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Radio diagnosis

DIAGNOSTIC ROLE OF ULTRASOUND IN NECK SWELLINGS - A HOSPITAL BASED STUDY

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ABSTRACT **BACKGROUND:** Ultrasonography is a radiologic technique in which deep structures of the body are visualized by recording the reflections (echoes) of ultrasonic waves directed into the tissues. For many years, Ultrasonography has played a major role as a diagnostic tool in various medical fields. Only recently has it been used for maxillofacial imaging. It has still not found its place as a routine diagnostic aid in this field. **OBJECTIVES:** To establish the efficacy of Ultrasonography as an effective diagnostic aid in the swellings of Head & Neck region. **MATERIAL AND METHODS:** 30 patients with swellings present in the Head & Neck region which includes enlargement of salivary glands, occult lymph node growths, odontogenic fascial space infections, cystic swellings, inflammatory swellings and neoplastic swellings. The patients were selected randomly irrespective of the age, sex, caste, creed and socio-economic status. All the patients were informed regarding the radiographic and experimental procedures and informed consent was obtained before these procedures. **RESULTS:** The total 30 subjects were examined clinically to derive at a clinical diagnosis and they were divided into 4 groups based on the type of swelling, consisting of 8 subjects each. The study was conducted to evaluate the efficacy of Ultrasonography in the diagnosis of head and neck swellings. The histopathological diagnosis obtained after definitive treatment procedures or FNAC/ Biopsy sample studies was considered the Final diagnosis against which the efficacy was measured of clinical diagnosis, USG diagnosis. This value was found to be maximum in case of Ultrasonography. **CONCLUSION:** The results obtained were used to calculate sensitivity, specificity, accuracy and significance of USG diagnosis for being efficacious diagnostic tool for head and neck swellings.

KEYWORDS : Ultrasonography; Head And Neck Swellings, FNAC/Biopsy; Histopathological Diagnosis

INTRODUCTION

Ultrasonography is a radiologic technique in which deep structures of the body are visualized by recording there reflections (echoes) of ultrasonic waves directed into the tissues.[1] For many years, Ultrasonography has played a major role as a diagnostic tool in various medical fields. Only recently has it been used for maxillofacial imaging. It is always vital to establish the correct diagnosis in order to choose the most appropriate treatment. Developmental defects and various disease processes may affect head and neck regions, which present clinically as swellings. The disease processes which lead to such types of swellings can be broadly classified as inflammatory, cystic, benign or malignant in nature.[2] In evaluation of such swellings, detailed case history and clinical examination are the most important and mandatory steps. But in some cases, such as chronic inflammation, abscess formation, deep-seated or infected cystic lesion and neoplasm, clinical examination and palpation do not provide complete assessment of the exact origin and nature of swellings; such cases require radiological imaging.[2] Therefore, to get a final diagnosis, clinical examination must be joined with various other investigative procedures. Radiology is the first, but not the only, method used to identify intra- and extra-osseous jaw lesions.[3-4] Ultrasonography (USG) is an inexpensive, non-invasive, sensitive, and readily available tool that has been used to depict lymph nodes, salivary glands, vascular structures, and inflammatory masses in the head and neck region.

Ultrasonography has obtained wide acceptance as a valuable diagnostic aid in the evaluation of head and neck lesions, such as lymph nodes of the neck,[5-6] salivary gland disorders,[7-8] and facial bone fractures[9] ; these studies were performed with transcutaneous sonography. In 1987 Yoshida et al[10] described the use of intraoral ultrasonic scanning with a small intraoral transducer. They used it clinically in the diagnosis of oral soft tissue lesions and reported that intraoral ultrasonic scanning was useful for that purpose. Since that time, other studies of intraoral scanning have been reported.[11] The role of USG in evaluation of neck region is becoming increasingly important due to the availability of high – frequency (7.5 to 15 MHZ) probes, which permit visualization of more suitable anatomical and pathological details.[4] High resolution B- mode sonography has improved in the past few years and has become a very valuable tool in the diagnosis of the disease of the head and neck. Sonography is commonly the first imaging modality after clinical examination. It is easily tolerated by patients without exposing the patient to the radiation (non-invasive) and is inexpensive. It shows the origin of the lesion and differentiates whether it is cystic or solid. It provides information about the site of origin and infiltration into the soft tissue or vessels and mass effects. It provides valuable diagnostic information with a high degree of diagnostic accuracy and useful in preparative evaluation of patients.

