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Evaluation of mandibular lesions via ultrasonography: An original research

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***Abstract*---**Introduction: Jaw bone lesions are common pathologic conditions. The role of ultrasonography in evaluation of the extra-osseous lesions is confirmed, however, this imaging modality is not the diagnostic routine for the intra- osseous jaw lesions. The purpose of this study was evaluation of mandibular lesions via ultrasonography. Materials and Method: A prospectively, 100 patients with intraosseous jaw lesions referred to department of radio diaganosis from Oral Surgery Department, DHIRAJ GERNAL HOSPITAL , Sumandeep Vidhyapeet Vadodara, Gujarat ,between July 2018 and June 2019. All patients had radiolucent or mixed-appearance intraosseous lesions in the mandible at time of the diagnostic process. The size of the lesions was measured by USG and then compared with CT or CBCT. Moreover, the correlation amongst

the echographic patterns and histopathologic results was evaluated. Results: USG is highly sensitive and specific for odontogenic cyst , artrio- venous malformation, and ca mandible showing 100% results in diagnosis followed by radicular cyst, dentigerous cyst, and osteomyelitis showing specificity of 95.6%. Most common appearance of radicular cyst on USG is simple cyst involving root of tooth appearing anechoic and without vascularity. Conclusion: Findings of this study suggested that USG might be feasible in estimating the size of intra-osseous jaw lesions with little underestimation. This study also confirmed that ultrasound imaging was a very useful imaging technique which could provide significant diagnostic information regarding the content of jaw bone lesions where the buccal bone thickness was thin enough.

***Keywords*---**ultrasonography, odontogenic tumors, odontogenic cyst, jaw.

Introduction

Imaging techniques play a crucial role in detecting, diagnosis, treatment and follow-up assessments of intra-osseous maxillofacial lesions. Because of the wide variation of jaw bone lesions, the diagnosis is often complex. [1-2] Following the advancements in technology, various imaging modalities have been introduced to professional use in this field; however, panoramic radiography is still the gold standard for the first-step two- dimensional assessment of jaw lesions among other conventional techniques. [3] Despite its high radiation dose, Computed Tomography (CT) scan is being used regularly as an advanced complementary method in diagnosis of jaw bone lesions. [4] Cone beam computed tomography (CBCT) is a more recent alternative to panoramic radiography with the benefit of lower radiation exposure. [5] Meanwhile, ultrasonography (USG) has been frequently used in evaluating the solid and cystic nature of the lesions. Although this technology is safe and non-invasive, its use in dental practice has been limited to soft tissues. [4] The number of studies investigating the role of ultrasound in evaluation of bony lesions is limited. In 1996, Lauria *et al.* [6] prospectively evaluated the role of ultrasonography as a complementary imaging modality in the diagnosis of intra-osseous jaw lesions. They concluded that USG was a useful technique in evaluation of the content of lesions. Cotti *et al.* in 2002, 2003 [1-2] and Gundappa *et al.* in 2006 [7] assessed whether combined use of USG and color Doppler could differentiate the periapical lesions based on their content. They concluded that USG was a useful technique to distinguish between cyst and granuloma by revealing the content of the bony lesion. Sumer *et al.* in 2009, [4] suggested that USG provided accurate information on the content of intra-osseous jaw lesions and Doppler ultrasound was capable of showing vascularization of such lesions. The purpose of our study was to evaluate the intra-osseous jaw bone lesions by means of conventional radiography, CT or CBCT scans, and USG regarding the size and content of these lesions and to compare the correlation between the ultrasonographic findings and histopathologic results.

Materials and Method

Criteria of Admission

This project evaluated, prospectively, 100 patients with intraosseous jaw lesions referred to department of radio diaganosis from Oral Surgery Department, DHIRAJ GERNAL HOSPITAL , Sumandeep Vidhyapeet Vadodara, Gujarat ,between July 2018 and June 2019. All patients had radiolucent or mixed-appearance intraosseous lesions in the mandible at time of the diagnostic process. All patients were informed about the study and an informed consent was taken.

Method Of Assessment

After the confirmation of an intraosseous lesion, an ultrasound and color doppler examination was performed

- Detect the lesions and to evaluate their content
- Size
- The relationship with anatomical structures
- Blood flow within or surrounding the examined lesion.

The examinations were performed with a colour-coded GE P9 with a 3-12 MHz linear-array transducer. To facilitate a comparative study with the final histopathological findings the US images were classified into four groups:

1. HYPER-ECHOIC (SOLID):- which is characteristic of odontogenic tumour because of the uniformity of the tumour mass.
2. ANECHOIC(CYSTIC):- which is characteristic of odontogenic cystic lesions because of their liquid content;
3. HYPO-ECHOIC(COMPLEX CYST):- which is exclusive of the keratocysts because of their dense and thick content (keratin).
4. MIXED ECHOIC:- which is characteristic of odontogenic and nonodontogenic tumours with cystic and solid areas combined in a same lesion.

