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Combination of Surgical and Medical Management of Cranial Osteomyelitis

Rasha Abdelhamid Zaki, Mahmoud Faried bathalla, Rabab Yahya AbdAl-kareem, Samy Ibrahim Kamel, Mostafa Gamaleldin Zahr, Mahmoud Kamel Elawady*
Neurosurgical Department, Al-Azhar University, Faculty of Medicine for Girls, Cairo, Egypt
* Corresponding author, Email: drmkawady@yahoo.com

Abstract:
Background and objective: One definition of the term "osteomyelitis" is inflammation of the bone and bone marrow. In spite of its rarity, cranial osteomyelitis may be fatal if not diagnosed and treated quickly. **Aim of work:** Outcome of combination of surgical and medical management of cranial osteomyelitis. **Patients and methods**: A retrospectives analysis study includes 40 patients with cranial osteomyelitis. All the patients had conducted a standard data collection including demographics data, comorbidities and predisposing factors, full medical history along with complete physical examinations, outcomes of pre- and post-operative imaging techniques including computed tomography (CT) and magnetic resonance imaging (MRI), as well as microbiological and histological analyses. The cases were separated into 2 groups (cryptogenic & non-cryptogenic). The study discusses the treatment of cranial osteomyelitis and the effect of medications in the beginning of the treatment followed by surgical intervention. **Results**: The most common risk factor of our study was smoking, observed in 30 (75%) of patients, while diabetes was the second, observed in 23(57.5%). Staphylococcus aureus represents the most common organism of analyzed patient (n=50) (41.7%), Mycobacterium TB. was the second pathogen identified (n=33) (27.5%). Successful treatment of cranial osteomyelitis was achieved in 97.5% starting with broad-spectrum antibiotic, followed by surgery. while unsuccessful treatment was found in 2.5%. with the same protocol. **Conclusion**: Complications from cranial osteomyelitis have decreased with the advent of broad-spectrum antibiotics and the development of advanced neurosurgical techniques. Our results demonstrate that empirical systemic antimicrobial therapy, and management of predisposing factors, Treatment of cranial osteomyelitis consists of antibiotics, followed by strict surgical debridement.

Keywords: cranial osteomyelitis, cranial infection, surgical intervention of cranial osteomyelitis**.**
Abbreviations: MRI= Magnetic Resonance Imaging. CT= Computed Tomography. TB= tuberculosis. SBO= skull base osteomyelitis

Introduction:

Skull base osteomyelitis (SBO) wasn't formally described until 1959 , when it was written up by Meltzer and Kelemen. Inflammation of the bone and marrow is what's meant by the term "osteomyelitis" **[1]**. The literature identifies two forms of osteomyelitis: acute (lasting less than a month) and chronic (lasting longer than a month). When chronic osteomyelitis does not react to medical treatments or comes back after proper treatment, the term "refractory osteomyelitis" is used to describe the condition**. [2]** Lateral, medial, and temporal bone osteomyelitis all make up the skull base. **[3]**

Clinically, acute cranial osteomyelitis in general can be present by fever, headache, edema, pain, photophobia, seizures, and focal neurologic signs**.[4]** Progressive headache, impaired mental status, sinocutaneous fistulas, and infectious consequences such meningitis and extradural, subdural, or intraparenchymal abscess are hallmarks of the chronic kind, which also has a higher risk of death**.[5]**

Vancomycin, Metronidazole, and a third-generation cephalosporin comprise the usual empiric antibiotic regimen. Isoniazid, rifampin, pyrazinamide, and streptomycin or ethambutol are the four

medications that make up the anti-tuberculous cocktail. Pesticides that kill worms (like albendazole and mebendazole). Acute infections often need antibiotic treatment for 4–6 weeks, but persistent infections require treatment for at least 12 weeks. Surgical intervention often entails debridement and repair of the skull bone. Soft-tissue reconstruction is the only kind that can be done in an emergency setting, whereas cranioplasty may wait until the second phase of treatment. **(2)**.