Two new dimensions of medical practice pervade our environs; non invasive diagnosis and cost control. Ultrasonography qualifies eminently in regards. While there have been many reports in its use in thyroid disease, there are few reports on its general use in the diagnosis of head and neck diseases. Ultrasonography gives an accurate information as to the form and content of cervical masses. It enables us to distinguish solid from cystic lesions. It may alert us to the probabilities of malignant versus benign nature of neck swellings.

Aim and Objectives:

The present study has been done with an aim to study the various ultrasonographic features of neck swelling.

The objectives of this study are

- To assess the role and efficacy of Ultrasonography in the diagnosis of swellings of head & neck region.
- To establish the efficacy of Ultrasonography as a first line diagnostic tool in the diagnosis of swellings of orofacial regions
- To assess whether USG can differentiate between inflammatory swellings, benign and malignant neoplasms and cystic swellings

Material and Methods

Study setting

This study was conducted jointly in the Department of Radiodiagnosis of Mayo Institute of Medical Sciences and Integral Institute of Medical Sciences & Research over a period of 12 months (July 2018 – June 2019). Patients were selected from the OPD at the above mentioned institutes.

Study subjects

30 patients with swellings present in the Head & Neck region which includes enlargement of salivary glands, occult lymph node growths, odontogenic facial space infections, cystic swellings, inflammatory swellings and neoplastic swellings. The patients were selected randomly irrespective of the age, sex, caste, creed and socio-economic status. All the patients were informed regarding the radiographic and experimental procedures and informed consent was obtained before these procedures.

Inclusion Criteria

i. For this single blind cross-sectional study, 30 cases with clinically

obvious swellings in head and neck regions were selected randomly.
ii. The study is gender neutral. Male-to-female ratio 1:1
iii. Age range of 08–70 years; Age limitation is not considered
iv. Both unilateral and bilateral swellings are included
v. Extraoral and Intraoral swellings are included

Exclusion criteria
i. Patient with systemic disease or immunocompromised status.
ii. Patient reluctant to undergo Ultrasonography.
iii. Developmental swellings are excluded.
iv. Any swelling extending below the neck is excluded.

Methodology
All potential participants were explained the need and design of the study. Potential benefits of undergoing thorough clinical, Ultrasonographic investigations were explained. After obtaining the informed consent, the individuals were included in the study. Form of the informed consent has been attached for reference. Based upon inclusion and exclusion criteria 30 subjects became part of this study and were assessed using a pre-designed and structural methodology.

Clinical Examination
Patients were made to sit comfortably on a dental chair. Recording of demographic data, history regarding the maxillofacial and neck swellings, general history and physical examination were carried out in a systematic manner. The patients' detailed case history was recorded and clinical examinations were carried out on the basis of criteria given by Das.[12] Criteria include inspection of swellings and palpation of swellings. In inspection, situation, colour, shape, size, border, surface and overlying skin over the swelling were noted; in palpation, consistency, tenderness, temperature, fluctuance, compressibility and fixity of skin over the swelling were recorded. Data so gathered was recorded in a performa specially formulated for the study. A copy of the performa has been attached for reference. Based on the history and clinical features, a most probable diagnosis was made, referred to as Clinical Diagnosis. Based on this clinical diagnosis the cases were divided into four categories, Inflammatory Swellings (Inf.), Cystic swellings (Cys.), Benign Swellings (Bns.) and Malignant Swellings (Mlg.). Eight (8) cases of each variant were selected for uniformity of data interpretation and easy comparative analysis.

