Juvenile mandibular chronic osteomyelitis: multimodality imaging findings

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Background and purpose. Juvenile mandibular chronic osteomyelitis is a rare entity that predominantly affects children and adolescents, but little is known about the factors that contribute to the recurrent course and eventual resolution of this disease. Here, we describe new findings of soft tissue and mandibular nerve canal involvement.

Materials and methods. Four patients with mandibular diffuse sclerosing osteomyelitis are presented; all were followed with CT, a few also with MRI and bone scan. We recorded imaging findings of lesion location, pattern of bone formation, presence and evolution of lytic lesions, mandibular nerve, and soft tissue involvement.

Results. In all patients we found enlargement of the mandibular nerve canal and soft tissue changes on CT and MRI (when available). All patients had ground glass bone patterns in conjunction with lamellated/onion skin new periosteal bone formation on CT, and all patients with follow-up CT had change in lytic lesion locations.

Conclusion. Mandibular nerve canal enlargement, soft tissue abnormalities, and change in location of lytic lesions may represent a diagnostic pattern in mandibular diffuse sclerosing osteomyelitis (Garré) that was not previously entirely recognized as such. (Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;111:e38-e43)

Our knowledge about diffuse sclerosing osteomyelitis dates back to 1893 when the Swiss surgeon Carl Garré first described a sclerosing type of osteomyelitis, clinically characterized by distention and thickening of the bone, but with lack of suppuration, sequestration, or fistulization.1 Since then, various names have been assigned to this entity based on a combination of clinical and imaging findings, including Garré osteomyelitis, periostitis ossificans, nonsuppurative ossifying periostitis, osteomyelitis with proliferative periostitis, nonsuppurative sclerosing osteomyelitis, and chronic sclerosing inflammation of the jaw.2 The variety of names for this entity reflects the multitude of speculations about its etiology and/or pathophysiology. In the recent literature the term “diffuse sclerosing osteomyelitis” (DSOM) is most commonly found.5,5 Heggie et al.6 and Wood et al.7 suggested that occurrence of this disease in the pediatric population represents a separate entity and should be called “juvenile mandibular chronic osteomyelitis” (juvenile mandibular chronic osteomyelitis [JMCO]). Here, the term JMCO is being used instead of DSOM when referring to children, although it may not have been used in the articles cited.

JMCO occurs more commonly in children and adolescents, the mean age being 13 years, and most frequently involves the mandible unilaterally.2 Various patterns of bone formation in JMCO have been described based on conventional radiographs,2 computed tomography (CT),8-10 magnetic resonance imaging (MRI),11 and nuclear medicine (NM).9 We had the opportunity to follow up and compare 4 pediatric patients with mandibular JMCO over several years with multiple imaging modalities, and we are presenting a new observation of mandibular nerve canal enlargement with JMCO.

MATERIAL AND METHODS

Four patients with a diagnosis of JMCO of the mandible, referred for imaging studies by a maxillofacial surgeon, were analyzed. Clinical information was obtained from archived medical records and from the referring surgeon.

All patients had an initial CT scan of the mandible and 3 of 4 patients had at least 1 CT follow-up, with a maximum of 5 follow-up CTs in 1 patient and length of follow-up intervals from first to last examination be-
between 1 month and 2 years. Two patients had additional evaluations with MRI, and 2 patients had NM bone studies. One patient had no follow-up imaging available for comparison.

Gender distribution was 3 female and 1 male; ages were 5, 10, 11, and 13 years at time of initial imaging.

Imaging techniques included the following: CT axial noncontrast helical 2.5-mm images of the mandible in soft tissue and bone windows, reformations in coronal plane soft tissue, and bone windows. MRI technique: 1.5-T MR images of the face with precontrast axial and coronal T1- and T2-weighted images, as well as postcontrast fat saturated axial and coronal T1 images of the mandible. NM technique: 99 Tcm-methylene diphosphonate (MDP) bone scans with early and delayed whole-body images.

The following imaging findings were recorded: location (right, left, bilateral mandible), CT bone pattern (lytic, concentric, fibrous dysplasia–like/ground glass\textsuperscript{11,12,14}), periosteal pattern, lesion evolution with time (new lytic areas, sclerosis), mandibular nerve canal enlargement (yes/no), and associated soft tissue abnormalities (masseter muscles, lymph nodes, skin). When applicable, MRI findings of soft tissue abnormalities and abnormal contrast enhancement were recorded; similarly, tracer uptake was recorded if applicable.

