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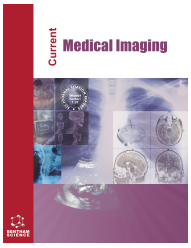

RESEARCH ARTICLE

Radiological Features of Rare Non-odontogenic Lesions of the Jaws

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Abstract:

Background:

The jaws can be affected by several lesions that manifest in the oral cavity, but little is known about non-odontogenic benign and malignant lesions and their radiological findings.

Introduction:

Our aim was to discuss the imaging findings of non-odontogenic jaw lesions to help the surgeon in the diagnosis and formulating a differential diagnosis for this vast spectrum of jaw lesions with overlapping clinical and imaging appearances.

Methods:

CT and MR images of the mandible, maxillofacial region, and neck were retrieved from the archive of the Radiology Department of Pamukkale University for the duration between 2012-2023 and assessed.

Results:

A total of 8125 CT and MR images were retrospectively analyzed. The mean age of the patients was 39.5 years in females and 43.2 in males, with a range varying from 15 to 72 years. Histopathologically approved benign and malignant non-odontogenic lesions were detected in only 19 patients out of 8125 images (0.23%). Osteomyelitis and abscess were the most common (n=3; 0.03%), followed by two cases (n=2; 0.02%) of each fibrous dysplasia, hemangioma, osteosarcoma, squamous cell carcinoma, and multiple myeloma, and one case (n=1; 0.01%) of each ossifying fibroma, osteoma, lymphoma, metastasis, and solitary bone cyst.

Conclusion:

Although non-odontogenic benign and malignant lesions of the jaw are rare, awareness of the radiological features of these lesions plays an important role in their diagnosis and management.

Keywords: Non-odontogenic lesions, Jaw, Radiological findings, Computed tomography, Magnetic resonance, multiple myeloma, Osteomyelitis.

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1. INTRODUCTION

Non-odontogenic lesions are divided into benign and malignant groups. Although most of these lesions are solid, rare cystic lesions can also be seen. Solid non-odontogenic lesions originate mostly from the mineralised matrix. However, cysts of non-odontogenic lesions may originate from several cell lines in the mandible and maxilla. These can be divided into neoplastic and non- neoplastic lesions including some specific conditions of the jaw like cysts and cyst-like lesions. On the other hand, neoplastic conditions include primary benign and malignant neoplasms as well as secondary and metastatic neoplasms were discussed. The classification of non-odontogenic mandibular and maxillary lesions is given in Table **1**.

Non-odontogenic lesions are rare; however, an exact and early diagnosis can be made by assessing the radiological characteristics of these lesions, such as bone density, zone of transition, the relationship between adjacent teeth and

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margination, and whether the lesion is lytic, sclerotic, or mixed. In the literature review, gnathic osteosarcomas (GOS) represent 4-8% of all osteosarcomas. However, osteomyelitis is much more common in the mandible and maxilla because of its rich blood supply. Different radiological modalities, such as plain X-ray, computed tomography, and magnetic resonance imaging (MRI), can be helpful for these diagnostic purposes [1 - 4].

Benign or low-grade malignant non-odontogenic lesions typically exhibit a narrow zone of transition and bulging, rather than infiltrating into the surrounding tissues. This characteristic appearance is indicative of a lesion with low biological activity, which is consistent with the behavior of most of these lesions. However, when a lesion displays a more aggressive appearance with broader zones of transition and soft tissue infiltration, it necessitates considering a broader range of differential diagnoses, including more malignant non-odontogenic conditions, as well as focal infectious and non-infectious inflammatory diseases.

This article aimed to discuss the imaging findings of non-odontogenic jaw lesions to help the surgeon in the diagnosis and formulating a differential diagnosis for this vast spectrum of jaw lesions with overlapping clinical and imaging appearances.

2. METHODS

This retrospective study was approved by the Pamukkale University, Non-invasive Clinical Research Ethics Committee, with approval number E-60116787-020-365589.

The study was carried out by retrieving 8125 computed tomography and magnetic resonance images of the mandible, maxillofacial region, and neck from the archive of the Radiology Department of Pamukkale University for the duration between January 2012 and March 2023.

Odontogenic lesions were excluded from the study. Exclusion criteria were defined according to the location of the lesions in the mandible, their radiological appearance, and the 2017 WHO classification of odontogenic and maxillofacial bone tumors. A total of 19 patients with non-odontogenic lesions were included in the study group. The initial diagnosis was based on clinical and radiological findings, and it was proven by histological findings following incisional biopsy.

Table 1. Classification of solid nonodontogenic lesions.

Solid Nonodontogenic Mandibular and Maxillary Lesions	
Benign	**Malign**
Idiopathic osteosclerosis	Squamous cell carcinoma
Cemento-ossifying fibroma	Osteosarcoma
Exostosis (Torus mandibularis)	Ewing sarcoma
Osteoma	Chondrosarcom
Fibrous dysplasia	Metastasis
Paget disease	Multiple myeloma/plasmositoma
Central giant cell lesion/granuloma	Lymphoma/Leukemia
Eosinophilic granuloma	Fibrosarcoma
Neurofibroma	Leiomyosarcoma
Schwannoma	-
Hemangioma	-
Abscess and osteomyelitis	-

Table 2. Summary of diagnostic tools and details about patients.

-	Age Renge	Percentage %	Patient Number	Male	Female
Neck CT	1-91	12,3	1501	912	589
Nrbita CT	1-92	12,0	811	534	277
Pns CT	0-92	12,4	2146	1117	1029
Temporal CT	1-91	11,6	1076	550	526
Temporomandibular CT	2-66	2,6	20	12	8
Maxillofacial CT	0-99	12,7	1235	841	394
Neck MRI	1-93	11,4	555	346	209
Nasopharynx MRI	11-84	6,6	148	100	48
Temporal MRI	1-83	10,5	425	192	233
Facial MRI	3-85	7,8	208	115	93
Total	-	100,0	8125	4719	3406

Table 3. Summary of diagnostic details from 19 patients.

