ORIGINAL ARTICLE

Osteomyelitis in the head and neck

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Abstract

Conclusion. All bones of the facial skeleton and spine are susceptible to osteomyelitis due to various predisposing conditions. Current radiological tools are sufficient to provide adequate diagnosis. Treatment can be conservative resection of the diseased bone with adequate radical clearance in all cases except in cases of osteomyelitis due to osteoradionecrosis (ORN) where resection has to be more radical. Objective. In today’s antibiotic era, osteomyelitis in the head and neck is a rare occurrence. Dealing with osteomyelitis in head and neck bones is not the same as in other bones of the body due to the nature of the bones, complex anatomy of the region, and esthetics. Our purpose was to analyze the behavior of osteomyelitis in the head and neck bones and its management. Materials and methods. A total of 84 cases of osteomyelitis in head and neck were reviewed in a 10-year period. Pus for culture, antibiotic sensitivity, and radiology were the main investigations. A medical line of treatment was effective in acute cases. Surgery was opted for in chronic cases. Results. Mandible, frontal bone, cervical spine, maxilla, temporal bones, and nasal bones were involved, in descending order of frequency, i.e. the mandible was the most common bone affected. Nine patients were diagnosed as having acute osteomyelitis (11%); 75 were diagnosed as having chronic osteomyelitis (89%). Radiation-induced ORN leading to osteomyelitis was the most common cause of osteomyelitis of the mandible (13 of the 32 cases; 41%). Odontogenic infections and chronic sinusitis each gave rise to osteomyelitis in 3 of 10 cases (30%) of the patients with osteomyelitis of the maxilla. Chronic sinusitis was the main cause of frontal bone osteomyelitis in all 20 cases (100%). Tuberculosis (10 of 15 cases; 67%) and malignancy (5 of 15 cases; 33%) were the main predisposing factors in cervical spine osteomyelitis. Malignant external otitis (MEO) with diabetes mellitus was an underlying factor in all four cases of osteomyelitis of the temporal bone. Of the 18 patients with a diagnosis of ORN, the mandible was found to be the most susceptible bone (13 cases; 72%), followed by the maxilla (four cases; 22%) and cervical spine (1 case). Acute osteomyelitis responded to antibiotics. Sequestrectomy was carried out in all chronic cases but in cases of ORN more radical surgery was performed.

Keywords: Osteomyelitis, head and neck, mandible, osteoradionecrosis (ORN), cervical vertebral osteomyelitis (CVO), nasal bone, temporal bone

Introduction

Although it has been suggested that osteomyelitis is a disappearing disease in developed countries, it is still commonly encountered in areas of poor socio-economic conditions and is a major medical problem in the developing countries. The general lack of awareness of the prevalence of the disease and its features often leads to a misdiagnosis and delay in treatment. Early detection of this condition and prompt attention will pre-empt the need for a surgical intervention in an otherwise protracted course of illness.

Osteomyelitis is more difficult to treat in the head and neck, because of the anatomical region and also because of esthetic considerations. The incidence of osteomyelitis in the head and neck, its etiology, clinical features, management and results, have not been studied in detail, although there is literature available on the diseases affecting individual bones. Osteomyelitis can be defined as an inflammatory condition of the bone, which begins as an infection of the medullary cavity, rapidly involves the haversian systems, and extends to involve the periosteum of the affected area [1]. Infection occurs as a result of
a bacteremia, an inoculation during aseptic or bone surgery or a contiguous infectious focus. Conditions altering the vascularity of the bone such as radiation, malignancy, osteoporosis, osteopetrosis, and Paget’s disease predispose to osteomyelitis. Systemic diseases like diabetes, anemia and malnutrition that cause concomitant alteration in host defenses profoundly influence the course of osteomyelitis [1]. The consequences of this infection range from the minor nuisance of a draining tract, to a pathologic fracture at the infected site, to the possible malignant transformation to carcinoma [2]. The bones reported to be involved by osteomyelitis in the head and neck are the mandible, frontal bone, cervical spine, maxilla, nasal bone, temporal bone and skull base bones. The diagnosis is mainly made by clinical presentations like discharging sinus, periosteal thickening and tenderness, confirmed by the presence of sequestrum or bony destruction with or without pathological fractures on radiography. Imaging with radionuclide scans, computed tomography (CT), and magnetic resonance imaging (MRI) are used for early detection, when the diagnosis of osteomyelitis is equivocal or to help gauge the extent of bone and soft tissue infection. Surgical treatment involves debridement of necrotic bone and tissue, obtaining appropriate cultures, managing dead space, and when necessary, obtaining bone stability. Acute cases respond very well to a medical line of treatment. Others require surgical intervention with long-term broad-spectrum antibiotic therapy for 4–6 weeks. A review of the literature reveals very little information on osteomyelitis in the head and neck. Here we present our experience in managing 84 patients with osteomyelitis of various bones in the head and neck, which makes it one of the biggest series on osteomyelitis so far.

