (75%) patients were Caucasian, 6/44 (13.64%) Hispanic and 5/44 (11.36%) African American.

The distribution of the lesions is presented in Table 1. All of the maxillary cases (3/3 (100%)) occurred in the anterior left quadrant. The most common location was the posterior mandible, according for 21/44 (47%) of the sample. The largest lesion measured 6.0 × 4.0 cm and the smallest was 1.0 × 1.0 cm. The largest 10 lesions appeared in the posterior mandible and the smallest 10 lesions were found in the anterior portion of the jaws. No displacement of the dentition or inferior alveolar canal was noted. No root resorption was identified. Similarly, no pain, paraesthesia or other clinical symptoms were recorded, except for one patient in whom swelling was clinically evident. This was the largest lesion

Table 1 Distribution of lesions

<i>Maxilla (3/44)</i>	
<i>Mandible (41/44)</i>	
Primary involvement	
Posterior quadrant (molar area)	21
Symphysis	10
Cuspid–bicuspid region	5
Multiple	3
Ramus only	1
Angle only	1
Secondary radiographic characteristics	
Cortication	11
Expansion	11
Mandibular molar	10
Symphysis	1
Root scalloping	11
Between roots	2
Anterior extension to ramus	2
Anterior extension to bicuspid	1
Impaction	1
Furcation	1
Periapical	1

(6.0 × 4.0 cm), concurrent with an impacted tooth, multilocular, and showing scalloping and located in the left posterior mandible.

A known history of trauma was present in three cases (7%): all Caucasian females. The age range of the patients with a history of trauma was 14–22 years, and all lesions were located in the posterior mandible. All of the lesions associated with trauma demonstrated a scalloped appearance and were circumscribed and not corticated. The vast majority of the cases (38 (88%)) were unilocular, and well circumscribed (36 cases (83%)) (Figures 1–5).

An association with FCOD was found in six cases (14%). All of the African American patients presented with radiographic and histopathological signs of FCOD. All six of these patients were female without a reported history of trauma. The other patient with concurrent FCOD was Hispanic. No other associated bone lesions were detected.

A history of orthodontic treatment was seen in 10/44 cases (23%) (Table 2). The patients ranged in age from 9 to 20 years with a median age of 17 years. All of the orthodontic care included full bimaxillary therapy. Pre-orthodontic treatment extractions were performed in four cases; none of the extractions occurred in the area in which IBCs developed. All of the IBCs associated with the orthodontic treatment were mandibular and well circumscribed. Scalloping was noted in 6/10 (60%) whereas bony expansion was found in 3/10 (30%). None of these patients had a history of trauma. The age-matched control group comprised 100 patients selected randomly from Nova Southeastern University College of Dental Medicine's patient files. The control group was age-matched (9–20 years) and gender-matched (46.6% male/53.4% female). 13 patients (13%) in this group had a history of orthodontic treatment.

Figure 1 Crop of panogram showing an example of an idiopathic bone cavity in the right posterior mandible. Note the radiolucent, well-circumscribed, unilocular lesion showing cortication

Figure 2 More extensive lesion than Figure 1 showing similar characteristics

Minimal fragments of tissue were obtained during the surgical explorations and epithelial lining was not found in any of the lesions (Figure 6).

Discussion

IBC is an asymptomatic lesion usually seen in young female patients in the mandibular molar area and most commonly appears radiographically as a well-circumscribed, non-corticated, unilocular radiolucency. It does not produce displacement of teeth or resorption of the roots.

The predilection for female patients may be influenced by oestrogens and progesterone deficiency, which is well known to promote bone resorption. At age 35 progesterone levels begin to decline. The oldest patients in this series were female. Female predilection may also be related to the association of FCOD that almost

Figure 3 Idiopathic bone cavity of the anterior mandible. Note the radiolucent, well-defined, corticated lesion in a patient with florid cemento-osseous dysplasia

Figure 4 Idiopathic bone cavity of the anterior mandible. Note the radiolucent, well-defined, non-corticated lesion

always occurs in female patients. All of the African American patients in this series presented an association with FCOD.