Case Number	Age /Gender	Diagnosis	Diagnostic Tool	Diagnostic Findings
1	55/M	Osteoma (GS)	Maxillofacial CT	Rounded, well-defined dens lesions similar to normal cortex
2	58/M,	Fibrous dysplasia	PNS CT	Ground glass well-defined usually expansile lesion with intact cortex
3	20/M,	Fibrous dysplasia	Maxillofacial CT	
4	15/M,	Hemangioma	Maxillofacial CT	Mixed or sclerotic bone lesion with internal fat and thickened vertical trabeculation
5	51/F,	Hemangioma	PNS CT	
6	18/M	Solitary bone cyst	Maxillofacial CT	Well defined geographic lucent lesions with a narrow zone of transition, thin sclerotic rim mostly with no periosteal reaction or soft tissue component
7	16/M	Solitary bone cyst	Maxillofacial CT	
8	67/M,	Osteomyelitis	Maxillary CECT	Ill defined destructive lesion, cortical erosion/distruction with periosteal reaction, sequestra, involucra, intraosseus gases, soft tissue swelling
9	33/M,	Abscess	Neck CECT	Fluid collection with peripheral contrast enhancement
10	37/M	Abscess	Neck CECT	
11	38/M,	Ossifying fibroma	Maxillofacial CT	Well-circumscribed with mild cortical expansion homogeneous lesion matrix surrounded by a sclerotic band
12	51/F,	Squamous cell carcinoma	Neck MRI	Bone destruction with resultant floating teeth. soft tissue swelling and infiltrative/invasive pattern.
13	57/M	Squamous cell carcinoma	Neck CECT	
14	24/M,	Osteosarcoma	Maxillofacial CT	Destructive with cortical involvement Heterogenous density, matrix calcification, intramedullary bone and soft-tissue extension
15	62/M,	Osteosarcoma	Maxilla CECT	
16	53/F,	Metastasis	Mandibular CT	Nonspesific lesion as like lytic, sclerotic or mixed. CT is excellent at showing of bony involvement
17	42/E,	Multiple myeloma/plasmositoma	Maxillofacial CT	Well-defined, "punched-out" lytic lesions with associated extraosseous soft-tissue masses, Subtle lytic lesions
18	72/F,	Multiple myeloma/plasmositoma	Maxillofacial CT	
19	53/M	Lymphoma/Leukemia	Facial CE-MRI	Diffuse destructive, infiltrative with soft tissue mass like lesion

Abbreviations: F: Female, M: Male. GS: Gardner Syndrome CT: computed tomography; CECT: Contrast-Enhanced computed tomography; PNS: paranasal sinus; MRI: Magnetic Resonance Imaging ; CE-MRI: Contrast-Enhanced Magnetic Resonance Imaging

2.1. Study Population

For the study, 8125 patients were analyzed. Table **2** shows the age and gender distribution of the patients.

3. RESULTS

The demographic characteristics and diagnostic findings according to the radiodiagnostic tools, including CT and MRI, of the patients included in the study group are provided in Table **3**. According to the results shown in Table **3**, most non-odontogenic lesions have been seen in male patients (15 patients, 78.9%), giving the impression of male preponderance. On the other hand, benign lesions were noticed mostly in the young age group, and malignant lesions were seen more in the older age group; infections, like osteomyelitis/abscess, were found in the different age groups.

3.1. Radiological Findings

A total of 19 patients were identified: one had osteoma, and the age of diagnosis was 55 years (n=1; 1%). One had ossifying fibroma, and the age of diagnosis was 38 years. One had metastasis, and one had lymphoma; the age of diagnosis was 53 years each. Diagnoses included FD, hemangioma, solitary bone cyst, SCC, osteosarcoma, and multiple myeloma in two patients each (n=2; 2%). One patient had chronic osteomyelitis and two patients (n=3; 3%) had abscess, aged 67, 33, and 37, respectively. Four of the patients were female (11%) and 15 were male (31%); the age range was 15-72 years, with a mean age of diagnosis of 39.5 years in females and 43.2 years in males. A summary of the diagnostic details of patients is provided in Table **3**. Images of some patients with lesions in the study are shown in Figs. (**1** to **16**).

4. DISCUSSION

This study aimed to discuss the imaging findings of non-odontogenic jaw lesions to help the surgeon in the diagnosis and formulating a differential diagnosis for this vast spectrum of jaw lesions with overlapping clinical and imaging appearances. All the images were retrieved from the archive of the Radiology Department of Pamukkale University. It should be noted that it is difficult to know the true incidence of the disease in such rare lesions due to the possibility of many undiagnosed people among the population who actually do not experience any symptoms or complains to visit a doctor.

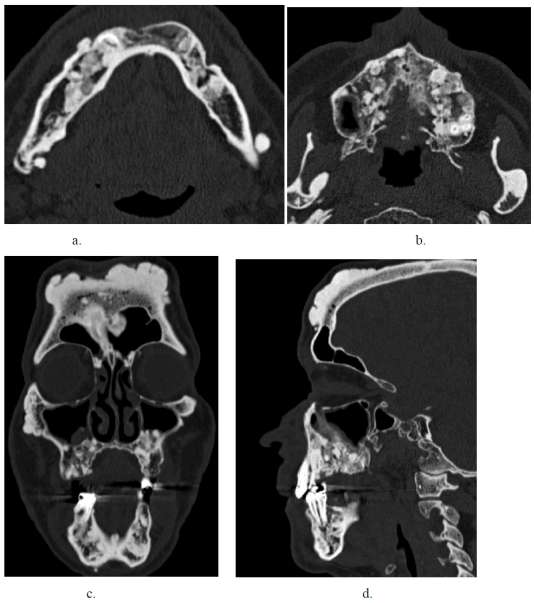


Fig. (1). (case **1**). Multiple osteomas in a 55-year-old patient with Gardner syndrome. Multiple osteomas in the maxilla, mandible, and cranial bones in a patient with Gardner syndrome in (**a** and **b**) axial, (**c**) coronal, and (**d**) sagittal maxillofacial computed tomography examination.