Ultrasonographic examination
An ultrasonographic investigation of each swelling was carried out in Radiodiagnosis department of both the previously mentioned institutes, using Hitachi F31, Hitachi Medical Corporation; Tokyo, Japan. A EUP-V53W (Probe Model) with operable mode – B mode using Single crystal transducer technology; 7 - 15 MHz linear transducer (with depth 10 cm). When the lesion was less than 3.5 cm in diameter, a linear transducer probe with a frequency of 15 MHz and a depth of 3 cm was used. A trans cavitary probe with a frequency of 7.5 MHz and a depth of 8 cm was used when the lesion was larger than 3.5 cm in diameter. A single type of probe is used with a frequency of 2-22 MHz and the lesion is less in depth like ophthalmic lesion and in blood flow measurement. A phased (sector) type is used with 2.5 MHz frequency in wide lesion like brain and cardiac lesions. In this study, different values of frequency were used because as frequency of ultrasound increases, depth of penetration of ultrasound decreases (there by reducing the visibility range of ultrasounds). At the same time as frequency increases, resolution increases. For better resolution, 15 MHz was used. The patients were made to lie down comfortably on a bed. The ultrasound transmission gel was applied and examined with multi-frequency linear transducer in all dimensions. All the examinations including real – time were performed over the swellings in the maxillofacial and neck region. Also USG examinations of bilateral swellings were done. In cases of doubt, the contra lateral / normal side was also imaged when the patient's head was tilted towards the side of lesion. The contents of the lesion were assessed on the ultrasound imaging using the density values as given by the computer.

RESULTS
The patients reporting to the Department of Radiodiagnosis, of both the medical institutes were taken up according to the inclusion and exclusion criteria of the study. Total numbers of subjects selected for the study was 30 and those subjects willingly gave consent for participating in the study, among which 20 were males and 10 were females. The total subjects were examined clinically to derive at a clinical diagnosis and they were divided into 4 groups based on the type of swelling, consisting of 8 subjects each. The study was conducted to evaluate the efficacy of Ultrasonography in the diagnosis of head and neck swellings. The histopathological diagnosis obtained after definitive surgical treatment procedures or FNAC/ Biopsy sample or enucleation or incisional or excisional treatment, was considered Final diagnosis against which the efficacy was measured of clinical and USG diagnosis. This value was found to be maximum in case of Ultrasonography.

The data was entered for all 30 patients on excel spread sheet, tabulated by using Microsoft Excel 2007 and a master chart was prepared and subjected to statistical analysis by using SPSS software. The probability (p) value of obtained values was determined by referring to the respective tables and thus results of the study were evaluated for statistical significance.

Inflammatory swellings
Out of 8 cases, 6 swellings were finally diagnosed as inflammatory swellings by carrying out surgical intervention investigation or treatment procedures. Of the two cases that were considered to be inflammatory swelling of odontogenic variety and diagnosed as Cellulitis clinically, 1 were found to be Odontogenic cyst in both imaging investigation and specimen study. By considering the Ultrasonographic features taken into account in the methodology, the findings were analyzed for key USG features. (Table 1)

Table 1: Inflammatory swelling

Grayscale Sonographic Features	Inflammatory Swellings	No. of Lesions	Percentage %
Boundary of Inflammatory swellings in USG	Very clear	2	24
	Relatively clear	5	60
	Partially clear	0	0
	Ill defined	1	16
Shape of Inflammatory Swellings in USG	Oval	2	20
	Lobular	1	12
	Polygonal	1	08
	Irregular	3	48
	Round	1	12
Echo Intensity of Inflammatory Swellings	Anechoic	2	32
	Isoechoic	1	12
	Hypoechoic	4	48
	Hyperechoic	0	0
	Mixed	1	08
USG Architecture of Lesions of Inflammatory Swellings	Homogenous	5	68
	Heterogenous	3	32
Posterior Echoes in Inflammatory Swellings	Enhanced	4	48
	Unchanged	3	36
	Attenuated	1	16
	Unenhanced	0	0
USG characteristic of Tissues in Inflammatory Swellings	Cystic	4	52
	Solid	3	36
	Mixed	1	12

Cystic Swellings
8 cases of cystic swellings were analyzed and it was found that such swellings are very characteristic in features. In only 2 cases clinical diagnosis did not match the final diagnosis (which was obtained from enucleation treatment procedure followed by histopathology examination) Though both of these swellings were also cystic swellings. Correlation between the 3 key diagnosis is compared in Graph 5. All the USG diagnosis matched the final diagnosis. By considering the Ultrasonographic features taken into account in the methodology, the findings were analyzed for key USG features. (Table 2)

Table 2: Cystic swelling

Grayscale Sonographic Features	Cystic Swellings	No. of Lesions	Percentage %
Boundary of Cystic swellings in USG	Very clear	7	92
	Relatively clear	1	08
	Partially clear	0	0
	Ill defined	0	0

