ORIGINAL RESEARCH

Prevalence of Jaw Osteomyelitis in Educational Dental Hospital, Cairo University: A 5-year Retrospective Study

Ahmed Metwally[1], Nayl Al-malahy[2], Manar A. Abdulaziz[1]

Abstract

Introduction: Osteomyelitis (OSM) is a condition of acute or chronic inflammation of the bone medullary cavity and periosteum, usually caused by bacterial infection and rarely by fungal infection. It could be suppurative or sclerosing. Jaw osteomyelitis is commonly arising fromodontogenic infection, post toothextraction infection and as a result of jaw fracture complication.

Aim: The purpose of this study was to evaluate the prevalence of jaw osteomyelitis diagnosed histopathologicallyin the Educational Dentistry Hospital at Cairo university and to compare the results with findings in the literature.

Materials and Methods: Data of jaw osteomyelitis diagnosed between 2018 and 2022 were collected from the files of the Educational Dentistry Hospital. Furthermore, stratification of age, gender, site affection, and etiological factor of each individual lesion will be performed.

Results: Jaw osteomyelitis in the present study constituted 1.02% (32 cases) of all the 3120 registered oral and maxillofacial biopsies. Chronic suppurative osteomyelitis was the most frequent type (53.13%) followed by fungal osteomyelitis (25%). The mandible and maxilla were equally distributed for OSM, while the posterior part of Mandible was the most frequently affected location. Females were commonly affected than males with ratio (1.4:1). The highest occurrence of jaw osteomyelitis was found with patients in the fourth and sixth decades.

Conclusion: In this study we observed an apparent geographic variation in the relative frequencies of differenttypes of jaw osteomyelitis in Educational Dentistry Hospital at Cairo.

Keywords: Cairo, Fungal osteomyelitis, Jaw, Odontogenic infection, Osteomyelitis, Prevalence.

Introduction

The term "osteomyelitis" is originated from the two ancient Greek words, i.e., "osteon" meaning bone and "muelinos" referring marrow and thus it is defined as the infection of the medullary portion of the bone, which consequently extends to the periosteum[1-2]. The most common etiology was odontogenic infections[3-4]. Especially secondary to dental extraction[2,5]. low socio-economic status, unavailability of primary health care services, and poor nutritional status in the rural areas[6]. The other etiological factors associated with OSM include traumatic injuries, fungal infections, radiation, poor oral hygiene, chemical agents etc.[3]

Several systemic diseases like Diabetes, Anemia, Malnutrition, osteoporosis, and Paget's disease also influence the progression of OSM[4-5]. Malignancy and odontogenic causes were other important predisposing factors in the mandible, while odontogenic infections and chronic sinusitis each gave rise to OSM in the maxilla[7].

OSM may involve one or more facial bones in head and neck, mainly mandible, frontal bone, cervical spine, maxilla and nasal bones[8]. Maxilla is less frequently involved as compared to mandible because maxilla has high blood supply and the mandible is dense yet poorly vascularized

[1] Oral and Maxillofacial Pathology, Faculty of Dentistry, Cairo University, Egypt; [2]Faculty of Dentistry, and Teaching Assistant in the Oral Pathology Department at Thamar University, Yemen.

Corresponding Author: Ahmed Metwally Abdelmoghny Metwally, Faculty of Dentistry Cairo University Elmanial Street, Cairo, Egypt. E-mail: ahmedmetwally@dentistry.cu.edu.eg.

How to cite the article: Metwally A, Al-malahy N, Abdulaziz MA. Prevalence of Jaw Osteomyelitis in Educational Dental Hospital, Cairo University: A 5-year Retrospective Study. Oral MaxillofacPathol J 2024; 15(2);204-209.

Source of Support: Nil

Conflict of Interest: None

Acknowledgments: Ahmed Metwally and Nayl Al-malahy wrote the manuscript and was responsible for data collection and entry. Manar Abdulwaniss supervised the project and were responsible for data curation and edited the manuscript for English language. All authors reviewed the final draft and approved it.

© 2024 Oral & Maxillofacial Pathology Journal, published by KSOMP. Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by-nc-sa/4.0/), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made. If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated.

cortical plates and only has a single blood supply from the inferior alveolar nerve[1,8].