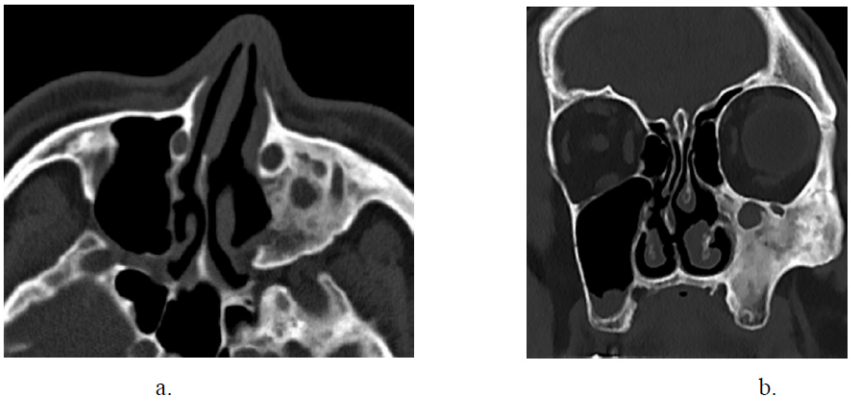


Fig. (2). (case **2**). 58-year-old male patient with fibrous dysplasia. (**a**) Axial and (**b**) coronal paranasal sinus computed tomography showing an osseous lesion that completely obliterates the maxillary sinus on the left and includes areas of soft tissue density in the ground glass areas, including the left upper maxillary alveolar process in the inferior part.

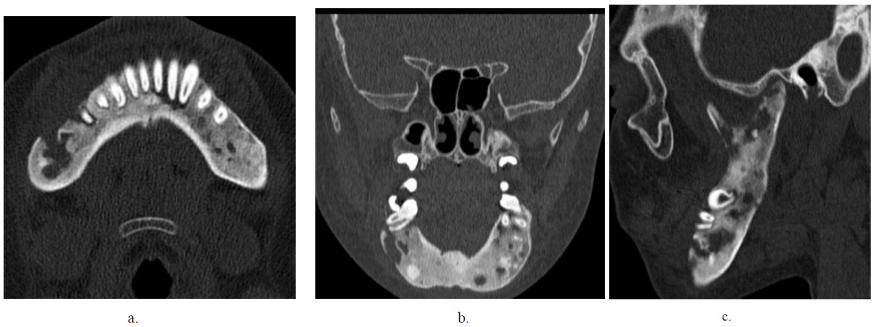


Fig. (3). (case **3**). 20-year-old male patient with fibrous dysplasia. (**a**) Axial, (**b**) coronal, and (**c**) sagittal maxillofacial computed tomography images showing diffuse infiltrative expansile ground glass areas extending towards the bilateral corpus and rami of the mandible, and involving small lytic areas and radiodense sclerotic areas.

Osteomas are benign tumors composed of mature compact bone [2]. They arise in the craniofacial bones, most commonly located in the posterior mandibular body or condyle. Multiple osteomas may be associated with Gardner syndrome (GS) [3]. The overall incidence of osteoma has been reported to be low at 0.01–0.04% of the population. In the current study, osteomas were detected as low as 0.01% in a male patient of 20 years old. These results have been consistent with the results of previous studies. Although osteoma can be seen in a wide age range (range 13-69, mean 40 years), Gardner syndrome has been mostly seen to occur in patients between 20-40 years old. These compact lesions appear more in males than females; however, the situation is the opposite for cancellous lesions [2]. Radiologically, osteomas appear as well-circumscribed sclerotic masses arising from cortical plates and not related to the adjacent tooth [2]. Osteomas may cause bone expansion with no perilesional halo. It may not be possible to differentiate osteomas from idiopathic osteosclerosis if no bone expansion is present. Moreover, osteomas may present as exophytic growth or may be associated with simple bone cysts [4]. Extraskeletal osteomas may be found in soft tissues [2] (Fig. **1**).

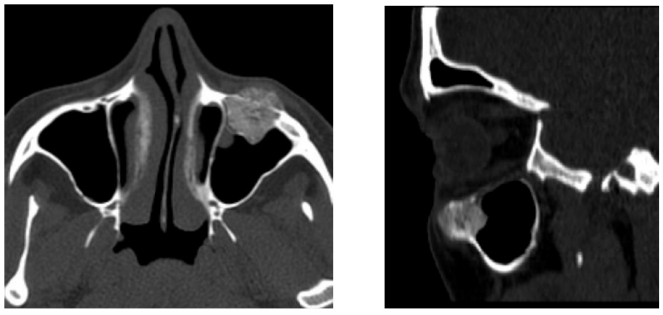
Fibrous dysplasia (FD) is a condition where normal bone and marrow are replaced by fibrous tissue [5]. FD has been reported to include about 7% of benign bone tumors with equal gender prevalence [6]. The precise incidence and prevalence of the disorder remain unclear. Mild cases often go undiagnosed, posing challenges in determining the true frequency of FD within the general population [7]. Within the scope of this study, two male patients, aged 20 and 58 years, were diagnosed with FD. Malignant degeneration of fibrous dysplasia was most commonly located in the craniofacial region.

The lesion in one case was located in the left maxilla and, in the other case, it was seen as multiple lesions in the mandible; therefore, cherubism was suspected. In fibrous dysplasia, it is known that the bone maintains its natural shape if there are no predominant cystic changes. Most craniofacial fibrous dysplastic lesions are monostotic (80%) [2]. There are different types of polyostotic fibrous dysplasia that may affect multiple craniofacial bones: craniofacial fibrous dysplasia, Lichtenstein-Jaffe fibrous dysplasia, Albright syndrome [5, 8, 9], and Mazabraud syndrome [2].