**RESULTS**

The imaging features of all patients are summarized in Table I. Of note, all patients underwent mandible biopsy showing bone marrow fibrosis and new bone formation. No infectious agent was detected in 3 of the patients; only patient number 2 had evidence of *Diphtheroides*, *Haemophilus* species, and *Veillonella* in the specimen.

**Patient number 1**

Patient 1 was a previously healthy 10-year-old girl who presented with left cheek swelling, pain, redness, and history of fevers. Dentition was unremarkable. She received 1 week of antibiotics for presumed facial cellulitis and the symptoms resolved. Three weeks later, the pain and swelling returned. A CT (Fig. 1, A) was performed showing left lateral mandibular thickening with lytic and sclerotic lesions affecting the angle and the posterior mandibular ramus. There was also swelling of the adjacent masseter muscle. A follow-up CT (Fig. 1, B) was performed 40 days later showing mild further mild sclerosis and thickening with no change in the extent of the abnormality and with a decrease in size of the lytic lesions. The overlying masseter muscle was less swollen. Both studies showed an enlarged mandibular nerve canal (Fig. 1, A and B). There was a concentric pattern of bone formation (Fig. 1, B). An MRI was performed (Fig. 1, C and D) at the same time as the follow-up CT. Despite reduction of

**Table I. Radiographic findings**

<table>
<thead>
<tr>
<th>Case</th>
<th>Involved side</th>
<th>Mandibular nerve canal</th>
<th>Involved soft tissues</th>
<th>Initial lytic lesions</th>
<th>Sclerosis</th>
<th>New lytic lesions</th>
<th>Periosteal bone pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left</td>
<td>Enlarged</td>
<td>Masseter</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Right</td>
<td>Enlarged</td>
<td>Masseter, LN</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Left</td>
<td>Enlarged</td>
<td>Masseter</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Bilateral</td>
<td>Enlarged</td>
<td>Masseter, LN, skin</td>
<td>Yes</td>
<td>No f/u</td>
<td>No f/u</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*f/u*, follow-up; *LN*, lymph node.

Fig. 1. Patient 1: CT axial noncontrast images of the mandible (A) and follow-up study (B) in the same location. MRI fat-saturated coronal T2 (C) and axial T1 (D) of the mandibular ramus. On CT there are initially lytic areas in the marrow space that have become sclerotic at follow-up (A, B, white hollow arrow); also sclerotic thickening of the cortex with onion skin/layered/lamellated appearance (A, B, small arrows) is better shown on the follow-up image (B). There is initial swelling of the masseter muscle (A, *), which is improved at follow-up (B, *). Note the enlargement of the mandibular nerve canal (A, B, thick arrows) and mandibular nerve contrast enhancement (D, thick arrow). MRI also shows extensive bone marrow edema (C, thick arrow) and involvement of the masseter muscle (C, *).
lytic components and increased sclerosis on the CT images, the MRI showed extensive bone marrow edema (Fig. 1, C), involvement of the bony cortex and shows involvement of the masseter muscle better than CT. Interestingly, there was contrast enhancement of the left mandibular nerve on MRI (Fig. 1, D).

**Patient number 2**

Patient 2 was a previously healthy 5-year-old girl with history of poor dentition who presented with pain and swelling of the right mandible that worsened with time. Antibiotic treatment was prescribed. Initial CT showed right mandibular periosteal thickening (thick arrows), cortical sclerosis (thin arrow), and lytic lesion (hollow arrow). Follow up CTs show development of new lytic lesions (D, hollow arrow) and resolution of the previously appreciated lytic areas and persistent periosteal bone thickening (B-F). Note the enlargement of the mandibular nerve canal (A-F, small arrows). The last follow-up performed 2 years later (G) showed almost complete resolution of disease with only minimal residual enlargement of the right mandible compared with the left mandible, and with normal bony architecture and complete resolution of lytic lesions. Abnormal tracer uptake was found on the affected side (H) on nuclear bone scan.

**Patient number 3**

Patient 3 was an 11-year-old girl with history of congenital mandibular and tongue dysplasia with multiple episodes of left facial swelling treated with antibiotics. No obvious dental caries or necrotic teeth were seen and no erythema or discharge was present. The patient underwent antibiotic treatment. After 10 months, a CT was performed showing left mandibular thickening with periosteal reaction and lytic lesions, ipsilateral masseter swelling, and enlargement of the mandibular canal (Fig. 3, A). Follow-up studies (the last was 2 years after presentation) showed sclerosis of the previously lytic lesions and development of new lytic lesions in different locations (Fig. 3, B-H). A bone scan was performed and showed isolated focally increased radiotracer uptake in the left mandible (Fig. 3, I and K). MRI showed left-sided mandibular bone marrow edema, masseter muscle enlargement, and muscle contrast enhancement (Fig. 3, L and M).

