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Research Article

COMPARATIVE EVALUATION OF ULTRASONOGRAPHY IN HEAD AND NECK SWELLINGS

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Taking into consideration the various advantages of ultrasonography and its ability to evaluate the extent of information available in various types of head and neck swellings, the present study was undertaken. The study was aimed at deriving various sonographic features depicted in imaging swellings of the head and neck.

INTRODUCTION

Sound was first applied to the human body through auscultation in 1761 and the stethoscope in 1819, and interpreting these sounds required imagination, as did interpreting the early sonographic images.[1] Sonography means *imaging with ultrasound*. The word sonography comes from the Latin sonus means sound and the Greek graphein to write.[2]

Swellings of the head and neck may be attributed to various reasons that include odontogenic, non-odontogenic, inflammatory lesions, cystic, vascular malformations, benign and malignant tumours. The evaluation of head and neck lumps can often present a major problem, thereby posing a challenge to the clinician in arriving at a diagnosis.

Ultrasonography is yet another diagnostic tool of greater flexibility[3]. It is comparatively of low cost, and other advantages such as real-time imaging and the use of nonionizing radiation with no known bio-effects make it a first-choice of diagnostic procedure.[4]

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It is a safe reliable method of examination that causes little patient discomfort.[5-6] It not only serves for the differentiation between benign and malignant lymphadenopathy and between intra-glandular and extra-glandular abnormalities of the salivary glands, with 90 to 95 % accuracy, but also for the assessment of the thyroid and atherosclerotic lesions of the extra-cranial vessels.[7] Ultrasound can also be used for the remaining cervical structures, particularly space occupying lesions.[8-9] It is a well-established method in lesions of salivary gland,[10] and it is useful in differentiation of cystic or fluid containing lesions from solid masses[11]. Since it also provides information on the site, nature and extent of pathology, it can be used in the guidance of Fine Needle Aspiration core biopsy and abscess drainage and also act as a guide to the need for further imaging, usually with CT or MRI.[12]

Taking into consideration the various advantages of ultrasonography and its ability to evaluate the extent of information available in various types of head and neck swellings, the present study was undertaken. The study was aimed at deriving various sonographic features depicted in imaging swellings of the head and neck.

METHODOLOGY

Sixty cases with obvious head and neck swellings were randomly selected for the study. The patients detailed case history was taken and clinical examination was done under artificial illumination as described by Kerr, Ash and Millard. The data obtained were recorded in the proforma (Annexure) and a provisional diagnosis was arrived. Based on the clinical diagnosis, swellings were divided into 5 groups as Inflammatory swellings, Cystics wellings, Musculars wellings, Lymph nodes and Neo plastics wellings that included both benign and malignant lesions. All the procedures were carried out after obtaining informed and written consent form from the patients. Relevant non-invasive investigations like CT, MRI were performed wherever indicated; F N A C when required was carried out following Ultrasonography or under its guidance.

Ultrasonographic Examination

Ultrasonographic investigation was carried out using a GEWipro400 Prologic Series with a Superficial Transducer Probe at a frequency range of 7.5 to11MHz.The couplinggel was applied over the area of interest to eliminatethinlayero fair that would reflect the sound, preventing its entrance into the body. The transducer was then moved in transverse or longitudinal direction whichever was more characteristic and informative.

Five features were considered in describing the Ultrasonographic images of swellings of head and neck in accordance with **Mayumi Shimizu *et al* (1999)[8].**

- ***Shape:*** Oval, lobular, polygonal and irregular.
- ***Boundary:*** Very clear, relatively clear, partially unclear and ill defined.
- ***Echo Intensity:*** Anechoic, slightly hypoechoic, hypoechoic, and hyperechoic.
- ***Distribution of internal echoes:*** Homogenous, multiple anechoic, heterotrophic with characteristic, heterotrophicwithout characteristic, and
- **Posterior echoes:** Enhanced, unchanged and attenuated[10]

Images obtained were interpreted by experienced and qualified sonologists by comparing with the images of neighboring structures and ultrasonographic diagnosis was made.