Fibrous dysplasia is seen radiologically as a heterogeneous lesion with a ground-glass appearance and a wide ill-defined transition zone, a feature that helps to differentiate it from ossifying fibroma. Its cortex is seen thickened and sclerotic [10]. Intraoral or panoramic radiographs provide valuable information for evaluating the bone pattern and extent of jaw involvement. For assessing craniofacial involvement, bone CT or cone beam CT is the preferred imaging modality, offering excellent capabilities to detect its presence. Additionally, CT scans are beneficial for monitoring disease progression, reactivation, or potential malignant transformation. MRI is a useful tool for evaluating complications of the disease as compression of neurological structures, identifying cystic degeneration, and detecting the formation of aneurysmal bone cysts. When there is suspicion of secondary malignancy, MRI serves as a complementary imaging technique to CT [2]. The radiographic appearance of FD is an expansile lesion with a ground-glass appearance and well-defined borders maintaining smooth cortical contour [6] (Figs. **2** and **3**). Furthermore, it has been reported that superior displacement of the mandibular canal is pathognomonic for FD [2].

Intraosseous hemangiomas of the jaw bones are rare benign vascular neoplasms. According to reports, intraosseous vascular anomalies are uncommon and represent less than 1% of all bony tumors [11, 12]. The vertebral column and the skull are the most commonly affected sites. Specifically, within the skull, the parietal bone is frequently involved, followed by the frontal bone. Vascular anomalies within the facial skeleton are observed in the mandible, maxilla, and nasal bones [13]. Females are more affected than males (2:1); they are most common in the second decade of life. In the current study, one of the patients was a 15-year-old male (case 4), and the other one was a 51-year-old male (case 5). The 15-year-old patient had hemangioma adjacent to the left mandible; however, the 51-year-old patient had hemangioma on the left maxillary sinus anterior wall.

Hemangiomas can be centrally located, showing multilocular small osteolytic components mimicking enlarged bone marrow spaces surrounded by coarse, dense, and well-defined trabeculae, resulting in a honeycomb or soap bubbles pattern (Fig. **4**) [6, 2]. The involved mandibular canal can be widened with a possible serpentine shape, the nearby teeth are often resorbed or displaced, and soft tissue phleboliths can be seen as well [2].



a. b.

Fig. (4). (case **5**). 51-year-old female patient with intraosseous hemangioma. (**a**) Axial and (**b**) sagittal paranasal sinus computed tomography on the anterior wall of the left maxillary sinus small expansile lesion with thickened vertical trabeculation giving the “polka-dot appearance”.

The solitary bone cyst (SBC) is also known as a simple bone cyst. It is not considered a true cyst, but rather a pseudocyst, because histologically, it consists of an idiopathic bone cavity filled with serous or haemorrhagic fluid and characterised by the absence of an epithelial lining. Most SBCs occur in areas of vital teeth often appearing as a scalloped radiolucency between the roots of teeth.

The reported incidence of cyst affecting the jaws is 1%, and it has a female predominance, occurring before the age of 20 [14, 15]. However, in our study, the solitary bone cyst was diagnosed in two male patients under the age of 20. In up to 75% of all cases, SBCs are seen in the posterior mandible. It is known that solitary bone cyst cases are mostly asymptomatic and discovered incidentally.

SBCs mostly appear as unilocular, well-defined radiolucent lesions of variable sizes, rarely extending to the cortical bone and, usually, there is no tooth displacement [15]. Cross-sectional imaging, such as CT and MRI, can provide information on the haemorrhagic content; however, the density or signal intensity, respectively, may vary depending on the age of the haemorrhage. The treatment consists of bone curettage, which may be complicated with bleeding and subsequent scar formation [16].

Osteomyelitis is defined as a polymicrobial bacterial infection of bone. The primary cause of mandibular osteomyelitis is typically an underlying tooth infection. However, other factors, such as fractures, osteonecrosis, and hematogenous spread of pathogens, can also contribute to the development of this condition [17]. Mandibular osteomyelitis can be categorized into acute or chronic forms, with the latter lasting for more than one month. Chronic osteomyelitis can further lead to complications, such as sinus tracks, fistulae, the formation of bony sequestra, or pathologic fractures.

Osteomyelitis can occur at any age. The use of cigarettes and alcohol products increases the risk of osteomyelitis [2]. Other risk factors for osteomyelitis include altered immunity, vascular compromise (such as sickle cell), and radiation therapy.

The incidence of osteomyelitis has decreased significantly since the introduction of antibiotics. In the jaw bones, however, osteomyelitis is particularly rare [18]. In our study, a 67-year-old male patient had chronic osteomyelitis located on the right mandible; the other two cases had abscesses, one in the left palatine tonsil and the other in the right submandibular region along the mandible (Fig. **9**).

Radiologically, these lesions are seen as mixed lytic and sclerotic bone changes with sequestra and laminated periosteal new bone formation. For identifying bone changes, the most useful tool is CT. MRI clearly shows soft tissue changes, and is highly sensitive to reveal bone marrow involvements [2]. The radiological appearance of osteomyelitis within the mandible is similar to osteomyelitis in other osseous regions in the body and is dependent on the chronicity of the infection and other associated complications [19]. Periosteal new bone formation can occur parallel to the original cortex and the presence of sequestra is within the differential findings for osteomyelitis [2].

Ossifying fibroma is encapsulated benign neoplasm composed of varying amounts of bone or cementum-like tissue in fibrous tissue stroma. Ossifying fibroma includes subtypes named cementifying fibroma, cemento-ossifying fibroma, and juvenile ossifying fibroma. It is slow-growing, but occasionally, it can be aggressive, especially in the juvenile subtypes [16]. The prevalence of OF has been reported to be 2.82% [20]. In our study, the incidence of OF was found to be 0.01%.

It has been reported that ossifying fibroma presents more commonly in women as painless swelling around the mandible; however, in our study, OF was diagnosed in a 38-year-old male patient. The lesion was located in the mid-left lateral of the mandible. The premolar and molar areas were most commonly involved. Although it may occur in different age groups, the peak incidence of ossifying fibroma is mostly seen in the 3rd and 4th decades of life. Because ossifying fibroma may occur outside the jaw, some contend that the cementum-like material found within some lesions represents a variant of bone rather than odontogenic products [20].