Materials and Methods:

This work was done between September 2015 and May 2020, in Alzhraa University hospital, Egypt. This work includes 40 patients with cranial osteomyelitis. 28 (70%) Male, 12 (29%) female, their age ranged from 5- 60 years old (Mean ±SD, 27.50±7.64)

For each patient, clinical information was recorded: 22 patients (55.0%) have fits, 5 patients (12.5%) with Chronic Headache, 13 patients with fever (32.5%), 3 patients with cranial nerves palsy (7.5%), one patient with scalp ulcer (2.5%). Together with demographics, comorbidities, and risk factors, Results of microbiological and histological examinations, hospitalization, and a full medical history were included. Medications, MRI, CT, and PET scan findings for a hidden illness, and a bone scan. All patients gave their informed permission, and then they were split into two categories: those with cryptogenia and those without.

Protocol*:*

Antibiotics were administered to all patients before any surgery was performed; after surgery, patients received culture- and sensitivity-specific antibiotic treatment before undergoing cranioplasty.

Statistical analysis: Using p-value was considered significant at the level of < 0.05.

Results:

Cranial osteomyelitis diagnosed in 28 male (70.0%) and 12 female (29.0%) with mean age (27.5 y), 27 patient (66.7%) of them were classified as non-cryptogenic osteomyelitis and 13 patient (33.3%) were cryptogenic.

The most common risk factor was smoking, observed in 30 (75%) of cases, while diabetes was the second, observed in 23(57.5%) of analyzed patients. The total leucocytic count of non-cryptogenic group ranged from 14000-18000, while cryptogenic group were ≥ 21000. Post firearm (n= 19) (47.5%) represent the most common causative agent, the second was Post traumatic depressed skull fracture represent (n=8) (20.0%), skull base osteomyelitis observed in (n=3) (7.5%) complicating chronic sinusitis, while post radiation necrosis was the least cause (n=1) (2.5%). Table 1

Table 1. illustrate number of cases and causes of cranial osteomyelitis:

Cause	NO. cases	Percentage
Post-surgical purr hole associated with subdural empyema	2	5.0%
Post purr hole of endoscopic surgery	1	2.5%
Post craniotomy with natural bone flap	2	5.0%
Post craniotomy with acrylic mesh	4	10%
Post craniotomy with titanium mesh	2	5.0%
Post firearm	19	47.5%
Post traumatic depressed skull fracture	3	7.5%
Spontaneous complicated from frontal sinusitis	4	10.0%
Spontaneous complicated from maxillary sinusitis	1	2.5%
Spontaneous complicated from sphenoid sinusitis	1	2.5%
Post radiation necrosis	1	2.5%
Total	40	100.0%

Fits (n=22) (55.0%) was the most common presentation of analyzed patients, Fever (n=13) (32.5%) was the second, Chronic Headache observed in (n=5) (12.5%), Cranial nerves palsy was observed in (n=3) (7.5%) while Scalp ulcer (n=1) (2.5%) was the least. Refractory cases (n= 4) (10.0%) represent the commonest complication of analyzed patient, Failed cases (n=1) (2.5%) was the second while Cranial nerve palsy worsened, not improved in one case (n=1) (2.5%).

Staphylococcus aureus represents the most common organism of analyzed patient (n=50) (41.7%) Mycobacterium TB was the second pathogen identified (n=33) (27.5%) other pathogens include MRSA (10.8%), *Pseudomonas aeruginosa* (9.2%), Staph. Epidermidis (6.7%) and Aspergillus (4.2%) Table 2, Fig.:1,2,3

Table 2: The pathogenic organisms.