**Materials and methods**

This was a retrospective study of 84 cases of osteomyelitis in the head and neck carried out over a period of 10 years from 1994 to 2004. This included osteomyelitis of the mandible, frontal bone, cervical spine, maxilla, temporal bone, and nasal bone. The age, gender, medical history, and examination findings of these patients were obtained from case records. Typical clinical findings included localized bone pain, erythema, draining sinus tracts, fluctuating abscesses, deformity, instability, local signs of impaired vascularity, impaired range of motion, presence of a previous open wound, and discharge. In addition to local signs of inflammation and infection, signs of systemic illness, including fever, irritability, and lethargy were used to diagnose osteomyelitis. Once a clinical diagnosis of osteomyelitis had been reached, the following investigations were carried out at the relevant site. (1) Radiological investigations such as orthopantomogram, plain X-ray of skull bones, X-ray of the neck (antero-posterior and lateral view). (2) CT scan. (3) Pus from the discharging sinus was investigated for culture and sensitivity. (4) Wide-bore needle aspiration cytology in cases of ambiguous diagnosis. (5) Biopsies from the granulation tissues for histopathological examination. (6) Routine blood examination, blood sugar analysis, and ELISA for HIV infection.

Once the diagnosis and the extent of disease were confirmed, patients were treated either medically, surgically or both depending on the site, chronicity, and severity of the lesion. Patients with acute osteomyelitis were diagnosed by abrupt onset of symptoms with early radiological changes or absence of radiological findings. These patients were treated with a combination of intravenous (i.v.) injections: crystalline penicillin 1–2 million units 6-hourly, gentamicin 80 mg 8-hourly, and metronidazole 500 mg 8-hourly for 15 days, followed by oral antibiotics for not less than 4 weeks and sometimes up to 6 weeks. Chronic osteomyelitis was diagnosed when the symptoms were long-standing and radiology showed sequestra, periosteal thickening or abscess, loss of joint mobility, bony irregularity, loss of bone or pathological fractures. In all such cases, surgical intervention was made with perioperative antibiotic cover. Osteoradionecrosis (ORN) was determined when there were symptoms of bone necrosis or infection after radiotherapy in the absence of local primary tumor-induced necrosis, recurrence or metastatic disease. Repeated biopsies were taken from the diseased site to rule out foci of malignancy. The surgical procedure undertaken depended on the site of the lesion. In all cases, the pus was sent for microbiological study and intraoperative granulations, if any, were sent for histopathological study. All patients were supplemented with a high protein, multivitamin diet and general nursing care. Antituberculous therapy and antiretroviral therapy were initiated in cases of tuberculosis and HIV infection, respectively.

**Surgery involving the mandible**

In chronic osteomyelitis, a wound debridement, sequestrectomy, and saucerization were done. In cases of ORN, a radical sequestrectomy or hemimandibulectomy was done. Intermedullary wiring and fixation with bone grafts, plates, and screws was done wherever necessary. A pectoralis major myocutaneous flap (PMMF) was used to fill the defect in cases of hemimandibulectomy.
Surgery involving the frontal bone

Limited osteomyelitis due to acute sinusitis was dealt with by functional endoscopic sinus surgery (FESS) for drainage of pus. Endoscopic frontal sinusotomy was performed with wide drainage. More destructive disease processes were dealt with by an external Lynch Howarth approach. In most cases, a conservative bone debridement was done. In cases of involvement of the anterior wall, Riedel's procedure was done by removing the anterior wall of the frontal sinus. In case of extensive involvement of the posterior wall, cranialization of the sinus was done. Osteoplastic flap was carried out in case of extensive osteomyelitis. In all cases, the pus in the frontal sinus and the subperiosteal abscess was evacuated and the diseased bone was debrided. The diseased sinus mucosa was removed. A draining tube was placed from the frontal sinus into the nasal cavity.

Surgery involving the cervical spine

Wide-bore needle aspiration was done for up to two sittings, as and when there was collection of pus, while the patients were put on i.v. antibiotics. When aspirations failed or were not considered adequate, patients were taken up for an external surgical approach. An incision was made along the anterior border of the sternocleidomastoid. The sternocleidomastoid and carotid sheath were retracted laterally. The abscess in the retropharyngeal space was drained. The body of the vertebrae was inspected and debrided, and granulations and pus were sent for histopathological analysis.

Surgery involving the maxilla

A sequestrectomy was done in most cases. Most cases of ORN presented with considerable bony destruction and a total maxillectomy was carried out.

Surgery involving the nasal bone

An external incision was applied at the naso-labial fold and a flap was elevated to reach the affected area. The diseased bone was then excised.

Surgery involving the temporal bone

A post aural incision was given under general anesthesia. The skin with the periosteum was elevated over the mastoid and along the external auditory canal. The necrosed cartilage and the osteomyelitic bone segment of the external auditory canal and the mastoid bone were drilled out until healthy bone was present without opening up the whole of the mastoid. A wide meatoplasty was performed. An antibiotic pack was placed and changed every 2 days until the wound healed. One of the patients received hyperbaric oxygen therapy. All patients were followed up regularly.

