Management of osteomyelitis of the anterior skull base and craniovertebral junction

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OBJECTIVES: **The study goals were to determine the patient demographics, identify predisposing factors, and determine efficacy of treatment for nonotologic osteomyelitis of the skull base and craniovertebral junction.**

STUDY DESIGN: **All patients with a biopsy-proven diagnosis of osteomyelitis of the skull base treated by the author from 1997 through 2001 were retrospectively evaluated.**

RESULTS: **Six patients were identified on review. The average age at presentation was 56.7 years (age range, 38 to 70 years), and all except one patient had an underlying immunocompromising condition (diabetes mellitus, human immunodeficiency virus infection, steroid use). Most presented with neurologic deficits associated with a destructive lesion of the osseous skull base. Aggressive debridement of involved bone enabled through the use of broad field standard skull base approaches was associated with clinical resolution of symptoms in each case. Systemic antibacterial/antifungal therapy and medical optimization remain important adjuncts in the treatment of this group of patients.**

CONCLUSION: **The diagnosis of this entity may be difficult to discern from neoplastic involvement of the skull base. Standard skull base approaches are useful for both the diagnosis and the treatment of nonotologic osteomyelitis.** (Otolaryngol Head Neck Surg 2003;128:39-42.)

Inflammatory conditions of the skull base may develop after paranasal sinus infections, secondary to cranial base trauma or previous local surgical intervention or in the absence of an obvious contiguous source of infection.[1] Severe complications such as osteomyelitis are expected to occur more frequently in patients with systemic immunocompromise (acquired immune deficiency syndrome, chemotherapy, systemic steroid use, diabetes mellitus, severe cachexia, etc) and in those with relative local immunocompromise as sequelae of previous external beam radiotherapy. In this patient population, the offending infectious agent is typically bacterial in origin, although invasive fungal species have also rarely been noted.[2] Osteomyelitis of the anterior skull base and craniovertebral junction is an uncommon condition that was almost always fatal in the preantibiotic era. Acute pyogenic or fungal infections of bone typically produce progressive osteolytic bone destruction with little chance for sclerosis or remodeling (in contradistinction to granulomatous conditions associated with chronic osteomyelitis). Such rapid osseous destruction may lead to cranial nerve palsies, vertebral instability, and intracranial infectious complications, leading to significant morbidity and mortality. Nonotologic osteomyelitis may be quite difficult to diagnose with certainty preoperatively.[3] As opposed to malignant otitis externa, there are no pathognomic findings on physical examination, nor unequivocal radiographic abnormalities that will reliably lead skull base surgeons to the diagnosis of skull base osteomyelitis. Thus surgical intervention is usually necessary to rule out an underlying neoplasm, identify the causative organism, and remove the offending area of bony destruction. Surgical removal of infectious sequestra, in conjunction with culture-guided antibacterial or antifungal systemic therapy, remains the cornerstone of treatment.[4]

In this article, we review a case series of patients presenting with progressive osteomyelitis of the anterior skull base and craniovertebral junction in whom aggressive surgical intervention with culture guided antifungal and/or antibiotic therapy was associated with rapid clinical improvement and disease resolution.

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Table 1. Clinical presentation, demographic data, surgical intervention, and outcomes of treatment in patients with nonotologic skull base and craniovertebral junction osteomyelitis

Patient	Gender (M/F)	Age (y)	Predisposing factors	Clinical findings
1	M	54	NIDDM, chronic frontal sinusitis Progressive disease despite 6 wks of IV antibiotic therapy	Frontal headaches, retro-orbital pain, frontal bone destruction (4 × 6 cm), extension to base of anterior cranial fossa
2	M	65	External beam radiation for a squamous cell carcinoma of the nasopharynx 8 years earlier, NIDDM	Right retroorbital pain, facial hypoesthesia, bony destruction within infratemporal fossa and enhancement of temporal lobe of brain
3	M	45	History of previous excision of squamous cell carcinoma of medial canthus and a full course of external beam radiation 1 year earlier; HIV positive	Soft tissue necrosis of right nasal root with osseous exposure and osteomyelitis of nasal bone, medial orbit wall and base of anterior cranial fossa
4	M	70	IDDM, on systemic steroids for COPD	Progressive left facial numbness, decreased level of consciousness, osteolytic lesion of infratemporal fossa with intracranial extension
5	M	68	IDDM	Progressive cervicalgia with upper extremity paresthesias Dysphagia to solids and liquids Osteolytic destruction of anterior arch of C1, C2, and clivus
6	F	38	None	Progressive frontal headaches, pathologic telecanthus, and decreased mentation Space-occupying lesion of ethmoids, orbits, and anterior cranial fossa Biopsy, fungal species, atypical cells, and dysplasia

RESULTS

All patients with a biopsy-proven diagnosis of nonotologic osteomyelitis of the skull base and craniovertebral junction were analyzed. Six such consecutive patients were identified; their data are presented in Table 1.

DISCUSSION

Chandler coined the term "malignant otitis externa" to characterize osteomyelitis of the temporal bone as manifested by a granulating, destructive process of the external auditory canal, otalgia, and otorhea positive for *Pseudomonas aeruginosa*.[5] Typically, this entity is noted in elderly immunocompromised diabetic patients and may be locally quite destructive, with multiple cranial neuropathies, cervical root lesions, and meningoencephalitis. Aggressive surgical debridement coupled with systemic antipseudomonal therapy has been the mainstay of treatment.

