Ultrasonography – A diagnostic modality for oral and maxillofacial diseases

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Abstract

Background: Many diseases present themselves in oral and maxillofacial regions and various modalities may be applied for their diagnosis, including intraoral and panoramic radiography, ultrasonography (USG), computer tomography, magnetic resonance imaging, and nuclear medicine methods such as positron emission tomography. Of these modalities, USG is easy to-use for the detection of non-invasive and soft tissue related diseases in oral and maxillofacial regions. USG plays an important role in analyzing normal and abnormal structures. In particular, in oral and maxillofacial regions, the USG may be clinically applied to evaluate lymph nodes, subcutaneous, and oral cavity-related diseases. Aims: The aim was to correlate the findings of USG and histopathology for the diagnosis of oral and maxillofacial pathology and to evaluate whether USG can be used as an adjunct in diagnosing oral and maxillofacial pathology. Materials and Methods: A total of 10 clinically diagnosed patients with intraoral cancerous growths, swellings in maxillary and neck region were included in this study. Incision biopsy was obtained for confirming provisional clinical diagnosis. The selected cases were advised USG. All patients were then posted either for hemi-glossectomy, hemi-mandibulectomy, and partial maxillectomy with or without radical neck dissection. Statistical Analysis: Student’s t-test and coefficient of correlation was used to statistically analyze significant relationship of both the methods. Result: In all 10 cases, USG correlated well with histopathology findings, it could also delineate tumor extent and measure tumor thickness. Conclusion: USG is an excellent method for the diagnosis of soft tissue lesions and can be used as an adjunct in diagnosing oral and maxillofacial pathology.

Keywords: Histopathology, lymph node, metastasis, squamous cell carcinoma, tumor thickness, ultrasonography

Introduction

National cancer institute has defined ultrasonography (USG) as a procedure in which high-energy sound waves are bounced off internal tissues or organs and make echoes. The echo patterns are shown on the screen of an ultrasound machine, forming a picture of body tissues called a sonogram.[1] “Sonography” means imaging with ultrasound; “ultra” means audible. The term ultrasound means the form of sound energy beyond audible range. USG used for diagnostic purposes has a frequency of 2-20 MHz, while that used for ophthalmology has a range of 2-50 MHz.[2] The principles and application of ultrasound was first discovered by Curie brothers in 1880. The Dussik brothers in Austria (1937) were the first to describe the use of USG imaging.[3]

Ultrasound wave is a form of longitudinal mechanical wave that needs a medium to transmit from one place to another. Ultrasound is produced by vibrating piezoelectric crystals using a high-frequency electrical pulse, which causes mechanical oscillation and produces ultrasound waves. Therefore, electrical energy is converted into mechanical energy. Diagnostic ultrasound utilizes a transducer, which generates a narrow focus beam. This beam is reflected from the tissue and sent back to the same transducer, which assembles these echoes into an image that can be visualized and recorded. USG has several advantages like it is harmless, radiation free, widely available, easy-to-use, noninvasive, inexpensive, and unaffected by metal artefacts such as dental restorations. It can be performed without heavy sedation. Ultrasound causes no health problems and may be repeated as often as necessary.[4]

Many diseases present themselves in oral and maxillofacial regions and various modalities may be applied for their diagnosis including intraoral and panoramic radiography, USG, computer tomography, magnetic resonance imaging and nuclear medicine methods such as positron emission tomography. Of these modalities, USG is easy-to-use for the detection of noninvasive and soft tissue related diseases. Recently, Doppler ultrasound imaging with the B-mode using the Doppler effect of flow in blood vessels has also been
applied to evaluate the presence or absence of vascular flow in normal tissues and in diseases of the oral and maxillofacial region.\[^{[5-7]}\]

Metastasis to cervical lymph nodes is a crucial factor in the prognosis of oral cancer. Early and appropriate treatment is very important for prognosis and overall well-being of the patient. A number of recent studies have identified tumor thickness and depth of invasion as an important prognostic indicator in oral cancers, especially as a predictor of regional lymph node metastasis.\[^{[8]}\] In USG, there is a facility of on-screen nodal measurement. Ultrasound is capable of differentiating cystic from solid lesions and is also helpful in differentiating benign from malignant masses. In particular, in oral and maxillofacial regions, the USG may be clinically applied to evaluate lymph nodes, subcutaneous and oral cavity related diseases. However, most dentists do not know the utilities of USG for the diagnosis of various kinds of oral diseases and it is very disadvantageous for patients with any of the diseases mentioned above.\[^{[9]}\]

Therefore, we designed a study to correlate the findings of USG and histopathology for the diagnosis and to evaluate whether USG can be used an adjunct in diagnosing oral and maxillofacial pathology.