Results

Age, sex, and site predilection

The age, sex, and site predilection of the 84 patients with osteomyelitis in this study are shown in Table I. The male female ratio was 1.7:1. Age ranged from 15 years (nasal osteomyelitis) to 70 years (mandibular osteomyelitis). In the present study the bones involved by osteomyelitis in decreasing order of frequency were the mandible, frontal bone, cervical spine, maxilla, temporal bone, and the nasal bones.

Predisposing factors

In the following analysis, some patients had more than one predisposing factor. Radiation-induced ORN leading to osteomyelitis (13 of the 32 cases; 41%) was the most common cause of osteomyelitis of the mandible. Malignancy (nine cases; 28%) and odontogenic causes (seven cases; 22%) were other important predisposing factors in the mandible (Table II). Odontogenic infections and chronic sinusitis each gave rise to osteomyelitis in 3 of 10 cases (30%) of the patients with osteomyelitis of the maxilla. Chronic sinusitis was the main cause of frontal bone osteomyelitis in all 20 cases (100%), 3 of whom had co-existing diabetes mellitus. Tuberculosis (10 of 15 cases; 67%) and malignancy (5 of 15 cases; 33%) were the main predisposing factors in cervical vertebral osteomyelitis (CVO). Diabetes mellitus with malignant external otitis (MEO) was the main predisposing factor in all four cases of temporal bone osteomyelitis.

Trauma predisposed to osteomyelitis of the nasal bones in two cases while a long-standing ulcer was the cause in another case. Contiguous infections

Table I. Age and sex predilection for patients with osteomyelitis.

<table>
<thead>
<tr>
<th>Site</th>
<th>0–20 years</th>
<th>20–40 years</th>
<th>40–60 years</th>
<th>&gt;60 years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandible</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>14</td>
<td>32</td>
</tr>
<tr>
<td>Frontal bone</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Cervical spine</td>
<td>2</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>Maxilla</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Temporal bone</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Nasal bones</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>11</td>
<td>9</td>
<td>33</td>
<td>84</td>
</tr>
</tbody>
</table>
were underlying conditions in 28 of the 84 cases (33%) of osteomyelitis of the bones in the head and neck. These included chronic sinusitis in most cases, rhinosporidiosis in one of the cases of osteomyelitis of the maxilla, MEO in temporal bone, and other nonspecific infections in cases of the mandible. All nine cases of acute osteomyelitis were associated with contiguous infection. ORN leading to osteomyelitis was an underlying condition in 18 of the 84 cases (21%), malignancy in 14 (17%), diabetes mellitus in 12 (14%), tuberculosis in 11 (13%), odontogenic infections in 10 (12%), and trauma in 5 (6%) cases. Of the 18 patients with a diagnosis of ORN, the mandible was found to be the most susceptible bone (13 cases; 72%) followed by the maxilla (4 cases; 22%), and cervical spine (1 case).

Clinical features and diagnosis

Nine patients were diagnosed as having acute osteomyelitis (11%) including five cases of osteomyelitis of the mandible, two of osteomyelitis of the maxilla, and two cases of osteomyelitis of the frontal bone, based on abrupt onset of symptoms such as pain, malaise, fever, exquisitely tender bone with reduced joint movement, and early radiological changes. In all, 75 patients were diagnosed as having chronic osteomyelitis (89%). In 32 patients with osteomyelitis of the mandible, pain and tenderness were present in all cases (100%), swelling in 30 cases (93.75%), discharging sinus with sequestra in 28 cases (88%) (Figure 1), periosteal thickening in 23 cases (72%), lymphadenopathy in 12 cases (38%), trismus in 11 cases (34%), bony irregularity in 11 cases (34%), loosening of tooth in 10 cases (31%), and pathological fractures in 5 cases (16%).

In 20 patients with osteomyelitis of the frontal bone, all patients had headache and sinus tenderness (100%). There was swelling over the sinus in 14 cases (70%) and pus in the middle meatus in 15 cases (75%).

In 15 patients with osteomyelitis of the cervical spine, 13 (87%) had tenderness over the cervical spine, 12 (80%) had neck rigidity, 10 (67%) had torticollis, 14 (93%) had bulge over the posterior pharyngeal wall, 5 (33%) had stridor, and 2 patients (13%) had neurological deficits.

In 10 patients with osteomyelitis of the maxilla, all had pain and swelling over the maxilla (100%). Tenderness and bony irregularity were each seen in eight patients (80%) and discharging sinus with sequestra in six (60%). Loosening of teeth and lymphadenopathy were each seen in five patients (50%), and trismus in one patient (10%) (Figure 2).

In four patients with osteomyelitis of the temporal bone, all had severe pain, tragal tenderness, and ear discharge. Facial nerve palsy and extradural abscess were each seen in one patient.

Three patients with osteomyelitis of the nasal bones all had swelling, discharging sinus, and tenderness (Figure 3).

Investigations in osteomyelitis

A preliminary X-ray was done in all cases. In acute osteomyelitis of all areas, X-rays were either normal or showed periosteal thickening, minimal abscess or new bone formation. In chronic osteomyelitis of the mandible, orthopantomogram revealed bony destruction, sequestra, and altered contours of the mandible in 27 of the 32 cases (84%) and pathological fractures in the remaining 5 cases (16%). In frontal sinus osteomyelitis, X-ray examination

Table II. Predisposing factors in patients with osteomyelitis.