Radiologically, OSM illustrates a fine radiopaque image with an unclear margin with bony destructions[7]. Differential diagnosis of OSM includes malignant tumors, which can be radiologically comparative and other disorders of bone such as fibrous dysplasia, Paget's disease and osteosarcoma[9]. Early diagnosis of OSM is reliable by tissue biopsy and a surgical approach by an excision or removal of infection with concurrent antibiotics[2]. The management of OSM of the jaws includes cessation of the cause, incision and drainage, sequestrectomy, resection of the jaw, antibiotics and hyperbaric oxygen therapy[8].

An overview of the literature on OSM reveals a wide variety of proposed classifications based on different aspects such as clinical course, pathological-anatomical and/or radiological features, etiology and pathogenesis[2,9]. Bernier S et al., (1995) classified OSM to three categories suppurative. non suppurative and osteoradionecrosis[10]. While Baltensperger M, et. al., (2004) classified OSM into acute osteomyelitis, secondary chronic osteomyelitis and primary chronic osteomyelitis. Various types of OSM include acute, primary chronic, and secondary chronic suppurative and fungal osteomyelitis[9].

One of the recently common type of OSM is fungal osteomyelitis, is caused by some species of Fungai (Mucorale species, Aspergillus species). Opportunistic funguses invade the arteries leading to thrombosis and further compromised blood supply to the soft and hard tissues of the affected region causing OSM[11,12]. Specific feature in fungal osteomyelitis is the involvement of maxillary sinus with a complaint of sinusitis associated with diabetes mellitus[13].

Osteoradionecrosis, is type of OSM, considered a serious complication of radiation therapy in cancer treatment where radiated bone becomes necrotic and exposed. It occurs most commonly in the mouth during the treatment of head and neck cancer[14].

This study is aimed to determine the prevalence of OSM diagnosed histopathological over a period of 5 years (from 2018 to 2022) in the Educational Dentistry Hospital at Cairo university. Furthermore, stratification of etiological factors, age, gender and site affection of each individual lesion will be performed.

Material and Methods

This retrospective cross-sectional study assessed the prevalence of OSMs in jaws over a period of 5 years (from 2018 to 2022). Information from case files and histopathology records of patients with OSMs were reviewed from archive of Cairo University, Faculty of dentistry, Oral and Maxillofacial Pathology Department. These OSM cases were assessed for age, gender and site. Descriptive statistical analysis was performed with all collected data using SPSS software (version 24; SPSS, Inc, Chicago, IL).

Ethics This study was approved by the Research Ethical Committee at Faculty of Dentistry, Cairo University (number: 27 4 23). Permission was obtained from Cairo's educational hospitals and institutions to access the database used for this study.

Results

From a total of 3120 oral and maxillofacial biopsies registered during the 5 years period from January 2018 to December 2022 in the Oral and Maxillofacial Pathology Department, Faculty of dentistry, Cairo University, only 32 cases were diagnosed as OSM.

1. Variable Prevalence rates of OSMs:

OSM represented (1.02%) of oral and maxillofacial lesions. Chronic suppurative osteomyelitis was the most frequent type of OSM, accounting for 17 (53.13%) followed by fungal osteomyelitis in 8 (25.00%), Garre's osteomyelitis 3 (9.38%), Condensing osteitis 2 (6,25%), and chronic diffuse sclerosing osteomyelitis for 2 (6,25%).

Chronic suppurative osteomyelitis was reported with other associated lesions as facial fibrous dysplasia (1 case), inflammatory periodontal cyst (1 case) and residual cyst (1 case).

The highest number of cases of OSM were diagnosed in 2022 14 (43.75%), followed by 2021 10 (31.25%), 2020 4 (12.50%), then 2018 3 (9.38%) and the least year was 2019 1(3.13%).

1.1 Distribution of OSMs in relation to age

OSM is found commonly in the age group ranged from 41 to 60 years with mean age of 47.4 years, while the least group was from 0 to 20. The distribution according to age was, 4(12.90%) patients within the age group of 0–20 years, 7(22.58%) patients within the age group of 21–40 years.14(45.16%) patients within the age group of 41-60 years. 6 (19.35%) patients within the age group of >60 years. Only one case was excluded because the age of patient was not documented.