Radiologically, ossifying fibroma typically appears as a solitary well-defined unilocular locally expansile lesion with a ground-glass appearance and sharp margins. The internal aspect can be granular, resembling fibrous dysplasia. Ossifying fibroma is mostly seen as corticated or surrounded by sclerotic bone and thin cortex, with an eggshell-like shape in some cases, and it may have a thin, radiolucent periphery representing a fibrous capsule [2].

It is worth mentioning that ossifying fibroma appears radiolucent in the early stages due to its nonmineralized osteoid content, but later on, it turns to be more radiopaque as the lesion becomes more mineralized. Soft-tissue components of the lesion show enhancement on contrast-enhanced images. Tooth displacement and erosion are common [1].

Differential diagnosis depends on the degree and pattern of internal radiopacity. Identification of a well-defined margin helps to distinguish it from fibrous dysplasia [2].

Squamous cell carcinoma (SCC), also known as epidermoid carcinoma, is the most common malignant neoplasm of the oral cavity [21, 22]. It mostly affects the male population over 50 years of age [2]. The incidence of jawbone-related SCC has been reported to be one or two per thousand individuals [23]. In the current study, the incidence of SCC was detected as 0,02%, the sex ratio of patients with SCC was 1:1, and their age was over 50 years; also, both cases had lesions in the mandible. SCC mostly affects the oral mucosa, especially overlying the posterior mandible with a high metastatic potential. It is strongly related to the consumption of alcohol and tobacco. Patients present clinically with pain, swelling, paresthesia (due to V3 invasion), and dental disorders. Since it is asymptomatic in the early stages, its diagnosis is usually delayed [2]. The radiological findings are that of an aggressive soft-tissue lesion invading the floor of the mouth, alveolar ridge, or retromolar trigone; however, patients in the late stages may only present with a pathological fracture [21]. Imaging often reveals these lesions as ill-defined margins, but sometimes, these could be seen as well-defined without

cortication and small lesions may resemble cysts. In SCC, the lesion on the jaw may exhibit lytic, moth bite destruction, with bony fragments. Multilocular lesions have been reported in some cases as well [2]. On MRI, SCC typically exhibits a low-to-intermediate signal intensity on T1-weighted sequences, and a moderately high signal intensity on T2-weighted and STIR sequences with a moderate enhancement following the administration of contrast material. The apparent diffusion coefficient (ADC) values are generally low, usually ranging around 1-1.1×10−3 mm^2/s. However, in cases where the tumor presents with large areas of necrosis, the ADC values may be higher, particularly in the context of necrotic lymph node metastases. The combination of the clinical, imaging, and histological results can help in making the final diagnosis and management decisions. Cross-sectional imaging plays a key role in precisely depicting deep tumour spread, as well as detecting lymph nodes and distant metastases. Surgery with or without radiotherapy is the treatment of choice. Prognosis depends on the histological type and the presence or absence of lymph node metastases [16].

Osteosarcoma is defined as a malignant bone tumor with the ability to produce osteoid or immature bone [6, 2]. It is one of the most common bony primary malignancies; however, osteosarcoma of the jaw is a rare malignant condition with a prevalence of 1%, as reported in the literature, and it occurs at an older age (peak incidence in the fourth decade of life), and is commonly osteoblastic; however, less than 10% of gnathtic osteosarcomas can be chondroblastic [24]. When the gender distribution is evaluated, it is seen twice as often in men than in women [2, 6, 25]. In the current study, osteosarcoma incidence was detected as 0.02%. Consistent with this information, all patients diagnosed with osteosarcoma were male. Its risk factors include prior head and neck radiation therapy, Paget's disease of bone, or other known osteosarcoma precursors. Mandibular osteosarcomas typically have an older onset and they are seen at later ages than long bone osteosarcomas, with the mean age of presentation within the third decade of life. Imaging can help in assessing the location, extent of the tumor, and type of the matrix present (chondroid or osteoid). Conventional osteosarcoma is usually seen as an ill-defined, sclerotic, and/or lucent lesion with an aggressive periosteal reaction [8].

Similar to our study, mandibular osteosarcoma demonstrates pronounced and aggressive bony alterations characterized by expansible, erosive, and destructive lesions accompanied by aggressive periostitis. In certain instances, a periosteal reaction may manifest as "hair on end" or the appearance of "sunray spicules," indicating the formation of new bone perpendicular to the cortex [2].

Osteosarcoma of the mandible poses a diagnostic challenge due to its rarity and overlapping clinical symptoms that lack specificity. Often, it is the radiologist who first raises the suspicion of this diagnosis. The standard therapeutic approach involves wide excision of the lesion. Additionally, neoadjuvant chemotherapy has shown promise in reducing tumor burden and improving patient outcomes [19].

Metastasis is considered when there is a spread of malignant cells from a primary site to the other parts of the body. Metastasis to the oral cavity is uncommon and presents about 1% of all oral malignancies [6, 26]. Metastases to the jaw mostly affect the mandible more than the maxilla. The most common sites vary according to gender; in men, the metastases are from lung, prostate, kidney, and liver tumours, whereas in women, the metastases are more common from breast, adrenal, gynaecological, and colorectal tumours.

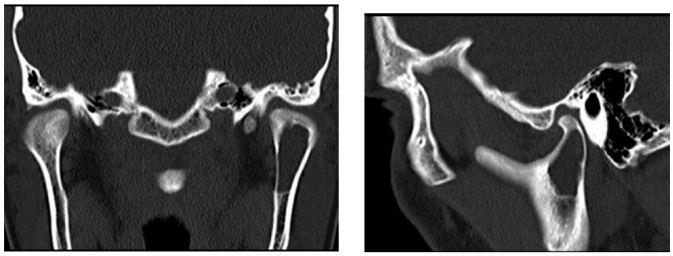
In the current study, metastases were detected in a patient with breast cancer. Clinical symptoms included pain, swelling, paresthesia, and temporomandibular joint derangement; however, in some cases, metastases to the jaw were clinically silent and found incidentally. There are no specific radiological findings seen for metastasis; they can appear as ill-defined radiolucent lesions with no periosteal reaction on conventional X-rays and CT. Moreover, metastases to the jaws are frequently seen as a moth-eaten appearance or poorly demarcated radiolucent lesion. However, some, like breast and prostate metastases, are osteoblastic in nature [6, 27, 28]. As the radiological finding of the metastatic lesion is not specific and the lesion shows no relationship to dental structures, the possibility of mandibular metastasis should be considered within the differential diagnosis, particularly in patients with a history of cancer [27, 28]. Nowadays, other imaging modalities, such as PET scan, can be used as well for detecting metastatic lesions.