<table>
<thead>
<tr>
<th>Predisposing factors</th>
<th>Mandible</th>
<th>Frontal bone</th>
<th>Cervical spine</th>
<th>Maxilla</th>
<th>Temporal bone</th>
<th>Nasal bone</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contiguous infections</td>
<td>2</td>
<td>20</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>Radiation</td>
<td>13</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Malignancy</td>
<td>9</td>
<td>5</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Diabetes</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Odontogenic infections</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Trauma</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

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showed bony destruction, sequestra, periosteal or extradural abscess, and haziness of the sinus in 14 of the 20 cases (70%) and loss of scalloping in 6 (30%). CT scan was also done in five cases that showed clear delineation of the extradural abscess and bone disease limits. In all 15 cases of CVO, X-ray soft tissue of the neck revealed widening of prevertebral space with destruction of one or more vertebral bodies and intervertebral discs. CT scan done in eight cases showed destruction of body of vertebra, prevertebral abscess in all cases, and compression of spinal cord due to abscess in two cases (Figure 4). CT-guided biopsy was done in two cases, including one case of ORN. In maxillary sinus osteomyelitis, X-ray showed haziness of maxillary sinus in 9 of the 10 cases (90%) along with bony destruction of the anterior wall in 7 cases (70%). CT scan determined osteomyelitis in all cases of nasal and temporal bone disease.

Pus from the diseased area was sent for culture and sensitivity in 77 of the 84 cases. The organisms cultured were Staphylococcus aureus in 38 cases (49%), Streptococcus pyogenes in 22 cases (29%), Streptococcus pneumoniae in 12 cases (16%), Mycobacterium tuberculosis in 11 cases (14%), Klebsiella ssp. and Pseudomonas aeruginosa in 5 each (7%), and Bacteroides in 1 case (1%). ELISA for HIV was positive in one patient who had osteomyelitis of the mandible. Biopsy was taken in 77 cases from granulations in and around the discharging sinuses from the mandible, frontal bone, vertebral bodies, maxilla, external auditory canal, and the nasal bone. Histopathological studies from the 77 biopsies performed in chronic osteomyelitis revealed chronic inflammation in 51 patients (66%), malignancy in 14 cases (18%), tuberculosis in 11 cases (14%), and rhinosporidiosis in 1 case of maxillary osteomyelitis (1%).

**Treatment modalities in osteomyelitis**

Five patients with acute mandibular osteomyelitis were managed medically with intravenous antibiotics and analgesics followed by dental extraction. They were cured of the condition. In 14 cases of chronic osteomyelitis, most of the patients had received prior courses of antibiotics elsewhere that had failed to resolve the condition. In 13 of these cases, surgical treatment was opted for that involved removal of the diseased segment of bone, exposing wide margins of healthy bone, along with antibiotics for 6 weeks. This included sequestrectomy with saucerization in seven patients (50%). Intermedullary wiring and fixation with plates and screws was done in six cases (43%) where a segment of the mandible had to be excised (Figure 5). There was no recurrence of osteomyelitis in any of the cases. One patient refused surgery and was put on broad-spectrum antibiotics and the patient was lost to follow up. In cases of ORN (n = 13), there was considerable loss of bone. A radical sequestrectomy was done in seven patients and hemimandibulectomy in six patients (Figure 6). A PMMF flap was used for filling the defect in most cases. None of them developed a flap failure or recurrence on follow-up.
Six of the 20 patients (30%) with limited frontal bone osteomyelitis involving one of the walls of sinus underwent FESS for drainage of pus. Two of these were osteomyelitis secondary to acute frontal sinusitis and were cured completely. Four cases of osteomyelitis due to chronic sinusitis did not improve after FESS and had to undergo a Lynch Howarth approach; 13 patients primarily underwent a Lynch Howarth approach (65%). Four patients with anterior wall lesion underwent Riedel’s procedure, one patient with posterior wall lesion underwent cranialization, and the rest underwent conservative drilling out of the lytic bone with adequate margins. One patient underwent an osteoplastic flap procedure. CSF leak was seen in two cases, both in cases of posterior wall osteomyelitis, which was repaired intraoperatively. All the patients received a course of antibiotics for 6 weeks. None of the patients developed recurrence.

Of the 10 patients with cervical spine osteomyelitis due to tuberculosis (n = 15), 2 patients improved with wide-bore needle aspiration followed by antituberculous therapy. Eight underwent external surgical approach for drainage of the abscess and sequestrectomy of the body of the cervical vertebrae, followed by antituberculous therapy. All patients had a cervical collar for a minimum period of 1 year along with physiotherapy. All patients responded well to this treatment. One patient had undergone radiation 6 months earlier for malignancy of the hypopharynx (T3N2aN0, stage IV) and he was subjected to wide-bore aspiration and antibiotics. He subsequently succumbed to the disease. Four patients had secondary metastatic deposits in the spine leading to osteomyelitis and abscess. Three of them underwent external drainage following failure of wide-bore needle aspiration. All of them subsequently succumbed to the disease. One patient had lung metastasis and died within a few days of admission.

