Bone Margin Analysis for Osteonecrosis and Osteomyelitis of the Jaws

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KEYWORDS

• Osteonecrosis • MRONJ • Osteomyelitis • ORN • Bone margins • Bisphosphonates • RANKL • HBO

KEY POINTS

- In advanced osteomyelitis medical and surgical interventions become necessary. Imaging is helpful in preoperative planning.
- In MRONJ, negative margins correlate well with resolution of symptoms. Intraoperative adjuncts, such as fluorescence-guided resection, may become helpful in the future.
- In ORN patients may have persistent disease despite radical resection.
- Margin status on histopathology may not correlate with the clinical outcome.
- High-level evidence data regarding bone margin analysis in osteomyelitis and osteonecrosis of the jaw are lacking. Further studies are needed in this area to help guide treatment and create consensus.

INTRODUCTION

Osteoradionecrosis (ORN), osteomyelitis (OM), and medication-related osteonecrosis of the jaw (MRONJ) are three entities that have a similar appearance clinically, yet are different in their pathophysiology. All three conditions may present with exposed bone within the oral cavity that fails to heal within an 8-week period. The bone can progress to an advanced stage, presenting with suppuration, gross mandibular necrosis, and/or pathologic fractures. Because of their differing pathophysiology, their treatments are also different. The surgical approach to determining margins and subsequent approach to pathologic bone margin analysis are controversial topics, because of the lack of high-level evidence. This article reviews the available evidence regarding bone margin management and interpretation for each of these entities.

OSTEOMYELITIS

OM is defined as inflammation of the bone and bone marrow caused by an infectious process.[1,2] Some of the etiologies that may result in OM include odontogenic infection, periodontal disease, trauma, inadequate treatment of mandibular fractures, failed mandibular implants or hardware, and hematogenous seeding from bacteremia.[1,3]

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Patients who have received radiation therapy or medications affecting bone metabolism (discussed later) may have an increased risk for OM.[4] There is a higher predilection for involvement of the mandible likely caused by decreased vascularity when compared with the maxilla. With prevalent use of antibiotics, the incidence of OM has significantly decreased.[1,4] The incidence in the jaws is reported to be around 3 to 4 cases per 100,000 annually.[5,6]

Clinical signs and symptoms associated with OM may include deep boring pain, intraoral or extraoral purulent drainage, intraoral and cutaneous fistula, pathologic fracture, trismus, and neurosensory disturbance.[7]

There is a lack of consensus on a classification system for OM, which may in part be caused by variability in presentation of OM.[8] Several classification systems exist but generally OM is classified as acute or chronic depending on whether the symptoms last over a 1-month period of time.[1] Chronic OM is usually divided into suppurative and nonsuppurative OM.[1,9]

Imaging may be helpful in establishing a diagnosis of OM, determining the extent of disease and subsequent surgical planning.[10] Computed tomography (CT) scan may show a moth-eaten appearance, bony erosion, sequestration, gross bony destruction, or any combination of these features. MRI may detect earlier stages of OM showing hypointensity of the marrow on T1-weighted images, and hyperintensity on T2 postcontrast images, signifying medullary inflammation. These changes appear on MRI before the occurrence of cortical osseous changes, making the MRI more sensitive and specific in the acute phase.[11–13] The most common nuclear medicine imaging techniques involves bone scintigraphy using a radiopharmaceutical tracer diphosphonates coupled to the radionuclide technetium-99m (^{99m}Tc). The tracer selectively accumulates on bone mineral matrix in areas of high metabolic/osteoblastic activity. This test is sensitive but not specific and can be positive in cases of trauma, tumors, and aseptic conditions. Autologous tagged white blood cell (leukoctyes) scitingraphy can help to localize the source as leukocytes accumulate by migration toward the bone infection. Another drawback to nuclear testing includes the time required (hours) and the poor image quality because of the spatial resolution of the gamma camera with the inability to detect bone sequestra less than 8 mm. Combined with other imaging modalities, such as single-photon emission CT or PET-CT, imaging can further improve the diagnostic yield and localize the infection.[14,15]

There is currently no consistent protocol or accepted guideline in the literature for the treatment of OM.[8] Most therapeutic recommendations are based of the findings of single reports or textbooks. Cases limited in extent, and/or cases of acute OM, may be managed with antibiotics with or without surgery. In chronic OM, surgical intervention is required in combination with antibiotics. The extent and type of surgical treatment depends on presentation and may include conservative debridement and/or sequestrectomy. Decortication and saucerization of the involved area of the mandible has also been reported to be successful in certain cases of OM.[16] Segmental resection is reserved for advanced cases of OM that fail medical therapy and demonstrate gross necrosis of the mandible, suppuration, draining cutaneous fistula, intractable pain, and/or pathologic fracture (**Fig. 1**).[1,4]

When segmental resection is deemed necessary for treatment, general consensus recommendation suggests a 1-cm bone margin beyond the identifiable boundary of the radiographic process when feasible. Additional bone should be resected if bleeding bone (a clinical surrogate for viability) is not observed.[4,17] Although evidence-based research regarding the placement of the most appropriate margin for resection of mandibular OM is lacking, there seems to be good correlation between cross-sectional radiographic studies and pathologic bony margins.[10] This correlation between preoperative imaging and accurate final pathologic bone margin status allows for ease in preoperative ablative and reconstructive planning. Microvascular free flap reconstruction is also helpful because it allows the surgeon the ability to attain generous resection margins with healthy viable bone (see **Fig. 1**).

Antibiotics are required in addition to surgery in the management of OM.[4] Kim and Jang[16] showed 95% control rates for OM when using surgery and 8 weeks of antibiotic therapy, compared with control rates of 60% in the surgery alone arm. Again, there is a lack of consensus with regards to the type and route of antibiotics to be used and the length of therapy.[8] These cases are best treated in a multidisciplinary fashion with infectious disease specialists, with individualized treatment being based on tissue cultures and clinical response.[2,4] The most commonly cultured microbes include normal oral flora, staphylococcus, and bacteroides.[16,18] Because it is important to select an appropriate antibiotic, one must remember that deep tissue cultures or marrow cultures from the specimen should be attained before the main specimen being immersed in formalin and sent to pathology.