Pathogen	**No. of cases**	**Percentage**
Staphylococcus aureus	**17**	**42.5%**
MRSA	**4**	**10.0%**
Staph. Epidermidis	**3**	**7.5%**
Mycobacterium Tb	**11**	**27.5%**
Aspergillus	**1**	**2.5%**
Pseudomonas aeruginosa	**4**	**10.0%**

None of the analyzed patients died. Successful treatment was achieved in (n=117) 97.5%, while unsuccessful treatment was in (n=3) 2.5%. Table 3

Table 3: Outcome after surgery

	Successful cases(n=37) 97.5%	**Non successful cases/ (n=1) 2.5%**	**P value**
Vault (n=31)	31 (1 of them was refractory)	0	0.035*
Skull base (n=9)	8 (3 of them refractory require prolonged therapy)	1	0.073

Using: x^2: Chi-square test
*p-value >0.05 is insignificant; *p-value <0.05 is significant.*
Fig.:1,2,3

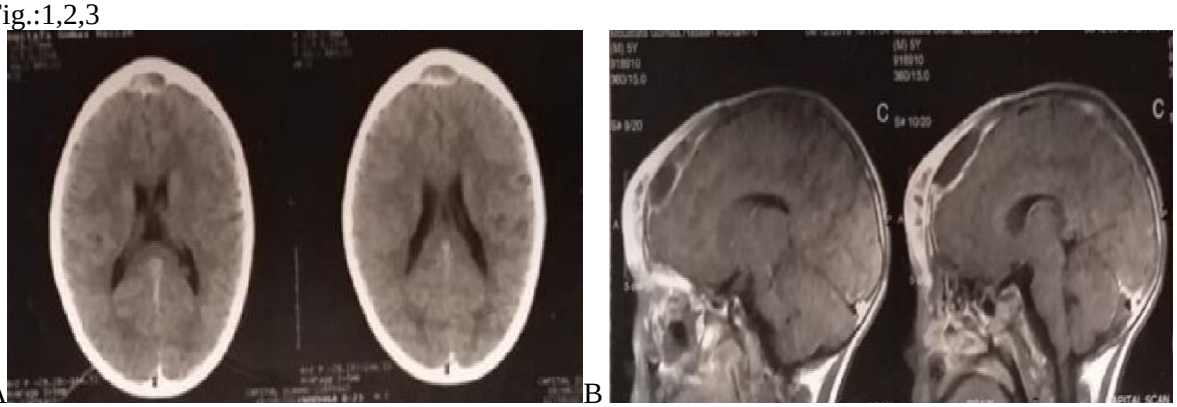

Fig.1 shows: A- CT brain axial view shows signs of infection with bone erosion. B. MRI sagittal view shows thinning of bone, edema of bone marrow, enhancement of dura with sub dural collection.

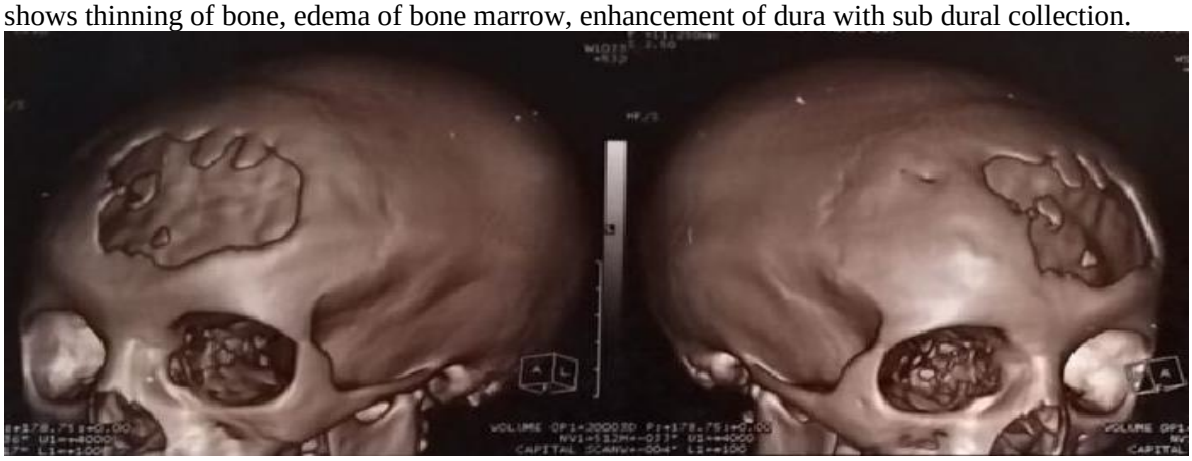

Fig.2: 3D CT of skull bone show rarefaction and thinning of bone table.