Chronic suppurative osteomyelitis was commonly seen among the age group of 41–60. Condensing osteitis was commonly in the middle age groups of 21-40 and 41-60 years. All cases of chronic diffuse sclerosing osteomyelitis were seen in the age group of 21-40 years, while Garre's osteomyelitis were detected in young age group with mean age of 14.3 years. Fungal Osteomyelitis were commonly detected in the age group of 41-60 years with the mean age of 49.2 years (Table 1).

1.2 Distribution of OSMs in relation to gender

From the 32 cases of OSMs, 18 (56.25) were females while 14 (43.75) were males. Chronic suppurative osteomyelitis, condensing osteitis and Garre's osteomyelitis were more commonly diagnosed among the female patients, while chronic diffuse sclerosing osteomyelitis was detected in males. Fungal Osteomyelitis had equal distribution among both gender (Table 2).

1.3 Distribution of OSMs in relation to location

The mandible and maxilla were most common sites for OSM and were equally distributed with 16 cases for each jaw. Chronic suppurative osteomyelitis and chronic diffuse sclerosing osteomyelitis were commonly occurred in the mandible, while fungal osteomyelitis and Garre's osteomyelitis were frequently affected the maxilla. Condensing osteitis had equal distribution between the jaws (Table 3).

OSM is commonly in the posterior region then anterior area. Chronic suppurative osteomyelitis, chronic diffuse sclerosing osteomyelitis occurred commonly in the posterior

region of mandible. Condensing osteitis had equal distribution between the jaws with predilection for posterior area. Garre's osteomyelitis occurred commonly in the posterior part with maxilla to mandible ratio of (2:1). Fungal Osteomyelitis occurred commonly in the anterior part of maxilla.

1.4 Distribution of OSMs in relation to signs and symptoms

The most common Signs and symptoms of OSM patients was pain (25%), followed by exposure of necrotic bone (17.86%), swelling (16.07%). Pus oozing (16.07%), Fistula (10.71%), looseness of teeth (7.14%), parathesis (3.57%) and the least one was nasal obstruction (1.79%). Only one case was without any signs or symptoms (1.79%).

The majority of patients of chronic suppurative osteomyelitis complained from pus drainage (23.52%), then pain (20.58%) and swelling (20.58%). The pain is the most signs of patients with chronic diffuse sclerosing osteomyelitis, condensing osteitis and Garre's osteomyelitis (100%), (50%) and (50%) respectively. Necrotic bone (35.71%) and looseness of teeth (28.57%) were the main findings of fungal osteomyelitis (Table 4).

1.5 Distribution of OSMs in relation to predisposing factors

History of extraction represented the main predisposing factor of OSMs in the jaws 11(28,21%), followed by Diabetes 10(25,64%), history of previous COVID-19 infection 5(12,82%), and Hypertension / heart disease 3(7,69%). 13 of 32 OSMs cases had no definite predisposing factor.

The main predisposing agent of chronic suppurative osteomyelitis was history of extraction with systemic disease "combined" 4(23.52%), followed by history of extraction 3(17.64), while all cases of fungal OSM had systemic diseases 8(100%), with high impact of Diabetes 6(42,85%) followed by post COVID-19 infection 4(28,57%). The history of extraction was the main predisposing factor in (50%) of the cases of condensing osteitis and chronic diffuse sclerosing osteomyelitis.

Discussion

Osteomyelitis is an inflammatory disease of bone and bone marrow affecting one or multiple bones of the body, commonly occurs in long bones. It can occur in the head and neck area especially in the jaws frequently after an odontogenic infection especially bacterial infection and rarely a fungal infection[2]. The most common predisposing factors for developing jaw OSM include diabetes, immunosuppressive patients, Covid-19 and systematic diseases[5].

Boymuradov et al., (2021) observed that maxillofacial OSM is one of the most severe complications of covid-19 appearing within 6–8 months after the acute infectious period, and long-term treatment[15].

The prevalence of jaw OSM was found in the current study (1.02%) in contrast to the study in Slovenia (7%)[16]. In our study we observed the increase in the incidence of jaw OSM per year especially starting from the second half of 2020, this may be attributed to the rise of covid-19.

The most commonly affected age group was middle age group 41-60y with a mean age of 47.4y. These observations were similar to the studies conducted by Konjević, D.et al., 2011; Kremers, H. M. et al, 2015; Andre, C. V. et al, 2017; Arani, R. et al., 2019; Wasan, B. et al., 2019[1,4,13,17,16]. In contrast to these studies, Haeffs, T. H.et al., 2018 and Ramani, P., & Akshayaa, L., 2021 revealed the predominance of old age[2,5]. The high incidence in young age group was found in India[7].