Multiple myeloma is considered a rare malignant disease affecting the bone marrow, as seen more commonly in the male population [29]. It has been reported that MM cases are most common in those older than 40 years of age, generally constituting 1-1.8% of all neoplasms, and the male-to-female ratio is 2:1 [30]. In our study, the sex ratio of patients with MM was 1:1, and the ages of the patients were 42 and 72 years. The clinical signs and symptoms of multiple myeloma mostly include anemia, bone pain, fatigue, and infections, and it is characterized by multiple punched-out radiolucent lesions [31]. Maxillofacial manifestations of multiple myeloma are rarely seen as an initial sign, but on the contrary, it may present as a primary manifestation in the advanced stages of the disease [31, 32]. The maxillofacial lesions are more common in the posterior region of the mandible, manifesting as odontalgia, paresthesia, dental mobility, gingival hemorrhage, and ulcerations [33] (Fig. **15**). The lesions are mostly seen as small, unilocular, round, or oval radiolucencies, but coalesce lesions seem much bigger and may appear as multilocular. Panoramic imaging shows lesions located in the ramus and angle. Lateral cephalometric imaging is useful for visualizing lesions located in the skull. It has been reported that 45% of patients have lesions in the skull. CT is the most successful tool to show the extent of the lesion in multiple myeloma [2]. The clinical features are due to the proliferation and expansion of neoplastic plasma cells in the bone marrow, leading to bone destruction and related symptoms. This disease accounts for about 1% of all malignancies and 10% of hematologic malignancies [33, 34].

Lymphomas are malignant tumours that can affect any organ containing lymphoid tissue. It has been reported that primary intraosseous non-Hodgkin lymphoma (NHL) of the mandible is rare and represents approximately 0.6% of all extranodal lymphomas. In the current study, NHL incidence was detected as 0.01%. All age groups can be affected by it;

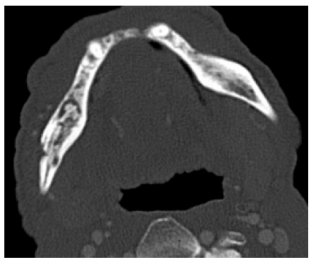
however, adults tend to be affected more often than children. The delay in the exact diagnosis may occur because it can mostly be confused with a dental infection. The clinical findings of mandibular NHL are not specific, and include pain, jaw swelling, ulceration, tooth mobility, and cervical lymphadenopathy. On panoramic views and conventional X-rays, these tumors are seen as radiolucent ill-defined lesions and, on the contrary to their large size, they can be easily missed.

According to existing literature, MRI offers superior visualization of submucosal tumor extension and enables better assessment of marrow infiltration compared to CT or CBCT. Distinctive features observed on MRI include low signal intensity on both T1 and T2 sequences, homogeneous contrast enhancement following the administration of gadolinium chelates, and the absence of necrotic areas despite the tumor's large size (Fig. **16**). Additionally, characteristic findings include low apparent diffusion coefficient (ADC) values typically ranging from 0.6 to 0.8×10−3 mm^2/s. The differential diagnosis of mandibular NHL includes other infiltrative bone marrow pathologies, such as myeloma, leukaemia, and bone metastases, making biopsy mandatory for the correct histological diagnosis. Treatment for mandibular NHL usually involves chemotherapy [35 - 37].



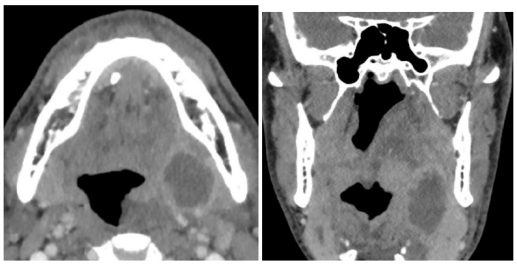
a. b.

Fig. (5). (case **6**). Solitary bone cyst in an 18-year-old male patient. In (**a**) coronal and (**b**) sagittal maxillofacial computed tomography examination, a well-defined cystic density lesion can be observed to be located in the medullar area in the left mandibular head-neck localization, causing thinning of the cortex.



a.

Fig. (6). (case **8**). Right mandibular chronic osteomyelitis in a 67-year-old male patient. (**a**) Axial contrast-enhanced maxillary computed tomography examination revealing a central sclerotic fragment (sequestrum) in the corpus of the right mandible and reactive new bone formation (involucrum) around it. There can be an irregularity observed in the outer cortex of the mandible posterolateral corpus (cloaca).



a. b.

Fig. (7). (case **9**). Left peritonsillar abscess in a 33-year-old male patient. (**a**) Axial and (**b**) coronal contrast-enhanced neck computed tomography examination revealing a loculated fluid collection located between the left palatine tonsil and the left submandibular gland and showing peripheral enhancement. In the adjacent adipose tissue planes, an increase in thickness and a decrease in density have been observed in the peritonsilar area secondary to the infectious process, and there has been a push towards the lumen in the left wall of the nasopharynx and oropharynx.

Our study has several limitations. First, it was a retrospective study. Second, these non-odontogenic lesions are considered rare lesions of the jaw bones with special predilections to the posterior portion of the mandible and typically involving the same basic tumorogenic processes as bone tumors in the other parts of the skeletal system, which may result in diagnostic difficulty. Finally, non-odontogenic lesions develop from osseous origin and are not tooth-related; therefore, these lesions usually, but not always, consist of a group of pathologies that may be seen anywhere in the axial skeletal system, and which may also result in diagnostic difficulty.