Shape of Cystic Swellings in USG	Oval	2	36
	Lobular	0	0
	Polygonal	0	0
	Irregular	0	0
	Round	6	64
Echo Intensity of Cystic Swellings	Anechoic	5	72
	Isoechoic	0	0
	Hypoechoic	2	20
	Hyperechoic	1	08
	Mixed	0	0
USG Architecture of Lesions of Cystic Swellings	Homogenous	7	88
	Heterogenous	1	12
Posterior Echoes in Cystic Swellings	Enhanced	6	88
	Unchanged	0	0
	Attenuated	2	12
	Unenhanced	0	0
USG characteristic of Tissues in Cystic Swellings	Cystic	7	88
	Solid	0	0
	Mixed	1	4

Benign Swellings

In the diagnostic examination and investigation of 8 Benign tumors of head and neck region it was found that 4 tumors that were misdiagnosed clinically were also benign tumors or neoplasms but differed in histopathological configuration which was obtained by excisional treatment of lesion followed by histopathological examination. And yet USG still had a high rate of efficacious diagnosis over clinical. By considering the Ultrasonographic features taken into account in the methodology, the findings were analyzed for key USG features. (Table 3)

Table 3: Benign swelling

Grayscale Sonographic Features	Benign Swellings	No. of Lesions	Percentage %
Boundary of Benign swellings in USG	Very clear	5	60
	Relatively clear	1	16
	Partially clear	0	0
	Ill defined	2	24
Shape of Benign Swellings in USG	Oval	2	20
	Lobular	1	12
	Polygonal	0	0
	Irregular	4	52
	Round	1	16
Echo Intensity of Benign Swellings	Anechoic	2	20
	Isoechoic	0	0
	Hypoechoic	3	44
	Hyperechoic	2	24
	Mixed	1	12
USG Architecture of Lesions of Benign Swellings	Homogenous	6	76
	Heterogenous	2	24
Posterior Echoes in Benign Swellings	Enhanced	5	68
	Unchanged	2	16
	Attenuated	1	16
	Unenhanced	0	0
USG characteristic of Tissues in Benign Swellings	Cystic	2	28
	Solid	5	56
	Mixed	1	16

Malignant swellings

Efficacious diagnosis of 6 malignant swellings was one area where all the 3 keys diagnostic methodologies were majorly inconsistent with the final diagnosis which was obtained by incisional treatment of lesion followed by histopathology examination. In malignant swellings, histopathological diagnosis did not match to clinical diagnosis in 3 cases. Carcinoma of right side of maxillary posterior region, carcinoma of mandible and lymphadenitis are clinically diagnosed but histopathological diagnosis is different. By considering the Ultrasonographic features taken into account in the methodology, the findings were analyzed for key USG features. (Table 4).

Table 4: Malignant swelling

Grayscale Sonographic Features	Malignant Swellings	No. of Lesions	Percentage %
Boundary of Malignant swellings in USG	Very clear	1	12
	Relatively clear	1	12
	Partially clear	1	16
	Ill defined	3	60
Shape of Malignant Swellings in USG	Oval	0	0
	Lobular	2	20
	Polygonal	0	0
	Irregular	3	68
	Round	1	12
Echo Intensity of Malignant Swellings	Anechoic	0	0
	Isoechoic	2	24
	Hypoechoic	3	64
	Hyperechoic	0	0
	Mixed	1	12
USG Architecture of Lesions of Malignant Swellings	Homogenous	5	80
	Heterogenous	1	20
Posterior Echoes in Malignant Swellings	Enhanced	2	28
	Unchanged	3	56
	Attenuated	1	16
	Unenhanced	0	0
USG characteristic of Tissues in Malignant Swellings	Cystic	0	0
	Solid	5	72
	Mixed	1	28

Table 5: Sensitivity, accuracy, and specificity of clinical, sonological and histo pathological diagnosis

Nature of neck swelling	Sensitivity			Accuracy			Specificity		
	CLI %	USG %	HP%	CLI %	USG %	HP%	CLI %	USG %	HP%
Inflammatory swelling	82	97	96	80	92	97	82	100	98
Cystic swellings	75	100	100	85	100	99	87	98	100
Benign swelling	82	92	98	82	92	98	90	93	99
Malignant swelling	80	76	98	80	76	95	85	88	95

DISCUSSION

Observation was made by comparing the diagnostic efficacy of Clinical, USG and histopathological for each study group that is the 4 swelling variants of head and neck region; which was as follows:

In the study conducted following observations regarding the diagnostic efficacy of each method and prominent features which led to a definitive diagnosis by ultrasound within the USG parameters were made. Among the 30 subjects of study group the minimum & maximum age were 08 years & 65 years respectively and mean age and standard deviation was 33.13 years & 5.36 years respectively. The clinical examination of all 30 subjects leading to a probable and provisional diagnosis known as clinical diagnosis in this study matched the final diagnosis(achieved after histopathological investigation) in 24 cases. Thus the sensitivity and accuracy of clinical diagnosis is 82%. The Ultrasonographic examination of all 30 subjects gave way to an imaging diagnosis called as USG diagnosis in this study which matched the final diagnosis (achieved after histopathological investigation) in 27 cases. Thus the sensitivity and accuracy of USG diagnosis is 100% and 90% respectively. The specificity was calculated to be 94.8%. The histopathological examination of 30 patients gave way to final diagnosis.

The sensitivity, accuracy and specificity is 98%. It can be observed that most of the inflammatory swellings had relatively clear boundaries, irregular shapes, hypoechoic intensity and homogenous architecture of lesion. The posterior echoes appeared enhanced and ultrasound characteristics of tissues were mostly cystic. The sensitivity and accuracy of USG diagnosis for this group was 92%. In the present study, most of cystic swellings were found to have very clear boundaries, round shapes and anechoic echo intensity. The ultrasound architecture of lesions of cystic swellings was homogeneous, posterior echoes appeared enhanced and ultrasound characteristic of tissues of

cystic swellings were cystic in nature. The sensitivity and accuracy of USG diagnosis for the group of cystic swellings was 100%. On sonographic investigation of the Benign swellings group it was found that most benign neoplasms had very clear boundaries, irregular shapes and hypoechoic echo intensity. The ultrasound architecture of lesions of benign neoplasms was homogeneous, posterior echoes appeared enhanced and ultrasound characteristics of tissues were solid in nature. The sensitivity and accuracy of USG diagnosis for the group of benign neoplasms was 92%. It can be observed that majority of malignant neoplasms had ill-defined boundaries, irregular shapes and hypoechoic echo intensity. The ultrasound architecture of lesions of malignant neoplasm was heterogeneous, posterior echoes appeared unchanged and ultrasound characteristic of tissues of malignant neoplasms were solid in nature. The sensitivity and accuracy of USG diagnosis for the group of malignant neoplasms was 76%. Out of the total 30 cases, there were 5 cases where the USG Diagnosis was inconsistent with the histopathological/final diagnosis. It was observed that out of these 5 cases there were 2 cases where the clinical diagnosis was also incorrect. All 2 were of the malignant neoplasm variant. USG limitations are more marked in areas of benign tumors or pathologies involving bone or hard tissue, this was evident when USG diagnosis was found to be inconsistent with the final diagnosis in cases of odontogenic tumors, and hard tissue malignancies. There were 2 cases under malignant swelling variant where the clinical, USG did not match the final diagnosis made after histopathological study. 1 of them was clinically assessed as Carcinoma mandible and 1 was Mucoepidermoid Carcinoma. Both of them were found to be highly expansile and heterogenous in USG scanning, thus diagnosed to be malignant, and could not be successfully judged in imaging analysis. Hence in some cases it was observed that efficacy of imaging can be limited in some cases due to anatomical considerations, and/or overlapping features of extensive yet benign pathologies.

CONCLUSION

The study results and observations imply towards a conclusion that ultrasonography can be considered the best initial investigation for the evaluation of inflammatory swellings, cystic swellings and benign neoplasms. USG has certain limitations regarding diagnosis of hard tissue pathology. It was observed in the study that USG has a better sensitivity and specificity for the maxillofacial and neck swellings. It can be inferred that as a diagnostic tool in comparison to advanced imaging modality, USG stands as a non-invasive, cost effective readily available and repeatable technique. It is relatively easier to use and does not involve ionizing radiation. Except with a few short comings USG surpasses all the other diagnostic modalities especially in cases of head and neck masses like space infection, cysts, lipomas and soft tissue malignancies. With the help of the present study, salient USG characteristics specific to a particular swelling type were identified. These specific features can be used to differentiate between various types of swellings. The intergroup comparisons undertaken in the present study were helpful in identifying USG features which can be used to compare different swelling types and help in presice diagnosis.

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