Regarding to the gender, our result showed a slight female predominance, this results similar to several studies done by Konjević, D.et al., 2011; Khullar et al., 2012; Andre, C. V. et al, 2017; Haeffs, T. H.et al., 2018 and Ramani & Akshayaa, 2021[2,4,5,16,18]. On the other side, OSM was found to be predominantly among males[3,7,13]. One study in India revealed no gender predilection[1].

In the current study, the mandible and maxilla were equally distributed with 16 cases for each jaw, in contrast to literature, which found the most affected site was mandible[4,16,17]. While maxilla was predominated in other studies, commonly the posterior region of the maxilla[1,2,3,17]. The predominant site was the posterior mandible in the half of the cases followed by anterior part of maxilla. These result in accordance with the most other reports done by Chandra et al., 2007[7]. But it is opposite to Ramani & Akshayaa., 2021 study who observed that the maxilla is mostly affected by OSM[2].

The most common Signs and symptoms of OSM patients in the present study was pain (25%), followed by exposure of necrotic bone (17.86%), swelling (16.07%), similar to the study done by Haeffs, T. H.et al., 2018[5].

In the present study, history of extraction represented the main predisposing factor of OSMs in the jaws (28,21%), followed by Diabetes (25,64%), history of previous COVID-19

Table 1: Distribution and Mean age of different types of OSMs according to age groups

Tumor Type	0-20	21-40	41-60	>60
Chronic suppurative osteomyelitis	1(16y)	3(30.3y)	8(47y)	4(62.y)
Condensing osteitis	0	1(23y)	1(42y)	0
Chronic diffuse sclerosingosteomyelitis	0	2(34.5y)	0	0
Garre'sosteomyelitis	3(14.3y)	0	0	0
Fungalosteomyelitis	0	1(35y)	5(49.2y)	2(65y)
Total	4	7	14	6

Table 2: The prevalence of different types of OSMs according to gender

Tumor Type	Male	Female
Chronic suppurative osteomyelitis	8(47%)	9(53%)
Condensing osteitis	0	2(100%)
Chronic diffuse sclerosingosteomyelitis	2(100%)	0
Garre'sosteomyelitis	0	3(100%)
Fungalosteomyelitis	4(50%)	4(50%)
Total	14(44%)	18(56%)

infection (12,82%), and Hypertension / heart disease (7,69%), this result is similar to the study of Haeffs et al., (2018) who documents 66.7% of cases have a history of dental extraction[5]. In contrast, Chandra Prasad et al., (2007) found that the most common cause of osteomyelitis of the mandible is radiation followed by malignancy then odontogenic causes[7].

The most frequent type of OSM in the jaws in our study was chronic suppurative osteomyelitis, followed by fungal OSM then Garre's OSM, in agreement with studies done by Chandra Prasad, K. et al., 2007 and Andre, C. V. et al, 2017[4,7]. This result is in contrast to the study done by Ramani & Akshayaa, 2021 who observed that 60% of the patients had been diagnosed with acute osteomyelitis, 20% of them diagnosed as chronic suppurative and fungal osteomyelitis[2].

The frequency of chronic suppurative osteomyelitis, accounting for(53.13%) was similar to the studies done by Andre, et al., 2017 and Haeffs et al (2018)[4,5].

Age of this type in the present study was observed to affect the age group of 41– 60 was slightly similar to the study done by Khullar et al, 2012 who observed that the average age is reported to be 50–60 years[18]. This result is opposite to the reported study of Koorbusch et al., 1992 who observed the age of the patients with the chronic suppurative osteomyelitis ranged from 19 to 88 years[19].

In our study the gender of patients affected by chronic suppurative osteomyelitis showed slightly female predominance similar to the reported result of Haeffs et al., 2018[5], and in opposite to Khullar et al., 2012 who suggest the male predominance[18].

Majority of cease in the present study was commonly occurred on the mandible, this observation consistent with the result of Haeffs et al., 2018[5] but opposite to Ramani & Akshayaa, 2021 who observed that the most affected location is the maxilla[2].