**Materials and Methods**

Institutional Ethical Committee approval and informed written consent from each patient was obtained prior to the beginning of the study. Clinically diagnosed cases of patients with intraoral cancerous growths, bony swellings, and neck mass were included in the study.

Cases were divided into four groups:
- **Group 1**: Tongue lesions \(n = 3\)
- **Group 2**: Buccal mucosa lesions \(n = 4\)
- **Group 3**: Intraoral bony swellings \(n = 2\)
- **Group 4**: Neck mass lesion \(n = 1\).

Incisional biopsy was obtained for confirming provisional clinical diagnosis. Selected cases were advised USG examination of the lesion and lymph nodes. Endocavity probe (RIC5 GE Voluson, USA) thinly coated with sterile gel without anesthetic solution was used. This probe/transducer is characterized by a pulsed 5-9 MHz ultrasonic beam and 3.4 cm long linear array. The ultrasonic images were acquired using a (730 Pro BTO8 GE Voluson, USA) ultrasound system. The patients were hospitalized 48 hrs preoperatively. Patients were then surgically treated with or without radical neck dissection. The surgically excised specimen from these patients was examined histopathologically.

Seven patients with intraoral cancerous growths of Groups 1 and 2 (Figure 1a and b) were clinically staged according to AJCCS criteria. The cancer cases were reviewed for following variables - (1) Histological grading: Well-differentiated (Grade I), moderately differentiated (Grade II) or poorly differentiated (Grade III) squamous cell carcinoma (SCC); (2) histological tumor thickness and depth of invasion was measured in each section using an ocular micrometer. The thickness was measured vertically starting from the surface of tumor up to maximum point of invasion; (3) the presence of metastasis in the lymph nodes.

Two patients with intraoral bony swellings (Figure 2) were subjected to clinical and radiographic examination (panoramic, occlusal and periapical). The patients were advised USG for evaluation of the content of the lesions using endocavity probe. The USG images were obtained at a 5-9 MHz frequency with the patient in a supine position and the probe/transducer moving along the affected area of the jaw.

One patient with neck mass (Figure 3) was also advised USG followed by surgical treatment. A comparison between the USG findings and the definitive diagnosis of all cases was carried out.

**Results**

The demographic analysis (age, sex, site, and nature of lesion) of cases in study Groups 1-4, USG findings and definitive histologic diagnosis are shown in Tables 1-4 respectively.

In all the seven intraoral cancerous growths, USG examination suspected malignancy (Figure 4a and b) and the diagnosis was confirmed on histological examination as SCC (Figure 5). Preoperative assessment for metastasis in lymph node by USG showed that in all the tongue lesions, lymph nodes were free of tumor and buccal mucosa lesions showed lymph node metastasis and this finding was also confirmed on histopathological examination. Out of the two intraoral bony lesions, USG examination showed the content of the lesions to be solid or mixed (Figure 6) and this finding correlated with histopathological diagnosis of ameloblastoma (Figure 7) and fibrous dysplasia (Figure 8), respectively. Similarly, in the neck mass case, USG examination suspected benign lesion (Figure 9) and was confirmed on histological examination as parangangioma (Figure 10).

**Statistical analysis**

There was a good correlation in length (coefficient of correlation \(r = 0.7309\)) and depth of lesions (coefficient of correlation \(r = 0.8219\)) on USG and histological findings, but there was poor correlation for width of the lesion (coefficient of correlation \(r = 0.1205\)). Student’s \(t\)-test was applied to compare the findings of USG and histopathology. By calculations with MS Excel, the test statistics for length (\(t = 0.6778\)), breadth (\(t = 0.4654\)) and depth of invasion (\(t = 0.1282\)) between two measurement
methods and the table value of $t$-test for two tails at 5% level of significance was $t = 2.4469$, which is greater than calculated values. Therefore, the findings of USG and histopathology were statistically significant.