Nonotologic osteomyelitis of the skull base is not as well defined or understood. The diagnosis is

Table 1. Continued.

Surgical intervention	Recurrent disease	Outcome
Frontal sinus obliteration, removal of all necrotic bone from frontal bone and base of anterior cranial fossa, primary cranioplasty	None (follow-up, 18 mo) Cultures, *Staphylococcus aureus*	Doing well Pain resolved All sites well healed
Le Fort I osteotomy approach to access the necrotic bone for complete debridement Dura intact Postoperative antibiotics for 6 wk	None (follow-up, 24 mo) Cultures: *Staphylococcus aureus*	Doing well Pain resolved All sites well healed
Direct debridement of necrotic nasal, medial orbital, and base of anterior cranial fossa bone, wound care and antibiotics for 6 wk	None (follow-up, 1 y) Cultures: mixed flora	Doing well No pain, no bone exposure
Infratemporal fossa approach (preauricular) to facilitate complete removal of necrotic bone Dura intact IV antifungals and antibiotics for 6 wk	None (follow-up, 10 mo) Cultures, invasive mucormycos is	Numbness resolved Normalized consciousness level Patient returned to premorbid functioning
Temporary halo placed Le Fort osteotomy with palatal split (hard and soft palates) to allow complete debridement of necrotic bone and C-spine stabilizing hardware IV antibiotics for 6 wk	None (follow-up 10 mo). Cultures-staphylococcus aureus.	Cervicalgia resolved Reversal of paresthesias in upper limbs, mild velopharyngeal insufficiency related to decreased posterior wall motion on video fluoroscopy
Subcranial approach to removal of all disease and necrotic bone of medial orbit and anterior cranial fossa floor Dura intact Anitfungals for 6 wk	None (follow-up, 24 mo) Cultures, invasive aspergillosis	Resolution of pain Telecanthus surgically corrected

not difficult in the presence of a persistent, generally long-standing contiguous source of infection such as a paranasal sinus, in an immunocompromised patient.[6] One of the patients in our series had a history of unremitting frontal sinusitis associated with progression of his symptom complex despite standard systemic antibiotic therapy. His diagnosis was suspected preoperatively and confirmed on biopsy of the osteomyelitic bone. This was not the case in many of the patients in our series. Although the diagnosis of osteomyelitis was in the differential, our working diagnosis was that of possible neoplasm. All patients had evidence on preoperative computed tomography (CT) scanning of osseous destruction of the skull base, with varying degrees of underlying dural enhancement. None formed a clearly delineated abscess, either intracranially or extracranially. Two thirds of our patients had focal neurologic deficits, all of which resolved after surgical intervention. Except for the one patient with invasive aspergillosis, all had evidence of systemic immunocompromise, with diabetes mellitus being the most common underlying condition. A history of previous radi-

ation therapy to the head and neck region seems to increase the predisposition to osteomyelitis in this patient population, as the area of involved skull base bone was within the radiation field in this subset of patients. Interestingly, unlike otologic osteomyelitis, the most common bacterial organism cultured in our series was *Staphylococcus aureus.* Systemic antibacterial therapy thus needs to be tailored to cover this organism. Internal medicine consultation was obtained for each of the immunocompromised patients to provide medical optimization of their underlying illnesses. Systemic antibacterial or antifungal therapy, based on culture results, was continued for a minimum of 6 weeks. The ideal length of treatment has not been prospectively evaluated for this patient population. It is the author's preference to obtain both CT scans and magnetic resonance images in preoperative evaluation of all skull base lesions, with the belief that these scanning modalities are complementary in this patient population. Response to treatment of osteomyelitis is generally guided by resolution of symptoms and normalization of the erythrocyte sedimentation rate (ESR), with or without reversal of abnormalities on serial gallium scans.[7] In the absence of any persistent neurologic deficit and in the presence of a normal ESR, it is reasonable to discontinue systemic therapy after 6 weeks. Persistent elevation of ESR or a return of symptoms, although not seen in our patient series, would mandate repeat imaging, including gallium scanning.

As noted in 2 of our patients with invasive fungal species, it is possible to have significant osseous destruction of the skull base with little to no deep fascial, orbital, or intracranial soft tissue involvement.[8] In such cases, the invasive fungal process appears to be less fulminant than when it is associated with significant soft tissue or fascial involvement.

Refractory osteomyelitis or recurrent osteomyelitis may be amenable to adjunctive treatment with hyperbaric oxygen to aid in neovascularization and the delivery of systemic antibacterial and antifungal agents.[9]

The mainstay of treatment of nonotologic osteomyelitis appears, however, to be broad exposure through standard skull base approaches, followed by aggressive complete removal of involved bone. This has been associated with a normalization of neural deficits in our patient population and a resolution of associated pain and radiographic progression of disease, as noted on serial CT scanning. The difficulty often encountered in differentiating this lesion from a neoplastic disorder further mandates surgical exploration for both diagnosis and treatment.

CONCLUSION

Nonotologic osteomyelitis of the skull base and craniovertebral junction is a locally aggressive disorder causing lytic destruction of skull base bone often with underlying dural enhancement. Systemic immunocompromise, such as diabetes mellitus, with or without a history of previous radiation therapy is usually noted. *S aureus* and various fungal species are the most commonly cultured organisms. Focal neurologic deficits are common and are potentially reversible in many cases. Aggressive surgical debridement of all affected bone achieved through the broad field exposure afforded by modern skull base approaches followed by culture-guided antifungal or antibiotic therapy is the mainstay of treatment.

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