The main predisposing agent of chronic suppurative osteomyelitis in the current study was history of extraction with systemic disease "combined" (23.52%), followed by history of extraction (17.64%), these findings were similar to the study done by Khullar et al., 2012 who found that the most case of chronic suppurative OSM occur as a result of dental extraction, trauma, or irradiation of the mandible[18], while Chandra Prasad et al., (2007) observed that radiation followed by malignancy then odontogenic causes were the most common cause of osteomyelitis of the mandible[7].

Surprisingly, in our study the second frequent type was fungal osteomyelitis, accounting for (25%) this result was in contrast to the result of Ramani & Akshayaa, 2021 who reports (20%) of cases was diagnosed as fungal osteomyelitis[2].

As regard to the age of the patients they have fungal osteomyelitis in the present study was 41-60 years similar to the age observed by Deokar, et al., 2023[20] but these results were opposite to Suresh et al., 2022 who suggest in their study that the fungal osteomyelitis mostly affect the age group of 34 years to 72 years[12] and to the study of Anehosur et al., 2019 who found that the fungal osteomyelitis affect the patients of 19 to 70 year of age[11].

In our results fungal osteomyelitis had equal distribution among both gender opposite to the research which found men were affected more than women, at a ratio of 2.5:1[11-12].

In relation to the site affected by fungal osteomyelitis

Table 3: The frequency of different types of OSMs according to site

Tumor Type	Maxilla		Mandible	
	Anterior	Posterior	Anterior	Posterior
Chronic suppurative osteomyelitis	3(17%)	3(17%)	0	12(66%)
Condensing osteitis	0	1(50%)	0	1(50%)
Chronic diffuse sclerosing osteomyelitis	0	0	0	2(100%)
Garre's osteomyelitis	1(33.3%)	1(33.3%)	0	1(33.3%)
Fungal osteomyelitis	6(86%)	1(14%)	0	0
Total	10(31%)	6(19%)	0	16(50%)

Table 4: Distribution of different types of OSMs according to the signs and symptoms

Tumor Type	Pain	Necrotic bone	Swelling	Pus	Fistula	Looseness of teeth	Paresthesia	Nasal obstruction	No S&S
Chronic suppurative osteomyelitis	7	5	7	8	5		2	0	0
Condensing osteitis	1	0	0	0	0	0	0	0	1
Chronic diffuse sclerosing osteomyelitis	2	0	0	0	0	0	0	0	0
Garre's osteomyelitis	2	0	2	0	0	0	0	0	0
Fungal osteomyelitis	2	5	0	1	1	4	0	1	
Total	14	10	9	9	6	4	2	1	1

presents mostly on the maxilla similar to studies done by Ramani & Akshayaa, 2021; Anehosur et al., 2019; Suresh, A. et al., 2021 and Deokar, et al., 2023[2,11,12,20].

The main predisposing factor of fungal OSM were Diabetes (42,85%) followed by post COVID-19 infection (28,57%), in agreements to studies conducted by Suresh et al., 2022 and Deokar, et al., 2023[12,20].

The incidence of Garre's osteomyelitis, accounting for 9.38% with average age of 14.3 years this result slightly similar to one study with mean age of 18 years[21].

All the reported cases of Garre's osteomyelitis in the present study were female similar to the studies done by Eyrich et al., 2003 and Bevin et al., 2008[22-23].

Additionally in our study the affected jaw by Garre's osteomyelitis was mostly the maxilla this is in contrast to researches of Eyrich et al., 2003 and Bevin et al., 2008 that suggested the predominance of the mandible[22-23].

The prevalence of Condensing osteitis, accounting for (6.25%) mostly affect the age 21-60 years similar to the result documented by Altun et al, 2014 and Yeh et al., 2015[24-25].

All the cases in our study were detected in females in agreement with the study done by Yeh et al., (2015)[24].

Regarding to the sites of the lesion in our study, equal distribution of the jaws was observed, this finding disagreed studies done by Miloglu et al (2009) and Yeh et al., (2015) who observed that the condensing osteitis mostly affect the mandible[24,26].

The main predisposing factor of condensing osteitis was the history of extraction (50%), opposite to the result of Yeh et al., 2015 who observed that the most cases of condensing osteitis were associated with inadequate root canal therapy[24].

The occurrence rate of chronic diffuse sclerosing osteomyelitis was (6,25%). Most cases in the present study were seen in the age group of 21-40 years. This result was opposite to study done by Matharu et al., 2020[27].