**Patient number 4**

Patient 4 was a healthy 13-year-old boy who presented with diffuse mandibular swelling and pain for 1 week. The patient underwent antibiotic treatment. A CT was performed and showed diffuse left mandibular thickening and cortical erosive changes with ground glass appearance, no periosteal reaction, as well as periosteal elevation on the right side (Fig. 4, A and B). Bilateral widening of the mandibular nerve canal and

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Fig. 2. Patient 2: Serial axial noncontrast images of the mandible dated 1/06 (A), 2/06 (B), 4/06 (C), 8/06 (D), 11/06 (E), 4/07 (F), 2/08 (G). Nuclear medicine scan 11/06 (H, affected side and I, unaffected side). Initial CT (A) showed right mandibular periosteal thickening (thick arrows), cortical sclerosis (thin arrow), and lytic lesion (hollow arrow). Follow up CTs show development of new lytic lesions (D, hollow arrow) and resolution of the previously appreciated lytic areas and persistent periosteal bone thickening (B-F). Note the enlargement of the mandibular nerve canal (A-F, small arrows). The last follow-up performed 2 years later (G) showed almost complete resolution of disease with only minimal residual enlargement of the right mandible compared with the left mandible, and with normal bony architecture and complete resolution of lytic lesions. Abnormal tracer uptake was found on the affected side (H) on nuclear bone scan.
swelling of the bilateral masseter muscles was appreciated (Fig. 4, C and D). There was no follow-up imaging in this patient.

DISCUSSION

JMCO presents a diagnostic and treatment challenge because of its overlapping features with a wide spectrum of malignant and benign disease entities, such as Ewing sarcoma, osteosarcoma, Caffey’s disease, fibrous dysplasia, hypertrophic osteoarthropathy, syphilitic osteomyelitis, healing fracture callus, and eosinophilic granuloma. Patients usually present with facial asymmetry and progressive swelling, with or without associated pain, malaise, or trismus. On physical examination usually unilateral induration is appreciated in the presence of normal overlying skin or mucosa. In our small group, 3 of the patients had unilateral disease and 1 patient had bilateral involvement, which has been described as a rare presentation.

The effectiveness of initial antibiotic therapy in the management of patients with JMCO is measured by the clinical response as well as the radiologic bony changes. Resolution of pain and swelling together with return to normal appearance of bone on CT scans is a sign of resolution of the condition. Should the signs and symptoms persist, CT scans can point up further damage to the bone and can assist in identifying appropriate location for biopsy. This usually results in multiple CT imaging studies, as in our cohort. Disadvantages of radiation risks are probably generally outweighed by the fact that CT represents the modality that best shows the characteristic bone changes, as detailed previously. Concerns for increased radiation exposure in children can be met by ensuring lowest possible dose imaging technique. As demonstrated in patient numbers 1 and 2 (Figs. 1 and 2), soft tissue changes can also be identified on CT images, but the radiologist needs to be aware of this potential finding and adjust the imaging field of view to include the masseter muscles and regional lymph nodes.

Various patterns of JMCO have been described based on imaging and histologic findings. Kawai et al. described 4 major radiographic types of gross periostitis ossificans in mandibular osteomyelitis: type A, onion skin/lamellated appearance; type B, fine bony spiculae perpendicular to the bone surface; type C, coarse trabeculation with wide marrow spaces; and type D, modified mature trabeculation. By histology, 3 major types have been described: fibrous dysplasia–like pattern (“ground glass appearance”) with (1) irregular trabeculae, (2) retiform pattern, or (3) parallel (“concentric,” “lamellated”) pattern. We found ground glass/fibrous dysplasia–like pattern in all patients; onion skin/concentric/lamellated appearance was seen in 3 of our patients. In the patient with bilateral disease, a
The affected bone was present in all patients; this feature has not been described in the literature. The only soft tissue abnormality that has been mentioned in JMCO of the mandible is lymphadenopathy\(^9\) and in our patient group there was ipsilateral lymph node swelling in 2 patients. Interestingly, one of our patients had ipsilateral skin thickening and stranding of subcutaneous fat, such as seen with cellulitis. MRI studies can be useful: we found bone marrow enhancement in 2 patients. Nuclear medicine bone scan can show uptake of tracer, seen in 2 patients and previously observed in JMCO of the mandible.\(^8,9\)