The most striking finding was the possible association between IBC and orthodontic treatment. The age of these patients is coincident with the usual age for adolescent orthodontic treatment. Therefore, this association may be an artefact. There were no references in the dental literature to this possible association. However, one-third of patients younger than 20 in these series had orthodontic treatment and it is therefore speculated that the incidence seems to be higher than might normally be expected. There were no reports of the incidence of IBC in the population; therefore the age-matched control group was investigated, as there was no incidence of orthodontic care published in the literature. This control group was age-matched (9–20 years) and gender-matched (46.6% male/53.4% female). 13 patients (13%) in this control group had a history of orthodontic treatment compared with 23% of the patient sample with traumatic bone cyst. The extraction sites were not related to the IBC

Figure 5 Maxillary lesion apical to the left second premolar. Note the unilocular, well-defined, vaguely corticated radiolucency apical to a vital tooth

Table 2 Lesions associated with orthodontic care

<i>Maxilla (0/10)</i>	
<i>Mandible (10/10)</i>	
Well circumscribed	10
Scalloping	6
Bony expansion	3
Trauma	0

locations; therefore, the association between trauma and IBC is not suggested in this series of cases. The authors therefore concluded that IBC may have an association with orthodontic treatment.

The presence of FCOD and/or adolescence in the clinical setting of orthodontic treatment appear to be the two most important influencing factors in the development of IBC. The following theories may be applicable to the aetiopathogenesis of IBC during orthodontic treatment.

- (1) An increased vascular activity, in the presence of vascular endothelial growth factor (VEGF), is seen in areas of tension and pressure during experimental tooth movement. Macrophages appear consistently near blood vessels in the areas of osseous stress.⁶ Osteoclasts are differentiated from macrophages by the presence of tumour necrosis factor (TNF)- α .⁷ The osteoclast's membrane is the resorptive organelle that is able to mediate bone resorption. This membrane is able to acidify the bone surface, thereby mobilizing inorganic bone minerals, resulting in bone resorption.
- (2) The piezoelectric effect may play an important role in the development of IBC. Piezoelectricity is the ability of some materials, including bone, to generate an electric potential as a response to an applied mechanical force. When pressure is applied, it causes mechanical deformation and displacement of charges. Marino and Becker⁸ stated: "In theory, this effect could translate an environmental stimulus into a biologically recognizable signal, controlling growth and resorptive processes." Bone produces charges

Figure 6 Surgical exploration disclosing an empty cavity

proportional to mechanical displacement. These charges stimulate osseous change. It is postulated that the piezoelectric effect may be able to change the chemistry and influence the cellular activity of osteoblasts and osteoclasts. The piezoelectric effect has been associated with bone growth, remodelling, regeneration and resorption.⁹

Conclusions

An IBC may occur in any bone of the body; the posterior mandible represents a common location. The name of traumatic bone cyst should no longer be used for this entity as there has been no proven association with traumatic events. This lesion is not a true cyst as there is no epithelial lining. The nomenclature of IBC is descriptive and appropriate, as this is a true cavity and the cause is not understood. IBC is asymptomatic. The

few maxillary cases in this series were anteriorly situated. There is a predilection for female patients.

IBC is, by far, more common in Caucasian populations. Traumatic events do not seem to play an important role in the development of this entity. Clinical findings of FCOD and/or orthodontic treatment appear to be the most consistently associated factors.

Radiographically, most of the lesions were unilocular, well-circumscribed, non-corticated, non-expansile radiolucencies. Scalloping and expansion were seen in some of the mandibular molar cases. The cortical bone was not normally affected by this process.

In the current knowledge base of scientific research, the cause of the enigmatic lesion termed IBC is not known. The cause of IBC is probably multifactorial, such as the presence of VEGF, which appears in areas of bone tension and pressure. The piezoelectric effect may also play a role as it has been associated with bone remodelling, regeneration and resorption. Further research utilizing prospective double-blind protocols is necessary to further elucidate the cause of IBCs.

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