In the present study most of the cases of chronic diffuse sclerosing osteomyelitis were detected in male, and as regard to the site, the mandible is highly affected, these results disagrees with Matharu et al., 2020; Van de Meent et al., 2020 and Jia et al., 2021[27-29].

The history of extraction was the main predisposing factor in (50%) of the cases of chronic diffuse sclerosing osteomyelitis in our study. This result disagreed with Matharu et al., 2020 who found the most predisposing factors is low grade infection[27].

Conclusion

This study is the first to examine the prevalence of these lesions in the Egypt. Our findings demonstrate that these lesions have a lower prevalence in the Egyptian population in Cairo and are more frequent among women, in particular age decades, and in the mandibular premolar-molar region.

The main risk factor for the majority of OSM, particularly chronic suppurative OSM, was a history of extraction. The occurrence of fungal osteomyelitis is one of the most frequent complications of COVID-19 infection.

We recommended to achieve further researches in other governments with the largest sample size and to focus on the relation of systemic conditions of the patients with incidence of different types of osteomyelitis.

References

1. Wasan B, Kumar GA, Hiralkar P, Mahajan SB, Luthra P, Tiwari RV. Epidemiological Study of Osteomyelitis in a Tertiary Centre: Single Centre Study. 2019.
2. Ramani P, Akshayaa L. Prevalence of Osteomyelitis in Jaws among the Patients Visiting Private Dental Hospital: An Institutional Study. Journal of Pharmaceutical Research International. 2021 Dec 30:425-32.
3. Peravali RK, Jayade B, Joshi A, Shirganvi M, Bhasker Rao C, Gopalkrishnan K. Osteomyelitis of maxilla in poorly controlled diabetics in a rural Indian population. Journal of maxillofacial and oral surgery. 2012 Mar;11:57-66.
4. Andre CV, Khonsari RH, Ernenwein D, Goudot P, Ruhin B. Osteomyelitis of the jaws: a retrospective series of 40 patients. Journal of Stomatology, Oral and Maxillofacial Surgery. 2017 Oct 1;118(5):261-4.
5. Haeffs TH, Scott CA, Campbell TH, Chen Y, August M. Acute and chronic suppurative osteomyelitis of the jaws: a 10-year review and assessment of treatment outcome. Journal of Oral and Maxillofacial Surgery. 2018 Dec 1;76(12):2551-8.
6. Goyal D, Malik N, Gupta N, Agarwal M, Kalla R, Agarwal S. Chronic Osteomyelitis of Jaw.National Research Denticon, 2021 Vol-10 Issue No. 1.
7. Chandra Prasad K, Chandra Prasad S, Mouli N, Agarwal S. Osteomyelitis in the head and neck. Acta oto-laryngologica. 2007 Jan 1;127(2):194-205.
8. Nezafati S, Ghavimi MA, Yavari AS. Localized osteomyelitis of the mandible secondary to dental treatment: report of a case. Journal of dental research, dental clinics, dental prospects. 2009;3(2):67.
9. Baltensperger M, Grätz K, Bruder E, Lebeda R, Makek M, Eyrich G. Is primary chronic osteomyelitis a uniform disease? Proposal of a classification based on a retrospective analysis of patients treated in the past 30 years. Journal of Cranio-Maxillofacial Surgery. 2004 Feb 1;32(1):43-50.
10. Bernier S, Clermont S, Maranda G, Turcotte JY. Osteomyelitis of the jaws. Journal (Canadian Dental Association). 1995 May 1;61(5):441-2.
11. Anehosur V, Agrawal SM, Joshi VK, Anand J, Krishnamuthy K, Kumar N. Incidence and treatment protocol for maxillofacial fungal osteomyelitis: a 12-year study. Journal of Oral and Maxillofacial Surgery. 2019 Nov 1;77(11):2285-91.
12. Suresh A, Joshi A, Desai AK, Juturu U, Kurian DJ, Jain P et al. COVID-19-associated fungal osteomyelitis of jaws and sinuses: An experience-driven management protocol. Medical Mycology. 2022 Feb;60(2):myab082.
13. Arani R, Shareef SN, Khanam HM. Mucormycotic osteomyelitis involving the maxilla: A rare case report and review of the literature. Case reports in infectious diseases. 2019 Jan 22;2019.
14. Chronopoulos A, Zarra T, Ehrenfeld M, Otto S. Osteoradionecrosis of the jaws: definition, epidemiology, staging and clinical and radiological findings. A concise review. International dental journal. 2018 Feb 1;68(1):22-30.
15. Boymuradov SA, Rustamova DA, Bobamuratova DT, Kurbanov YX, Karimberdiyev BI, Yusupov SS, Umarov RZ. Complications of COVID-19 in the maxillo-facial region: Clinical case and review of the literature. Advances in Oral and Maxillofacial Surgery. 2021 Jul 1;3:100091.
16. Konjević D, Jelenko I, Severin K, Poličnik H, Janicki Z, Slavica A et al. Prevalence of mandibular osteomyelitis in roe deer (Capreolus capreolus) in Slovenia. Journal of Wildlife Diseases. 2011 Apr 1;47(2):393-400.
17. Kremers HM, Nwojo ME, Ransom JE, Wood-Wentz CM, Melton III LJ, Huddleston III PM. Trends in the epidemiology of osteomyelitis: a population-based study, 1969 to 2009. The Journal of bone and joint surgery. American volume. 2015 May 5;97(10):837.
18. Khullar SM, Tvedt D, Chapman K, Herlofson BB. Sixty cases of