Following clinical and ultrasonographic diagnosis and appropriate further investigations, surgical intervention was carried out by incision anddrainage or excision as indicated. The obtained biopsy specimens were submitted for histopathological examination and diagnosis.

Statistical Analysis

The obtained results were tabulated and statistically analysed by considering the final diagnosis as gold standard. Sensitivity, Specificity, Positive predictive value and Negative predictive value were calculated to evaluate reliability and diagnostic efficacy of ultrasonography as aninvestigating tool.

	Disease	No Disease
POSITIVE	A True Positive	C False Positive
NEGATIVE	B True Negative	D False Negative

Sensitivity: It is defined as percentage of persons with the disease of interest who have positive test results. greater the value more likely the test will detect persons with the disease of interest, The sensitivity was calculated using the formula:

$$\text{Sensitivity} = \frac{A}{A+C} \times 100$$

Specificity*:* It is defined as percentage of persons without the disease of interest who have negative test results; the specificity was calculated using the formula:

$$\text{Specificity} = \frac{D}{B+D} \times 100$$

Positive predictive value: It is defined as percentage of persons with positive test results who actually have the disease.

$$\text{Positive predictive value} = \frac{A}{B+A} \times 100$$

Negative predictive value: It is defined as percentage of persons with negative test results who do not have the disease.

$$\text{Negative predictive value} = \frac{D}{C+D} \times 100$$

RESULTS

The sensitivity and specificity of ultrasonography in inflammatory swellings was 96.5%.Forcystic swellings,swellings of muscularorigin, lymphnode swellings and malignant neoplasms it was 100%, and for benign neoplasms, it was 92.86%.

In our study inflammatory swellings appeared as follows

- Abscess appeared as an ill-defined hypoechoic mass with heterotrophic without characteristic i.e. with very few internal echoes
- Obstructive siala denitis appeared as duct dilation proximal to an obstructing calculus.
- Calculi classically appeared as hyperechoic foci with distal acoustic shadowing whereas fibrotic obstruction typically appearedas hyperechoic foci without posterior shadowing
- Parotitis appeared as enlarged hypoechoic gland with coarsening of gland texture Cystic swellings appeared as anechoic homogeneous well-defined mass with posterior acoustic enhancement.
- Swellings of muscle origin appeared as homogeneous structure lying adjacent to the echogenic band of the mandible with increase in its width.
- Lymph node swellings in which Reactive lymph nodes tend to be oval or elongated in shaped, with anS/Lratiooflessthan0.5,with the preservation of the oval shape, neoplastic node were without definite internal or hilarechoes, but measuring 10mm.

Benign neoplasms had the following features[13-15]

- Pleomorphic adenoma sonsonogram appeared as rounded, circumscribed and hypoechoic, with distal acoustic enhancement.

- Lipomas sonographically appeared as oval or elliptical masses with regular margins and a typical striped or feathered internal echotexture.
- Haemangioma appearedas multiple hypoechoic areas.
- Malignant lesions appeared as Polygonal Heterotrophic ill-defined lesions.

The study concluded that Ultrasonography is a valuable and accurate diagnostic tool in diagnosis of head and necks swellings, with minimal or no patient discomfort, though ultrasonographic images were consistent and are reliable they should be use donly as an added informative investigation tool in diagnosing benign neoplasms, malignant neoplasms and swelling so flymphnode origin. The images that were acquired by using 7.5-11MHz transducer in this study revealed quality images and may be recommended for use in centers. (fig1 & fig 2)

Figure 1 GE Wipro 400 Prologic series ultra sonogram used at frequency at range of 7-11 MHz

Figure 2 SuperficialTransducer

Ultrasonography is known to provide valuable information concerning the size, nature, and location of head and neck lumps.[5]It is capable of differentiating not only the cystic from solid lesions but also could be helpful in the diagnosis of malignant versus benign masses.[7].