After the ultrasound examination, the patients underwent CT Scan and biopsy followed by surgical treatment in necessary cases and the specimens were submitted for routine histopathological examination.

Results

Most common age group was 21 to 30yrs (30%) followed by 31 to 40yrs (24%). Male:female ratio is 3:2 in the present study. TABLE1,2 The most common site of involvement is body of mandible (43%) followed by angle of mandible (17%). TABLE 3 USG helps in differentiating between cellulitis and abscess and also in demarcating the extent and depth of the lesion from the superficial skin. USG is highly sensitive and specific for odontogenic cyst , artrio- venous malformation, and ca mandible showing 100% results in diagnosis followed by radicular cyst , dentigerous cyst, and osteomyelitis showing specificity of 95.6%. Most common

appearance of radicular cyst on USG is simple cyst involving root of tooth appearing anechoic and without vascularity.TABLE 4 Most common appearance of dentigerous cyst on USG is simple cyst involving impacted tooth seen in 90% cases and with mixed echogenicity and vascularity seen in 10% cases. Odontogenic keratocyst appears as complex cyst with internal septation and vascularity in 100% cases. Amyeloblastoma appears mixed heterogenous in 90% cases and hyper echoic solid appearance in 10% cases and having increased vascularity in 100% cases. Ossifying fibroma appears as mixed heterogenous in 40% cases and as a hyper echoic solid appearance in 60% cases with increased vascularity in 100% cases. Osteomyelitis gives mixed heterogenous appearance in 80% cases and hyper-echoic solid appearance in 20% cases with increased vascularity in 90% cases. Arterio venous malformation appears as mixed heterogenous lesion in 100% cases giving characteristic arterial and venous wave pattern on colour doppler. Ca mandible gives mixed heterogenous appearance with destruction and involvement of adjacent structure with lymph nodes involvement in 100% cases and with increased vascularity seen in 98% cases. Overall, sensitivity and specificity of ultrasound in correlation with histopathological finding is 97.4%. Table 5

Table 1: Distribution of participants according to age group

Age group (in years)	Total (n)	Percentage (%)
01-10	01	1.0
11-20	06	6.0
21-30	30	30.0
31-40	24	24.0
41-50	18	18.0
51-60	13	13.0
61-70	08	8.0
Total	100	100.0

Table 2:- Distribution of participants according to gender

Gender	Total (n)	Percentage (%)
Male	60	60.00
Female	40	40.00

Table 3:- Distribution according to the site of involvement

Ramus of mandible	07	04	10
Site	Clinical	Radiographic	Ultrasonographic
Symphysis	07	10	10
Parasymphysis	18	21	15
Body of mandible	44	44	43
Angle of mandible	24	15	17
Coronoid process	00	04	04
Condyle	00	02	01
Total	100	100	100

Table 4: Histopathology of the lesions and comparison with the USG

Pathology	Radiology (opg)	USG					Total cases on usg	Histopathology
		Simple cyst (anechoic)	Complex cyst(hypo with int septation)	Mixed(heterogenous)	Solid(hyperechoic)	Vasularity		
Radicular cyst	Unilocular radio lucent lesion involving root of tooth	16	0	2	0	Absent	18	20
Dentigerious	Unilocular radiolucent lesion involving crown of an unerupted tooyh	13	0	2	0	Abesen t	15	16
Odentogenic keratocyst	Unilocular, well ncorticated, radi olucent,	0	10	0	0	Present	10	10
Amyeloblastoma	Multilocular, explancile cystic lesion	0	0	15	2	Present	17	16
Ossifying fibroma	Radiolucent with calcified patches	0	0	2	9	Present	11	10
Osteomelitis	Radiolucent with periosteal reaction	0	0	19	05	Present	24	23
Avm	Radiolucent	0	0	2	0	Present	2	2
Ca mandible	Cortical erosion	0	0	03	0	Present	3	3

Table 5:-Statistical analysis of mandibular lesions

	Senitivity	Specificity	Positive predective value	Negative predictive value
Odentogenic keratocyst/avm/ ca mandible	100.00	100.00	100.00	100.00
Ossifying fibroma	100.00	90.91	100.00	98.89
Osteomyelitis	100.00	95.83	100.00	98.70
Radicular cyst	97.56	95.00	90.00	97.56
Dentigerious	98.82	93.75	93.75	98.82

Amyeloblastom	98.82	100.00	94.12	100.00

Discussion

As stated previously, only a limited number of studies have investigated the role of ultrasound in diagnosis of jaw bone lesions, particularly in evaluation of the size of these lesions.