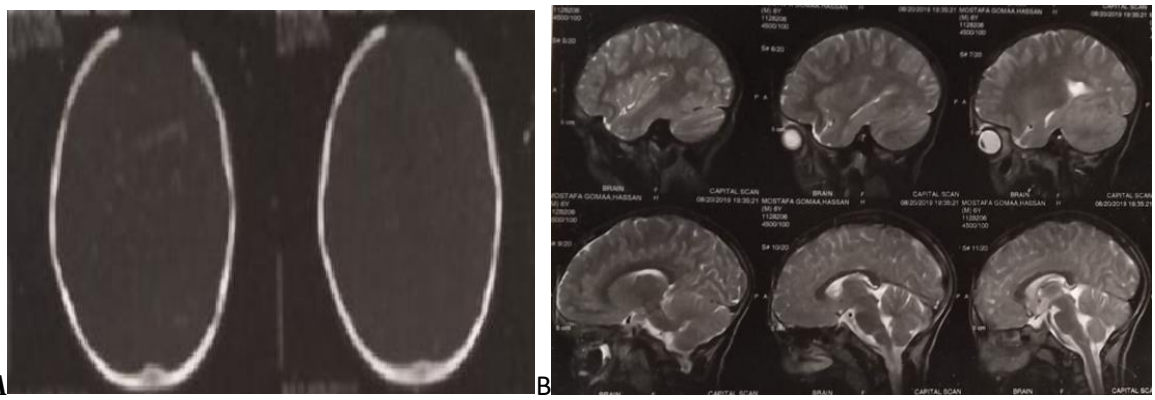

Fig.3: A- shows postoperative axial CT brain with bone removed. B- MRI sagittal view post-surgical excision of diseased bone with no residual and no extra or intracranial collection

Discussion:

Brainstem vault When left untreated, osteomyelitis may spread to the brain and spinal cord, making the illness fatal **[6]**. Involvement of the skull base is less prevalent than involvement of the cranial vault **(2)**. Staphylococcus aureus, streptococci, and anaerobes are the most typical etiological agents**.[7]** Sagittal sinus thrombophlebitis, brain abscess, and subdural empyema are all examples of hematogenous dissemination that may develop through valveless diploic veins.**[8]**

In our study Cranial osteomyelitis was diagnosed in 28 male (70.0%) and 12 female (29.0%) with mean age (27.5y). 27 patients (66.7%) of them were classified as non-cryptogenic osteomyelitis and 13 patients (33.3%) were cryptogenic. 57.14 percent of patients had diabetes, and a single patient had Adison-Biermer anemia.

Paranasal sinusitis, direct head traumas, scalp infections, and craniotomy-related infections are the most prevalent causes of cranial osteomyelitis in low-resource areas of the world. **[9]**. The most common comorbid risk factor was smoking, observed in 30 (75.0%), while diabetes was the second, observed in 23 (57.5%) of analyzed patients. Total leucocytic count of non-cryptogenic group ranging from 14000-18000, while cryptogenic group were ≥21000.

There are no statistics on the prevalence or connection of particular risk factors for iatrogenic cranial osteomyelitis, as described by **Khan et al. [10]**. The greatest indicators, however, were said to be associated with the actual surgery itself. Posttraumatic injuries such as scalp wounds, needle insertions, Post cephalohematoma infection, craniofacial injuries, penetrating injury, and trauma have been linked to a high incidence of cranial osteomyelitis.