Two patients with acute osteomyelitis of the maxilla due to chronic sinusitis who were managed medically responded well to the treatment. Four patients with chronic osteomyelitis underwent sequestrctomy. One patient had a recurrence following which a sequestrectomy was again performed. Radical sequestrectomy and total maxillectomy were each done in two cases of extensive ORN. In one case of radical sequestrectomy, there was a recurrence and a total maxillectomy was then performed. Two patients did well on follow-up and two other patients died due to recurrence of malignancy in the primary site.

All the four patients with temporal bone osteomyelitis underwent debridement using a post-aural incision followed by wide meatoplasty along with antibiotics for 6 weeks. An extradural abscess was drained in one patient. One of the patients did not respond to debridement and developed facial nerve palsy and meningitis. He then received hyperbaric oxygen therapy and debridement once more, after which the disease showed complete regression.

All the three cases of nasal bone osteomyelitis were managed by sequestrectomy followed by broad-spectrum antibiotics for 6 weeks. All patients recovered completely.

Discussion

The term ‘osteomyelitis’, which was introduced by Nelaton [3] in 1844, implies an infection of the bone and marrow. Osteomyelitis most commonly results from bacterial infections, although fungi, parasites, and viruses can affect the bone and marrow. Although osteomyelitis in the long bones of the body can be broadly comparable to the flat and irregular bones of the head and neck as regards etiopathology, their management varies in the head and neck due to anatomical and cosmetic considerations. Various classifications of osteomyelitis are
In some cases no causes can be identified and surgery, infections of the oral cavity leading to infection, trauma, especially compound fractures, predisposing factors for osteomyelitis include dental by means of caries and periodontal disease [7]. The infectious and inflammatory agents to invade bone presence of teeth creates a direct pathway for unique from other bones of the body in that the inflammatory lesions are by far the most common and neck present with mandibular disease [7].

Antibiotics. In addition, chronic osteomyelitis tends to be polymicrobial in terms of both aerobic and anaerobic microorganisms. An open wound or sinus tract is always a potential source of superinfection. In instances where appropriate antibiotic therapy was started to treat the organisms initially recovered from the infected site, there is the potential for successive infections with more virulent, more resistant or opportunistic organisms [6].

Most patients with acute osteomyelitis in the head and neck present with mandibular disease [7]. Inflammatory lesions are by far the most common pathologic condition of the jaws. The jaws are unique from other bones of the body in that the presence of teeth creates a direct pathway for infectious and inflammatory agents to invade bone by means of caries and periodontal disease [7]. The predisposing factors for osteomyelitis include dental infection, trauma, especially compound fractures, surgery, infections of the oral cavity leading to periostitis, infections from furuncles or lacerations. In some cases no causes can be identified and hematogenous spread is presumed to be the origin. Conditions leading to decreased bone vascularity like malignancy, tuberculosis and radiation can also predispose to osteomyelitis. Dental infections are the most frequent cause of acute osteomyelitis of the jaws [8]. In both acute and chronic forms, the most common sites of the mandible are the posterior bodies of the mandible [8]. A study by Taher [9], of 88 cases of osteomyelitis of the mandible, found trauma to be the most common predisposing cause for osteomyelitis, attributing it to the geo-political difficulties. In our series we found that radiotherapy and malignancy preceded odontogenic infections and trauma as a predisposing cause for chronic osteomyelitis. In our series we found that the clinical features are the same for both the acute and chronic variants except that in chronic osteomyelitis these symptoms are milder. Clinical features documented are deep intense pain, high intermittent fever, paraesthesia or anesthesia of the lip due to involvement of the mental nerve, pus and sequestra exudates through fistulae, trismus, regional lymphadenopathy, induration of soft tissue, and wooden character of bone with pain and tenderness on palpation. The associated teeth may be mobile and sensitive to percussion [7]. Teher [9] found that 37% of his patients had fistulas and sequestrations and 3% had pathological fractures, fistulas, and sequestrations. In the present series, discharging sinus with sequestra was seen in 88% of patients and pathological fractures in 6%. This difference can be attributed to the fact that most of our cases were secondary to radiotherapy and malignancy, as compared with trauma in Teher’s series.

Culture and sensitivity of the discharge usually reveals staphylococci, streptococci, pneumococci, and anaerobes such as bacteroides, as was the case in the present series. Before application of any cross-sectional imaging modality, the orthopanoramic view is indispensable in recognizing direct radiographic signs of osteomyelitis. The orthopanoramic view is the procedure of choice in follow-up examinations in patients who have osteomyelitis [10]. We found an orthopantomogram (performed in 84% of cases) to be a very useful tool in the diagnosis. This showed scattered areas of bone destruction, sequestra/involucrum, alteration in the contour of the mandible, and occasionally pathological fractures. If surgical treatment is planned, high-resolution CT is required to specify the degree of cortical destruction, the presence of sequestra in particular, and to define the extent of osseous removal required [10]. To detect early osteomyelitis, a two-phase technetium bone scan followed by a gallium citrate scan may help to confirm diagnosis [7]. Histopathological examination of the surgical specimen or granulation...
tissues was carried out in most of our cases, which helped in accurate diagnosis of the predisposing factors such as malignancy, tuberculosis or other granulomatous conditions, while ELISA helps in the diagnosis of HIV infection, seen in one of our patients. The treatment protocol consisted of a combination of surgery and antimicrobial treatment. The aim of surgery was elimination of all infected, necrotic tissue, to facilitate drainage and provide an opportunity for reperfusion in the areas of insult. The type of surgery depended on the extension of osteomyelitic process, and included conservative sequestrectomy and radical sequestrectomy.