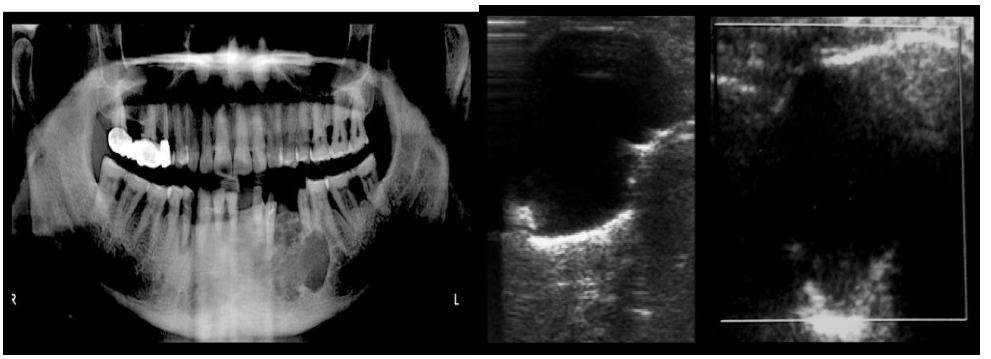

Figure 1: A case of radicular cyst. (A) Panoramic view reveals a radiolucent lesion on the anterior right side of the maxilla. (B) USG image shows most common appearance of radicular cyst which is anechoic lesion without internal echoes with involvement of root of tooth. There is no vascularity seen on doppler. There is an another appearance of cyst showing mixed heterogenous lesion

Our findings regarding the content of lesions were comparable with Lauria *et al.* [6] and Sumer *et al.* [4] who concluded that USG could provide accu- rate information on the content of intraosseous jaw lesions before any surgical procedure. Neither of these studies provided information on the size of lesions comparing USG with CT or CBCT. To the best of our knowledge, this study is the first one that has simultaneously evaluated the size and content of the jaw lesions by means of USG and com- pared it with gold standards (CT or CBCT) and histopathological results. The size of lesions was more re- garded in this study. Since CT and CBCT are the gold standards in lesion size assessment, [8] the measurements obtained from USG were compared with those of CT and CBCT. In 9 out of 15 cases in which the lesions were measured by linear probe of USG with the frequency of 7.5 MHz, sizes had negligible differences in comparison with CT /CBCT results. In 3 other cases in which the size of lesions was larger than 5 cm, convex probe was used to cover a larger field of view that could measure the whole lesion. In these cases the results were very close to CT or CBCT results. In three cases, because of thickness of buccal cortical plate, the radiologist could not measure the lesions accurately. The loss of continuity of buccal cortex, not the content of these lesions, was more important in assessment of the size of lesions in USG.

All measurements were underestimated using USG compared with CT or CBCT. Based on our findings, this might be due to the projection of acoustic shadow of the bony edges on the lateral walls. There- fore, placement of the electronic calipers for exact measurements is difficult. As mentioned previously, ICC

between the two modalities (US and CT) was 0.99, confirming their complete agreement. Echographic pattern in all these lesions were evaluated with USG. Five out of 15 lesions showed anechoic pattern (no internal echoes) with respect to their cystic content. These odontogenic cysts included radicular, residual, and dentigerous cysts (Figure 1).

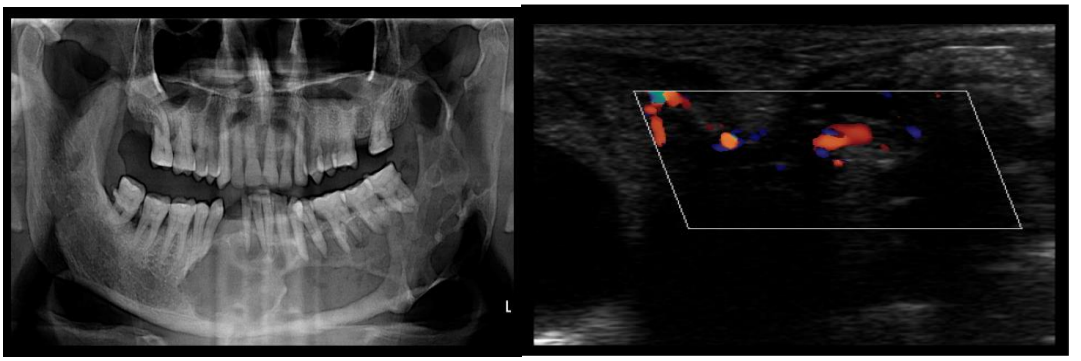

Figure 2: A case of odontogenic keratocyst. (A) Panoramic view reveals a radiolucent lesion in left posterior region of the maxilla. USG image of same lesion shows densely hypoechoic lesion with internal septations seen because of presence of dense and thick keratin. on dopper lesion there is increased vascularity