In our study post firearm (n= 19) (47.5%) represent the most common causative agent, the second was Post traumatic depressed skull fracture represent (n=8) (20.0%), skull base osteomyelitis observed in (n=3) (7.5%) complicating chronic sinusitis, while post radiation necrosis was the least cause (n=1) (2.5%) and post-surgical purr hole represent (2.5%)

Sreepada et al., [11] reported that if the infection is not treated or diagnosed promptly it can lead to early abducent nerve palsy then other cranial neuropathies, resulting from extension of the infection to the brainstem, the facial nerve is the most often damaged and the first cranial nerve when infection travels sub temporally via the stylomastoid foramen, as observed by **Unnikrishnan R et al., [12].** Involvement of the jugular foramen and cranial nerves IX, X, and XI may occur if the tumor progresses farther posteromedially. When the petrous apex is at fault, cranial nerves V and VI are impacted.

In our study, skull base osteomyelitis diagnosed in (n=9) (22.5%) patients secondary to chronic sphenoid, maxillary, and frontal sinusitis, Chronic Headache observed in (n=5) (12.5%), while Cranial nerves palsy was observed in (n=3) of them, the fifth , third and fourth cranial nerves was affected as infection spread from sphenoid sinus in to cavernous sinus in one case it was bilaterally with ptosis of eye lid and squint, the other two cases was unilateral affection. Rest of cases diagnosed as vault osteomyelitis, Fits (n=22) (55.0%) was the most common presentation of analyzed patients, Fever (n=13) (32.5%) was the second, while Scalp ulcer (n=1) (2.5%) was the least.

In our study refractory cases (n= 4) (10.0%) represent the most common complication of analyzed patient required prolonged therapy with anti-tuberculous drugs, Failed cases (n=1) (2.5%) was the second while Cranial nerve palsy worsen, not improved in one case (n=1) (2.5%). Staphylococcus aureus was shown to be the primary germ responsible for the infection in **Antonella et al.'s [13]** study of posttraumatic cranial osteomyelitis. However, other diseases, such as mycobacteria, fungi, and parasites, may also cause cranial osteomyelitis, particularly in its chronic forms. While **Jacek et al., [14]** study skull base osteomyelitis secondary to otitis media & chronic paranasal sinusitis, he found in most cases, *P. aeruginosa* is found in culture This also was supported in our study , we found that, Staphylococcus aureus represent the most common organism of analyzed patient (n=50) (41.7%) mycobacterium Tb was the second pathogen identified (n=33) (27.5%) other pathogens include MRSA (10.8%), *Pseudomonas aeruginosa* (9.2%), Staph. Epidermidis (6.7%) and Aspergillus (4.2%) Successful treatment was achieved in (n=39) 97.5%, while unsuccessful treatment was in (n=1) 2.5% with no mortality.

In our study we give empirical systemic antimicrobial therapy according to location of infection, ICU resuscitation, and causative agent, followed by adequate surgical intervention. In diabetic and immunocompromised patients, we used anthelminthic therapy acting as an immunomodulator which helps in improving the results. In refractory cases we added anti tuberculous drugs, also Hyperbaric oxygen was given as adjuvant therapy. This was supported up by study conducted by **Khan et al. [10],** in which the authors recommended using intravenous broad-spectrum antibiotics for many months early on, in addition to hyperbaric oxygen therapy (HBO) and conservative surgical treatments, both of which seem to enhance clinical result.

Conclusion

Our results demonstrate that empirical systemic antimicrobial therapy according to location of infection, ICU resuscitation, and management of predisposing factors, followed by adequate surgical intervention better than starting by surgical intervention at first. Anthelminthic therapy has a good role in immunomodulation and improves the results. Anti tuberculous drugs are helpful in cases with recurrent or refractory osteomyelitis. Any patient with refractory osteomyelitis must be investigated regularly every 2 weeks or in an emergency till complete resolve of the lesion. Regular lab investigation monitoring for anti-microbial test. Hyperbaric oxygen adjuvant therapy may be necessary. Functional patient rehabilitation may be needed.

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