Doses above 50 Gy usually are required to cause ORN and the mandible is the most commonly involved bone. As in our series, Hao et al. [11] also found the mandible to be the most commonly involved bone in ORN. The nasal bone, nasopharynx, palate, and temporal bone ORN reported in their series was not encountered in our series. In our series, we report ORN of the maxilla and cervical spine, mention of which is made only twice in the literature [12,13]. In cases of ORN, Hao et al. [11] \( n = 26 \) and Shaha et al. [14] \( n = 6 \) have advocated the necessity of radical debridement and resection of dead bone, although the amount of bone that needs to be removed is a matter of debate. In our series we also approached ORN \( n = 13 \) more radically, opting for radical sequestrectomy in seven cases and hemi-mandibulectomy in six cases. Hao et al. [11] advocated the use of a flap outside the radiation field, especially a free flap. We have used the PMMF with good results. None of our patients underwent hyperbaric oxygen therapy for ORN.

Osteomyelitis of the diploeic frontal bone is most often the result of infections of the frontal sinus. It can also be due to trauma or surgery on the anterior wall of the sinus and can be aggravated by swimming. The thin compact bony floor is the first to be involved. Osteomyelitis may be fulminating type (Figure 7), spreading type, localized type or sclerosing type. The fulminating type develops after surgery or virulent sinusitis and is characterized by massive tissue death and gross sequestration. High fever, headache, and swelling over the forehead are seen. The disease can localize to form subperiosteal abscess or spread to cause intracranial extension. The spreading type is less dramatic than fulminant, presenting as high fever, headache, and cellulitis of the orbit and forehead. Sequestra and multiple puffy tumours (Potts) form over the frontal bone, which can later spread to the parietal and occipital bones, and even to the whole calvarium if untreated (necrotizing calvarium). The localizing type is usually due to chronic sinusitis causing local necrosis of the bone and a subperiosteal abscess. Sequestrum does not occur. Sclerosing osteitis is a form of localized disease due to long-standing abscess leading to sclerosis of frontal sinus. According to Zielnik-Jurkiewicz et al. [15] teenagers are the most frequently affected. In our series, we found that the 20–40 and 40–60 year age groups were the most commonly affected. In Bondar’ and Nekhopochin’s series of the 21 patients with frontal bone osteomyelitis, 18 were of traumatic origin and 3 were rhinogenic [16]. In our series all 20 cases were rhinogenic in origin, while 3 had co-existing diabetes. Marshall and Jones [17] in their series reported seven patients, five of whom presented with swelling of the forehead, three with frontal pain, and two with sinocutaneous fistula. We also have recorded similar features except that of sinocutaneous fistula. X-ray of the paranasal sinuses showed subperiosteal and extradural abscess, moth-eaten appearance of the bone and sequestra in 70% of our cases and loss of scalloping in 30% of the cases. However, the imaging modality of choice for detection of complications is CT scan. We found that X-rays showed osteomyelitis fairly accurately in most cases. CT scans carried out for five patients in whom an X-ray was also done showed greater clarity of the abscess planes and bone disease limits than the X-ray examinations. Bone scanning will detect osteomyelitis but cannot define soft tissue suppuration [18]. Our experience with the use of FESS showed that cases of osteomyelitis secondary to acute frontal sinusitis responded well to endoscopic frontal sinusotomy, debridement using curette, and wide drainage. The disease recurred in the cases in which FESS was used as the option for limited disease in chronic osteomyelitis where the clearance probably had to be wider and was not possible with endoscopy. Endoscopy has been used in combination with a percutaneous approach [18]. Marshall and Jones [17] used an external approach in all their cases, including the Riedel’s procedure in two cases, which involved removing the anterior wall of the

Figure 7. Frontal bone osteomyelitis – fulminating type.
drainage of the cavity for 24
an enlarged frontonasal anastomosis, and prolonged
suppurative epidural layers and further formation of
the pathological focus, removal of the mucosa and
the neurosurgical approach, with a wide revision of
frontal sinus walls, preference should be given to
suturing the wound. In advanced osteomyelitis of the
litic lesions of the frontal bone can be removed by
muscle tissue. They suggested that small osteomye-
resection of the pathological focus, with the host
tamponade of the cavity, that developed after the
frontal sinuses via the frontonasal anastomosis, and
removal of osteomyelitic bone lesions, drainage of
ing of the wound after dissecting the fistula and
commend three therapeutic approaches: closed heal-
frotal sinus. Bondar' and Nekhlopochin [16] re-
methylene, liver disease, diabetes, previous surgery/
theseproblematic causes of CRMO in our series. Although the lumbar and
dorsolumbar spine are most commonly affected by
tuberculosis, while the cervical and upper dorsal
spine are rarely involved, in our series 10 cases
(67%) had involvement of the cervical spine by
tuberculosis. The patients present with varying
symptoms such as restricted and painful neck
mobility, torticollis, trismus, posterior pharyngeal
wall bulge, fluctuant neck swelling, and stridor.
While prevalence of a prevertebral abscess was seen
in 53% of the cases in one series [19], we found
abscess to be present in all cases (100%). Patients
can also have neurological deficits due to the
pressure effect of cold abscess over the spinal cord,
this being the case in some of our patients. In
contrast with other locations of spinal infections,
osteomyelitis of the cervical spine can be more
dramatic, leading to early neurological deficit [20].