Out of total 60 patients with head and neck swellings:

- 11 were inflammatory swellings (18.3%)
- 10 were benign neoplasms (16.66%)
- 15 were cystic swellings (25%).
- 8 were lymph node swellings (13.33%).
- 6 swellings were of muscle origin (10%)
- 8 were malignant neoplasms (16.66%). (Graph 1)

Following the clinical diagnosis, all patients were subjected for Ultrasonographic examination for sonomorphologic appearance of various swellings of head and neck with respect to Shape, Boundary, EchoIntensity, Distribution of internalechoes and Posterior echoes (ShimizuM. *et al*) and the final diagnosis following histopathological examination was compared with clinical and sonographic diagnosis.

Inflammatory swellings

Among11inflammatory swellings 7 (63.63%) was from Odontogenic origin and 4 was from non-Odontogenic origin 36.36 % (7 out of 11). Sigert Rinhis study of inflammatory soft issue swellings, classified the sonographic images into five types[16]

- ***Edema:*** Slight echo reduction and enlargement of the visible anatomical structures.
- ***Infiltrate:*** Diffused area of increased echo reduction so that it becomes difficult to delineate anatomical structures.
- ***Preabscess:*** Infiltrate in which there was slight, not well defined echo reduction.
- ***Abscess:*** Slightly delineated areas with posterior enhancement with echo free internal structure.

In our study, inflammatory swellings appeared irregular by shape (54.54%)with ill- defined borders (45.45%) and the echoes intensity were slightly hypoechoic (36.36%) to hypoechoic(36.36%), internal echoes was heterotrophic without characteristic (63.6%) and Posterior echoes were unchanged in (63.63%)

In seven out of eight clinically diagnosed cases of cellulitis, seven patient sultra sonographically showed are as of hypoechoic internal echoes with ill-defined borders suggestive of abscess and were found to have pus on surgical exploration. One patient who was diagnosed as cell ulitisclinically which on ultra sonogram showed as ill-defined homogenous hypoechoicmass with difficulty in delineating anatomical structures and was histopathological diagnosed as extra nodal lymphoma.

In the present study, 14 cases of abscess sonographically appeared as ill-defined hypoechoicmass with heterotrophic without characteristic cappearancei.e. with very few internal echoes which is in accordance with the description given by SiegertR (1987),[16] Benjamin T(2005)[17] but only 4.6%lesions showed posterior enhancement. Hence, the sensitivity and specificity of clinical diagnosis was 47.62% and 100%respectively where as the sonographic diagnosis had 96.5 % sensitivity and specificity indiagnosing inflammatory swellings of head and neck. This is in concurrence with the previous studies done by Siegert R (1987)[16], Yusa *et al*. (2002)[18], Benjamin T (2005)[17], Vivek(2006)[19]

In the present study of the non-odontogenicin flammatory swellings, 4 were obstructive submandibular sialadenitis and 3 cases were Parotitis on clinical diagnosis.

None of the 4 cases of submandibular sialadenitis revealed calculi on conventional radiographs. On ultrasonogram they typically appeared, as ductdilation proximal to anobstruction.2cases of calculi obstruction appeared as hyperechoic foci with distalacoustic shadowing where as 2 cases of fibrotic obstruction appeared as

hyperechoicfoci without posterior shadowing. These findings were consistent with previous studies by Partridge. M *et al*. (1986)[20]. Alyas *et al*.(2005) [12] concluded that reticulated pattern with multiple, rounded, hypoechoicfoci seen within the gland parenchyma. These hypoechoic areas represent areas of non-obstructive sialectasis

In our study, out of three cases two cases had coarsening of glandular parenchyma with multiple anechoic areas as seen in chronic parotitis described by Alyas *et al*. (2005)[12], Traxler M. *et al* (1992)[21] and Howlett D C (2003)[22]One case showed enlargement of gland with coarsening of glandular texture which was seen in the initial stages of Parotitisas described byHowlett D C (2003)[22], Alyas *et al*. (2005)[12].