extreme osteonecrosis and osteomyelitis of the mandible and maxilla in a West African population. International journal of oral and maxillofacial surgery. 2012 Aug 1;41(8):978-85.

19. Koorbusch GF, Fotos P, Goll KT. Retrospective assessment of osteomyelitis: etiology, demographics, risk factors, and management in 35 cases. Oral surgery, oral medicine, oral pathology. 1992 Aug 1;74(2):149-54.
20. Deokar V, Mandale MS, Bhavthankar JD, More J, Nandhekar V, Wagh S. POST COVID JAW OSTEOMYELITIS WITH MUCORMYCOSIS-AN INSTITUTIONAL STUDY: Case Series. International Journal of Histopathological Interpretation. 2023 Apr 11;12(1):14-26.
21. Berglund C, Ekströmer K, Abtahi J. Primary chronic osteomyelitis of the jaws in children: an update on pathophysiology, radiological findings, treatment strategies, and prospective analysis of two cases. Case reports in dentistry. 2015 Sep 7;2015.
22. Bevin CR, Inwards CY, Keller EE. Surgical management of primary chronic osteomyelitis: a long-term retrospective analysis. Journal of Oral and Maxillofacial Surgery. 2008 Oct 1;66(10):2073-85.
23. Eyrich GK, Baltensperger MM, Bruder E, Graetz KW. Primary chronic osteomyelitis in childhood and adolescence: a retrospective analysis of 11 cases and review of the literature. Journal of oral and maxillofacial surgery. 2003 May 1;61(5):561-73.
24. Yeh HW, Chen CY, Chen PH, Chiang MT, Chiu KC, Chung MP et al. Frequency and distribution of mandibular condensing osteitis lesions in a Taiwanese population. Journal of Dental Sciences. 2015 Sep 1;10(3):291-5.
25. Altun O, Dedeoğlu N, Umar E, Yolcu Ü, Acar AH. Condensing osteitis lesions in Eastern Anatolian Turkish population. Oral Surg Oral Med Oral Radiol. 2014 May;2(2):17-20.
26. Miloglu O, Yalcin E, Buyukkurt MC, Acemoglu H. The frequency and characteristics of idiopathic osteosclerosis and condensing osteitis lesions in a Turkish patient population(2009).
27. Matharu J, Taylor H, Sproat C, Kwok J, Brown J, Patel V. Diffuse sclerosing osteomyelitis: a case series and literature review. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020 May 1;129(5):437-46.
28. Van de Meent MM, Pichardo SE, Appelman-Dijkstra NM, Van Merkesteyn JP. Outcome of different treatments for chronic diffuse sclerosing osteomyelitis of the mandible: a systematic review of published papers. British Journal of Oral and Maxillofacial Surgery. 2020 May 1;58(4):385-95.
29. Jia K, Li T, An J. Is Operative Management Effective for Non-Bacterial Diffuse Sclerosing Osteomyelitis of the Mandible?. Journal of Oral and Maxillofacial Surgery. 2021 Nov 1;79(11):2292-8.