The diagnosis of CVO can be accomplished in
most cases by using plain X-ray films and CT scans.
Nevertheless, preferential use of MRI in cases in
which there is a neurological deficit is helpful in
identifying epidural compressive processes [19]. All
identified series of CVO were strongly biased toward
surgical intervention. In acute cases and in terminal
cases, we carried out a wide-bore aspiration with
antibiotic cover. However, in most other cases, an
external approach is recommended as it provides a
good exposure of bone for sequestrectomy. In
addition to abscess drainage, neurologic decompression or vertebral stabilization may be necessary.
In patients with secondaries in the spine with osteo-
myelitis, drainage of pus is done along with antibi-
otics for 6 weeks and chemotherapy. Alan et al.
[12] apparently reported the first case of ORN of
cervical vertebra and occipital bone in a patient
treated by surgery and radiotherapy for neck metast-
sis from an unknown primary. We also present one
case of ORN of the first and second cervical
vertebrae. As was the case in the report by Alan et al.
[12], our patient also succumbed to ORN following external drainage of the abscess.

Although osteomyelitis of the maxilla is rare, it is
more frequently seen in infants and children, as
more bone is available in the maxilla during infancy.
Osteomyelitis of the maxilla is much less frequent
than that of the mandible because the maxillary
blood supply is more extensive [1]. During the pre-
antibiotic era, phossy jaw and other forms of
chemical osteomyelitis resulted from medicines like
mercury, arsenic and bismuth and environmental
pollutants like lead and phosphorus used in safety
matches. The predisposing factors for osteomyelitis
of maxilla include dental infections, maxillary sinus-
itis, trauma, or conditions which compromise the
blood supply of the bone such as radiotherapy and
malignancy. In our series, contiguous infections such
as maxillary sinusitis and odontogenic infections were the main causes of maxillary osteomyelitis, followed by trauma. There are case reports citing maxillary osteomyelitis, but very few series. Ours is one of the largest series in recent years, with 10 cases. Liu et al. [21] reported actinomycosis in a patient treated for ORN of the maxilla while receiving radiotherapy for nasopharyngeal carcinoma. Likewise, in our series, we had a similar case of ORN of the maxilla secondary to radiotherapy and superinfection with rhinosporidiosis. Osteomyelitis can occur in infants secondary to hemogenous spread from the umbilical cord or boils, perinatal trauma of the oral mucosa from the obstetrician’s finger or the mucus suction bulb, or from contaminated human or artificial nipples [1]. In our series, the age incidence was 20 years and above. Clinical features are fever, rigors, pain and tenderness over the maxilla, halitosis, loosening of teeth, discharging sinuses, numbness of cheek, cellulitis of face, ocular symptoms like epiphora, proptosis, impaired eyeball movements, occasionally blindness, and lymphadenopathy. Radiography shows multiple small radiolucent patches with sequestrum after 10 days [22]. Kaneda et al. [22] in their series of 11 cases studied maxillary osteomyelitis clinically and radiologically. In their series, the molar area was most affected, while in our series the molar was also the most common site of odontogenic infection. In Kaneda et al.’s series [22], radiologically, the spotty type of osteolytic change was the most frequent, osteosclerosis was rare and sequestrum was not a clear feature. In our series, X-ray showed haziness of maxillary sinus in 9 of the 10 cases, along with bony destruction of the anterior wall in 7 cases. These were the only findings with no clear sequestra visualized. In all cases, conservative debridement of the diseased bone gave good results. In acute osteomyelitis, medical therapy is effective, which includes parenteral broad-spectrum antibiotics and high protein and multivitamin diet for 4–6 weeks. Ang et al. [13], who had one case of ORN of the maxilla, stated that conservative measures, such as limited debridement and HBO therapy, may be effective in preventing the progression of ORN. However, conservative measures fail to eradicate established ORN, which requires radical surgical resection followed by functional reconstruction with well-vascularized tissue. We did not use flaps in our cases of ORN of the maxilla, but we agree that radical surgical resection is the treatment of choice.

Osteomyelitis of nasal bone is a very rare entity. It is usually associated with osteomyelitis of neighboring bones such as the maxilla. We had one case of osteomyelitis of maxilla and nasal bone due to a long-standing ulcer and two cases following trauma.