**Discussion**

Though the principles and application of ultrasound was discovered by Curie brothers in 1880, the Dussik brothers in Austria (1937) were the first to describe the use of ultrasound imaging and later in 1972, Kossoff in Australia and others introduced grey scale USG. Thus, after a long gestation and childhood, diagnostic ultrasound is now reaching adolescence with a potential for considerable future growth. Vincent in 1988 stated that sonography is widely applicable in the diagnosis of a variety of soft tissue abnormalities. Though the major application of USG is in cardiology, gastroenterology, obstetrics and gynecology, it is recently gaining importance in the diagnosis of oral and maxillofacial lesions.$^{[10]}$ Tongue and buccal carcinomas commonly present as a slow growing mass on tongue and buccal mucosa respectively. Small lesions tend to be asymptomatic and are often noted surprisingly on dental examination. Pain commonly occurs as the lesion enlarges and ulceration develops. Oral intake may worsen the pain and lead to malnutrition and dehydration. Associated symptoms include bleeding, poor denture fit, facial weakness or sensory changes, dysphagia, odynophagia and trismus.$^{[11]}$ A detailed medical history is important to determine the patient’s candidacy for surgery or radiation therapy. The person often has a history of betel nut chewing, tobacco, and alcohol use. A history of previous malignancies of the upper aero digestive tract should also be ascertained. The appropriate management of the nodes in patients with head and neck cancers is critically important because the presence of cervical metastasis is the most powerful independent indicator of loco-regional recurrence and overall survival rate. Clinically undetectable nodal metastasis is the worst possible scenario for treatment failure. Incidence of neck metastasis in oral SCC is reported to be 34-50%.$^{[11]}$
We had seven cases of oral SCC including three of ventrolateral surfaces of tongue and four of buccal mucosa. Our results matched with study of Chammas et al., who concluded that intraoral sonography is useful for identifying oral tumors and measuring their thickness by intraoperative ultrasonography (IOUS) shows a good correlation with histological measurements. Shintani et al., concluded that the incidence of cervical metastasis increases markedly when depth of invasion of oral tumor is over 0.5 cm histologically and in this case, elective neck therapy is strongly indicated. Results of our study are in accordance with the results of these authors except for one case where...
Figure 5: H and E stained section (x10) showing well differentiated squamous cell carcinoma with malignant squamous cells in sheets and keratin pearls

Figure 6: Ultrasonography image of ameloblastoma showing hyperechoic lesion characteristic of solid content

Figure 7: H and E stained section (x10) of ameloblastoma showing proliferating odontogenic epithelium in plexiform pattern

Figure 8: H and E stained section (x10) of fibrous dysplasia showing proliferation of delicate collagen fibers with plump fibroblast and variable number of calcified bodies without osteoblastic lining

Figure 9: Ultrasonography image of neck mass showing well defined hypoechoic oval lesion suspecting benign lesion

Figure 10: H and E stained section (x10) of paraganglioma showing tumor composed of lobules and clusters of round to polygonal cells characterized by zellballen appearance
in spite of depth of invasion being over 0.5 cm, there was no cervical metastasis.

In our study, the tumor thickness over 1.8 cm served as cut-off point to predict cervical node metastasis in evaluating carcinoma by IOUS and this result correlated well with the study of Chammas et al.\(^{(12)}\) who concluded that the cut-off point of tumor thickness based on IOUS evaluation for predicting neck metastasis was determined to be 1.8 cm.

Thus we can very categorically state that tumor thickness and depth of invasion as gauged on USG significantly correlates with histopathologic findings.

Our cases of solid and mixed jaw lesions as diagnosed by USG correlated with histopathological findings and this results are in tune with the study done by Lauria et al.\(^{(11)}\) who concluded that the use of USG is of importance in evaluating the solid, cystic or mixed components of jaw lesions and that the contents of lesion correlate with the histologic findings. The identification of lesion contents would facilitate the decision whether to perform an incisional biopsy as a next step or to undertake the complete surgical treatment of the patient immediately.

We had one case of neck swelling, which was predicted as benign neck mass by USG and correlated well with histopathology, which was diagnosed as parangangioma. McKenna et al.\(^{(6)}\) has reported that USG of boundaries, echo intensity and ultrasound architecture of lesions are statistically significant to differentiate benign neoplasms from malignant neoplasms in head and neck swellings.

Regional nodes can also be evaluated by USG and metastasis can be diagnosed. Aggarwal et al.\(^{(14)}\) in their study have shown that gray scale USG can be used to assess suspicious nodes for metastasis and that there was a significant relation between size of node and echogenicity of the node. The significant fact is that lymph node status can be evaluated successfully preoperatively by USG then the need for extensive surgeries like commando operations can be obviated in some cases and precise treatment can be rendered thus reducing the morbidity and improving the prognosis.

Ultrasoundography can also be used to evaluate salivary gland diseases. Not only does it enable confirmation or exclusion of the presence of a mass, but in many cases nature of underlying disease can also be suggested by USG. Use of high resolution high-frequency linear ultrasound imaging can be used in evaluating morphologic patterns of salivary gland diseases. USG guided fine-needle aspiration cytology is also an emerging valuable adjunct in assessing salivary gland diseases.\(^{(15)}\)

Our case series investigated 10 patients of variety of lesions but the number of cases in each group was less. We suggest that increasing the number of cases in each group could be more helpful to verify and confirm the role of USG examination for diagnosis of oral and maxillofacial pathology.

**Conclusion**

Ultrasoundography findings correlate well with histopathology. Lymph node metastasis can be efficiently predicted and USG can be used as an adjunct in the diagnosis of oral and maxillofacial pathology.

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