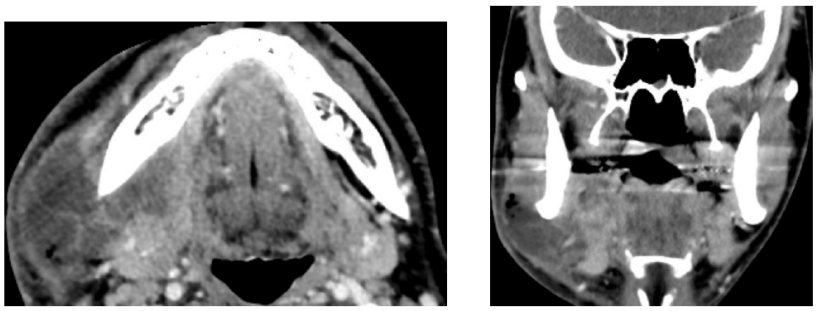


Fig. (8). (case **10**). Submandibular abscess in a 37-year-old male patient. (**a**) Axial and (**b**) coronal contrast-enhanced neck computed tomography examination demonstrating peripherally enhanced collection view with axial images starting from the submandibular region in the right half of the neck and extending along the mandible.

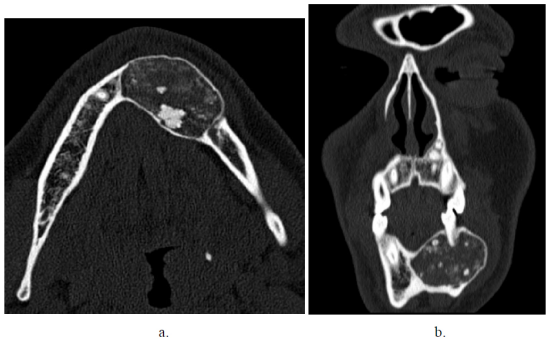


Fig. (9). (case **11**). Cemento-ossifying fibroma in a 38-year-old male patient. (**a**) Axial and (**b**) coronal maxillofacial computed tomography examination showing hypodense heterogeneous lesion with multiple calcifications and smooth contours, causing expansion in the bone structure in the middle-left lateral part of the anterior mandible.

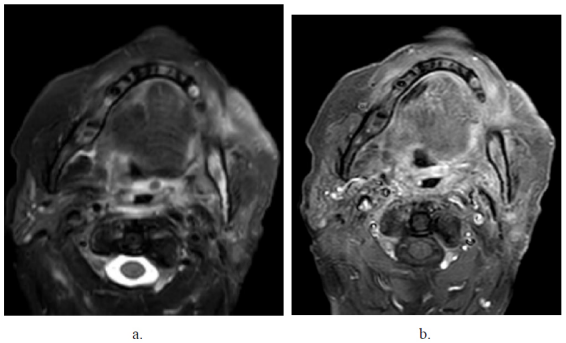
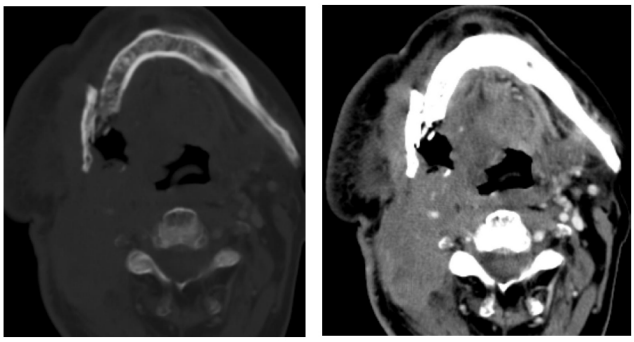
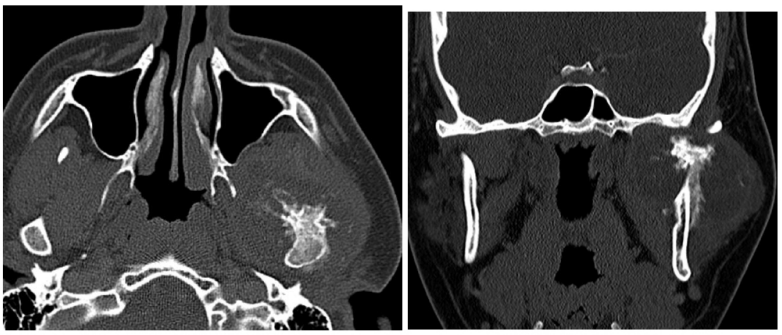


Fig. (10). (case **12**). 51-year-old female patient with SCC mandibular invasion. (**a**) Axial fat-suppressed T2 sequence and (**b**) postcontrast fat-suppressed T1 sequence of residual-recurrent SCC that invades and causes destruction of the left mandibular corpus-ramus, enhanced in postcontrast series.



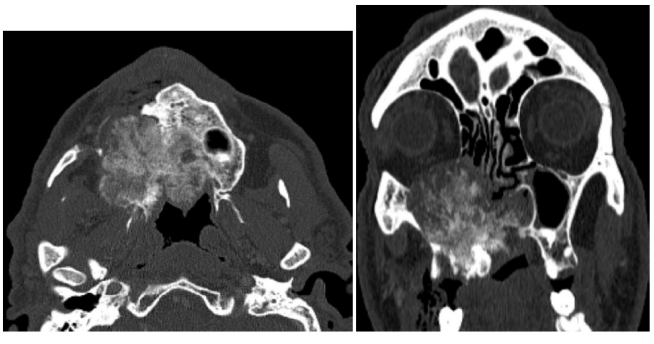
a. b.

Fig. (11). (case **13**). SCC mandibular invasion in a 57-year-old male patient. (**a**) Bone window and (**b**) soft tissue window in axial contrast-enhanced neck computed tomography, starting from the floor of the mouth on the right and extending posteriorly to the paraspinal muscle planes and the inferior part of the occipital bone, destroying the right half of the mandible corpus, invading the carotid artery and jugular vein, and narrowing the air passage with malignant mass lesion.



a. b.