Nasal osteomyelitis can be clinically diagnosed by the discharging sinus, periosteal thickening, and bony tenderness. X-ray of nasal bones may show a hypodense area and no special investigation is required. Local debridement along with a course of broad-spectrum antibiotics for a period of 1 month gives good results.

Osteomyelitis of temporal bone is a rare disease that occurs secondary to malignant external otitis (MEO) or chronic suppurative otitis media. Chandler in 1968 was credited with coining the term malignant external otitis. The term malignant is used to emphasize the serious nature of this infection, as in the original historical report 6 of the 13 patients died. The disease occurs predominantly in elderly diabetics and the causative agent is almost uniformly Pseudomonas aeruginosa. We found that all our patients had Pseudomonas infection with or without associated staphylococcal infection. The other predisposing factors include immunocompromised individual, radiotherapy, malignancy, and trauma. Schweitzer [23] listed warning signs of temporal bone osteomyelitis as: (1) deep pain (temporal, parietal, post auricular, retro-orbital); (2) intermittent, foulotorrhea and spiking fever; (3) preauricular cellulitis; (4) woody induration of pinna; (5) chronic mastoid cutaneous fistula; (6) fibrotic mastoid granulation tissue; (7) intermittent facial twitching suggestive of facial canal dehiscence; and (8) persistent leukocytosis and an elevated sedimentation rate. Plain radiograph in temporal bone osteomyelitis shows sequestra. CT scan is helpful in accurate diagnosis and may show sclerosis of temporal bone. Other modalities include 99mTc medronate methylene diphosphonate bone scanning, and gallium citrate (67Ga) scintigraphy. Treatment consists of broad-spectrum antibiotics for not less than 3 months, along with surgical debridement and a wide meatoplasty. Local treatment of the auditory canal includes meticulous cleaning and debridement plus topical application of antimicrobial agents. Strict diabetic control is necessary. In our series, we had four cases of malignant otitis externa with osteomyelitis of the temporal bone and with involvement of either the cartilage of the external auditory canal or the part of the conchal cartilage adjacent to the opening of the external auditory canal. We treated this by wound debridement through a post auricular approach and with a wide meatoplasty. Only minor deformity of the auricle resulted, perhaps due to the fact that only the part of the conchal cartilage adjacent to the opening of the external auditory canal was involved in these cases. Despite the reported efficacy of prolonged systemic antibiotic therapy, treatment failures do occur due to tissue hypoperfusion and
hypoxia, where the use of hyperbaric oxygen increases wound PO$_2$ levels, enhances phagocytic oxidative killing of aerobic microorganisms, and promotes angiogenesis and osteogenesis. Treatment consists of 100% oxygen in a multipurpose chamber under 2.5 standard atmospheres of pressure (ATA) for 60 min (with two 5-min breaks) once daily, 5 days a week [24]. Dudkiewicz et al. [25] described osteomyelitis of the temporal bone beyond the mastoid framework as an unusual complication of acute mastoiditis. The disorder is characterized by a failure to respond both locally and systemically to accepted medical and surgical therapy, persistent fever, high levels of inflammatory markers, and CT findings of temporal bone destruction. These authors advocate antibiotics and at least a cortical mastoidectomy, which provides good prognosis.

Skull base osteomyelitis (SBO) is an aggressive, invasive, indolent infection with potentially significant morbidity and mortality. The most common form of skull base osteomyelitis is MEO. The course of antibiotic therapy varies from a short 2–3 weeks course for MEO in children to 6 months for skull base osteomyelitis in adults. Baseline CT and radionuclide scans will attempt to differentiate otitis externa from MEO and skull base osteomyelitis. The role of surgery is not very well defined, except for biopsy and local debridement of necrotic tissue and drainage of abscess or formal tympanomastoid procedures such as modified radical or radical mastoidectomy with partial petrous apicectomy and embolectomy for jugular vein thrombosis. Concern exists that surgery may enhance MEO and skull base osteomyelitis by opening facial spaces and new tissue planes with spreading infection. Prolonged antibiotic therapy with third-generation cephalosporins or oral fluoroquinolones has been the principal means of therapy.

**Conclusion**

Osteomyelitis in the head and neck is a difficult disease to treat. The series in the present study shows that this condition can affect the most important bones in the face and the skull base. The treating otolaryngologist must harbor a high index of suspicion in patients with predisposing conditions, so as to effectively diagnose osteomyelitis early when it can be treated completely. Simple investigations like X-rays and CT scans generally suffice for diagnosis but bone scans will detect early disease. Long-term appropriate antimicrobial therapy usually suffices in acute cases. Surgical intervention in the form of adequate debridement of diseased bone with good margins and long-term antibiotics have given us good results in dealing with chronic osteomyelitis. ORN of any bone requires radical surgical intervention followed by tissue perfusion in the form of flaps or hyperbaric oxygen therapy. Regular follow-up examinations and radiology of the affected region are part of the standard therapy. As yet, in some areas of the Asia-Pacific region, the incidence of osteomyelitis is still relatively high, and statistics emphasize the need to prepare for a resurgence of bone and joint infections due to the spread of HIV and other acquired immune suppression diseases.

**References**