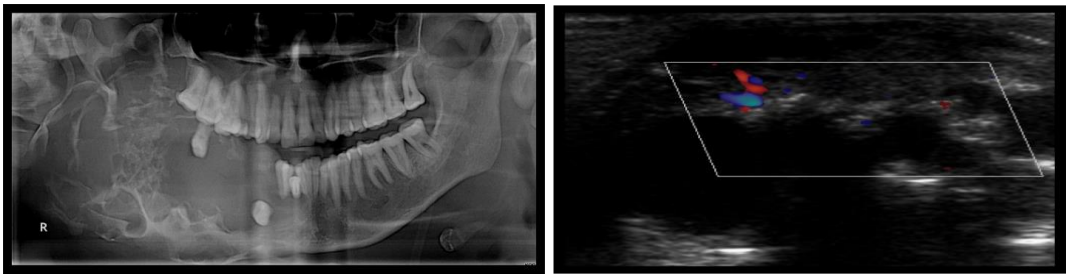

Figure 3: A case of ameloblastoma. (a) panoramic view reveals large radiolucent lesion in right mandibular ramus. Usg image shows mixed predominantly hypo-echoic lesion which causes erosion of underlying alveolar process of mandible showing minimal increased vascularity on doppler study. A hypoechoic area is an area on the image with fewer reflected echoes, darker than the surrounding tissues which can be an indication of a semi-solid con- tent. [9-11] Three lesions revealed a hypoechoic image based on the nature of their content which was infected radicular cysts and odontogenic keratocyst (OKC). Histologically, these two types of cysts contain a denser liquid compared to other cysts. Higher viscosity might be due to pus accumulation in the infected radicular cyst and the keratin content in OKC. There- fore, their hypoechogenicity in comparison with other cysts (anechogenicity) may confirm this internal viscosity (Figure 2). Based on the oral radiology text- books, the density or viscosity of keratin contents of OKC would not affect the internal architecture of this lesion in conventional radiographs; however, USG had the advantage of differentiating these lesions with respect to these changes in keratin viscosity.A hyperechoic area has higher echo intensity (demonstrates more reflected echoes) than the sur- rounding tissues, and it almost always indicates solid content. Three lesions which revealed a

hyperechoic pattern were ameloblastoma, mural ameloblastoma, and Pindborg tumor (calcifying epithelial odontogenic tumor). These tumors had a solid content which was consistent with their histopathologic results (Figure 3). USG pattern of three lesions including two central giant cell granulomas and one odontogenic myxo- ma was hyperechoic-hypoechoic (mixed echogenic), indicating solid and mixed content of these lesions [9, 12]. Based on our findings, the irregular hyperechoic pattern in anechoic area detected in the case of simple bone cyst was highly suggestive of air similar to the echographic appearance of the air in other parts of the body such as lungs. [10, 13-14] Based on review of the literature, there has been no report of this unique appearance in the USG findings of jaw lesions prior to this study. In all the aforementioned cases, there was complete agreement between the USG and histopathologic results regarding content assessment. Ultrasound does not eliminate the necessity of using invasive procedures namely aspiration, incisional and excisional biopsies to obtain final diagnosis for intraosseous lesions. However, based on our findings this safe modality is highly recommended whenever possible (i.e., the thin buccal cortical plate permits the penetration of sound waves) prior to any invasive di- agnostic procedure for evaluation of intraosseous jaw lesions in size and content. USG is not routinely used to evaluate the size or content of the intraosseous jaw lesions in the literature, therefore, the number of cases in this study seems to be reasonable. Future studies with bigger sample size would help disclosing more feasible aspects of USG in assessment of jaw osseous lesions (15,16).

Conclusion

Ultrasound can provide accurate information on the content of intraosseous lesions of the jaws before any surgical procedure. It is noninvasive, low cost and recommended as a complementary imaging modality for intraosseous lesions of the jaw. Additionally, the use of colour and power Doppler ultrasound allows the detection of vascularisation within or around the examined tissue. The patient history and careful consideration of the location of the lesion within the mandible, its borders, its internal architecture, its vascularity and its effects on adjacent structures generally make it possible to narrow the differential diagnosis using USG thereby making it one of the choice of modalities for evaluating mandibular lesions.

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