An interesting feature of JMCO is the involvement of the periosteum. In several ways, JMCO has overlapping features with an entity called “cortical hyperostosis” or “Caffey’s disease,” which is seen infants. Just as in JMCO, cortical hyperostosis can have isolated mandibular involvement,\(^18-20\) presents with pain, has associated soft tissue swelling, shows new periosteal bone formation, is of unknown etiology, and is self-limited.\(^17\) In fact, the mandible is a commonly involved bone in cortical hyperostosis.\(^17\) Rarely, lytic areas have been described in cortical hyperostosis.\(^17\) Similarly to JMCO, multiple pathogenetic hypotheses have been suggested for cortical hyperostosis, including infection and genetic, immunologic, vascular, and viral allergic reactions in collagen tissues.\(^17\) Recently, a genetic defect encoding the alpha-1 chain of type 1 collagen, which is present in bone, skin, ligaments, and teeth, has been described as an important factor in the etiology of cortical hyperostosis.\(^17,21\)

Genetic analysis of fibrous dysplasia has shown that it is caused by mutation in Gs alpha, a protein subunit that activates the cAMP-dependent pathway by activating adenylate cyclase.\(^22,23\) Further mouse model analysis of fibrous dysplasia by Kashima et al.\(^24\) showed that transformed osteoblasts express high levels of periostin as a marker of intramembranous ossification. The latter may represent a diagnostic tool and/or therapeutic target for fibrous dysplasia. It would be of interest to evaluate similar genetic features and diagnostic/therapeutic options in patients with JMCO.

Mandibular nerve canal enlargement was seen in all CT imaging of our patients, as well as contrast enhancement in 1 patient who underwent MRI imaging (Fig. 1). It is unclear if this finding indicates inflammatory enlargement of the mandibular nerve causing remodeling of the canal, or abnormal widening of the canal in the absence of associated nerve pathology. Tanaka and Hayashi\(^25\) described a CT finding of the mandibular nerve canal in JMCO of the mandible as “indistinct canal wall” and suggested a repeated state of fibrous tissue proliferation and incomplete new bone formation as the underlying process. However, they did not comment on the size of the canal being larger than

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Fig. 4. Patient 4: CT noncontrast images of the mandible, axial (A), reformatted coronal (B), and reformatted curved (C) bone images. Companion case (D), healthy patient with curved reformatted CT of normal mandibular canals. There is bilateral mandibular bone thickening (A, large arrows), areas with ground glass appearance (B, small arrows), and lytic changes (C, large arrows). The curved reformatted images also show nicely the mandibular nerve canal widening with an indistinct canal wall (C, small arrows) that lost the typical higher density cortical bone (D, small arrows).

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lamellated pattern was seen in the mandibular ramus, whereas the body of the mandible showed a solely fibrous dysplasia–like pattern.

There is debate whether JMCO has an infectious etiology or not. In many cases, JMCO was observed after dental infection\(^2,15,16\); however, in 3 of our patients no history of mandibular infectious disease was present and no infectious agent could be isolated on bone biopsies. Pelkonen et al.\(^16\) reported a series of patients with chronic recurrent multifocal osteomyelitis (n = 8), osteomyelitis of Garré (n = 4), and isolated clavicle disease (n = 2) in which a bacterial agent could not be identified, except for 1 patient. In a literature review by Kawai et al.,\(^14\) there were certain patterns of JMCO (perpendicular bone spiculae and coarse new trabeculation) in which no causative factor could be identified in up to 38% of cases. This could be secondary to partial treatment of the presumed infection by the time of diagnosis/biopsy, or a noninfectious etiology of the disease. In fact, recently, the more common multifocal form of JMCO has been considered to be an autoimmune disorder\(^17\) with a genetic component.

A changing pattern of the lytic lesions with evolving sclerosis and formation of new lytic bone areas was seen in 2 of our patients who had follow-up studies (Fig. 3). Swelling of the masseter muscle adjacent to
on the unaffected side. The meaning of this finding as a diagnostic feature of mandibular JMCO is unclear, as are the implications for the underlying pathophysiologic processes.

CONCLUSIONS

In our series of 4 patients, JMCO of the mandible presented as an expansile, mixed lytic, and sclerotic process that evolved over time. The combination of bone lesions with mandibular nerve canal enlargement, adjacent soft tissue involvement, and the change in location of lytic lesions over time have not been described as a pattern in JMCO of the mandible before.

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REFERENCES


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