Fig. (12). (case **14**). Osteosarcoma in a 24-year-old male patient. (**a**) Axial and (**b**) coronal maxillofacial computed tomography examination demonstrating a heterogeneous mass lesion compatible with osteosarcoma in the left mandible condyle-ramus localization with osseous components that fill the left masticator distance and show radial extension from the mandible.



a. b.

Fig. (13). (case **15**). 62-year-old male patient with osteosarcoma. (**a**) Axial and (**b**) coronal contrast-enhanced maxilla computed tomography examination showing a malignant mass lesion that causes destruction in bone structures, has dense calcific components, extends to the left along the hard palate in the right maxilla, completely fills the maxillary sinus, extends into the nasal cavity, and invades the nasal septum.

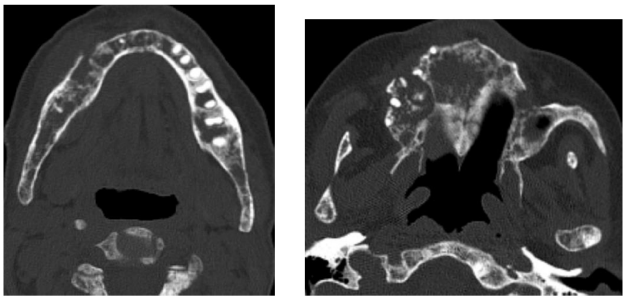


Fig. (14). (case **16**). A 53-year-old female patient with multiple metastases in the maxilla and mandible. (**a** and **b**) Axial mandible computed tomography showing multiple lytic destructive lesions (metastases) in the mandible and the maxilla.

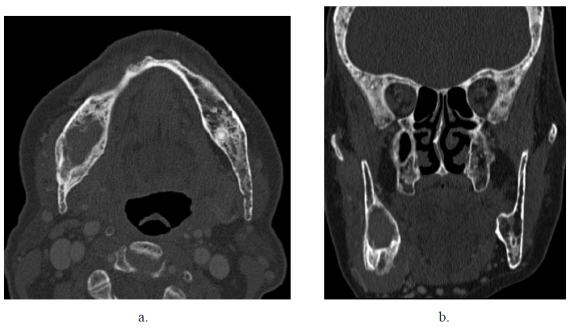


Fig. (15). (case **18**). Plasmacytoma and multiple myeloma in a 72-year-old female patient. (**a**) Axial and (**b**) coronal maxillofacial computed tomography showing hypodense, lytic mass (plasmocytoma) extending from the level of the right mandible angulus to the mandible corpus and causing destruction in the mandible. Diffuse lytic lesions (multiple myeloma) in all calvarial bone structures.

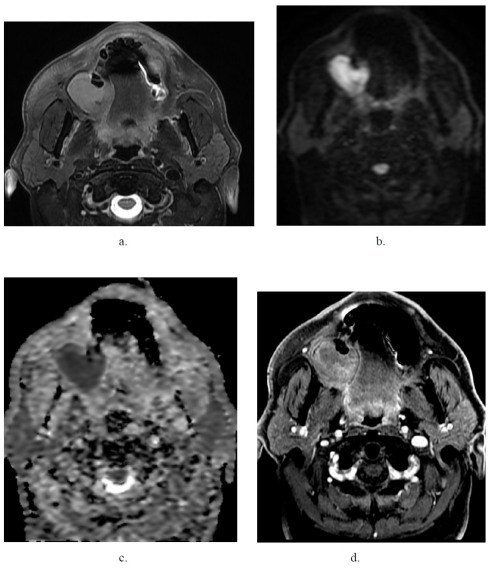


Fig. (16). (case **19**). A 53-year-old man with mandibular lymphoma. (**a**) Axial fat-suppressed T2, (**b**) diffusion-weighted imaging, (**c**) ADC imaging, and (**d**) postcontrast fat-suppressed T1A sequences in contrast-enhanced facial MRI, T2W hyperintense, DWI hyperintense, and markedly low ADC values, causing expansion in the corpus of the right mandible and bone destruction lesion with faint and mostly peripheral enhancement in postcontrast series.

CONCLUSION

The mandible and maxilla are commonly imaged bones with overlapping radiological features and a wide differential diagnosis, susceptible to many non-odontogenic pathologies.

Most radiolucent lesions of the mandible and maxilla seen on conventional X-rays reveal benign lesions that do not need more follow-up [1, 2]. Nevertheless, certain radiological features, such as large size, ill-defined borders, bone erosion, relationship with an impacted tooth or mandibular canal, and tooth resorption may need further radiological assessment. In undiagnosed cases, histopathological evaluation is required.

The time required to reach the correct differential diagnosis and initiate the appropriate treatment of these rare lesions may be prolonged because the patient is asymptomatic, or the disease is chronic and slowly progressing. A systematic approach to the evaluation of mandibular and maxillary lesions is obtained through a collaborative interaction between the dentist, oral surgeons, and radiologist in view of appropriate evaluation and imaging. The most important issue in the evaluation is to analyse the lesion according to its matrix whether it is lytic or sclerotic, its relationship with the adjacent teeth, and its location. These basic observations are essential for evaluating the type of mandibular and maxillary lesions.

When these observations are done, it is easy to make a possible list of differential diagnoses. The results of this study differ from previous studies in terms of gender and age. This may be due to the insufficient number and distribution of the study groups for such rare diseases. The current study's results can be helpful for future studies and better surgical implications.

LIST OF ABBREVIATIONS

GOS	=	Gnathic Osteosarcomas
MRI	=	Magnetic Resonance Imaging
GS	=	Gardner Syndrome
FD	=	Fibrous Dysplasia
SBC	=	Solitary Bone Cyst
SCC	=	Squamous Cell Carcinoma
NHL	=	Non-hodgkin Lymphoma
ADC	=	Apparent Diffusion Coefficient

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Pamukkale University Faculty of Medicine's ethics committee (Number: 60116787-020/365589).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees, and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

A written informed consent was waived because of the study's retrospective observational nature.

STANDARDS OF REPORTING

STROBE guidelines were followed in this study.

AVAILABILITY OF DATA AND MATERIALS

All the data and supporting information are provided within the article.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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