On comparison, though clinical diagnosis was not conducive with final diagnosis in eight patients, the sonographic diagnosis of all the cases matched with the final diagnosis. Hence, both sensitivity and specificity of sonographic diagnosis in our study was 100%. In our study of sonographic diagnosis, which is not in accordance with the previous studies by Alyas *et al* (2005).[12] Traxler M. *et al* (1992).[21] Howlett D C (2003)[22]. Thisvariation is probably because of the less sample size in our study.

Cystic swellings

In the present study 15 cystic swellings (25%) were visualized, Cyst on sonogram appeared as a nechoic which are due to, liquids are homogeneous and there are no structures to produce internal echoes, there is little or no attenuation of sound as it passes through, which creates enhanced transmission of sound at the distal aspect of cystic mass. If the cyst becomes infected then the content of the lesion can produce some echoes producing hypoechoic picture as described by Ishikwa H.*et al* (1983)[23]

In our study all the patient shad posterior enhancement (100%) and 12 cases were totally anechoic (80%) and the internal echoes were homogenous. These findings were consistent with the studies by Ishikwa H.*et al* (1983)[23], PogrelM.A.(1982)[3]

However, 3 cases 15.8% had hypoechoic internal echoes which could be because of infection which has produced some internal echoes.

Inourstudy, 3branchialcleftcy stand onese baceous cyst were studied. Branchial cyst classically appeared as anechoic homogeneous well-defined mass with posterior acoustic enhancement. The sebaceous cyst appeared as superficial well-defined hypoechoicmass with posterior acoustic enhancement. Comparing the clinical diagnosis with final diagnosis one patients clinical diagnosis did not correspond with the final diagnosis and on comparison of final diagnosiswithsonographicdiagnosisallthesonographicdiagnosis didcorrespond with the final diagnosis.

In present study, since the sonographic diagnosis in all the cases did correspond with the final diagnosis. The sensitivity and specificity of sonography in diagnosing cysts of head and neck was 100%. These results are concurrent with the studies done by Ishikwa H. *et al* (1983)[23], Pogrel M.A. (1982),[3]and Osama, and Corney (1993).[31]

Swellings of muscle origin

Six cases (10%) of Massetric hypertrophy were included in our study. Masseter on sonogram appeared as homogeneous structurelying adjacent to the echogenicb and of the mandible and the muscle width was measured both in relaxed and contracted state by asking the patient to clench his teeth and normal range for transverse dimension is 8.5– 13.5mm. Emsh of R *et al*. (2003)[24], Morse *et al*.(1989)[25] In our study, all the volunteer shad relatively clear borders(100%),and they appeared as homogenous with hypoechoicb and(100%)with the transverse measurement of 15 mm-21 mm(Table 9)m The sonographic and clinical diagnoses ofall cases are in conformity with the final diagnosis so the sensitivity andspecificity of sonographic and clinical diagnosis was 100% in our study. Our results could not be compared aswe failed to find studies on sonographic features of Massetric hypertrophy in the literature. But the muscle measurement was significantly greater than the normal range (8.5-13.5mm) as described by Morse *et al* (1989)[25]

Swellings of lymph nodeorigin

Swellings of lymph nodeorigin comprised of 8cases (13.33%) Reactive lymph nodes tend to be oval or elongated in shaped, appear hypoechoic with or without the presence of echogenic hilus. The L /S ratio will be less than 0.5, TakashimaS *et al*. (1997)[28], Quetz JU, *et al*. (1991)[26], AtulaT S. *et al*.(1996)[27]. Neoplastic node will have indefinite internal or hilarechoes, measures 10 mmor more in the short axis, and a ratio of the longto short axis (L/S ratio) of 0.5 or more. Yuasa K *et al*. (2000)[29] On sonogram, 50% had relatively clear border, 25% ill defined and partially unclear was seen in 25%. 37.5% had oval shape and 25% had ill-defined shape25% were hypoechoic. 62.5% was homogenous .Six patients had neoplastic enlargement of lymph nodes most of which had heterogenous internal structure with lossof hilum and their shape was more than10 mm. these findings are similar to that of SumiMisaetal.(2001),YuasaK *et al*.(2000), Takashima S. *et al*. (1997), Quetz JU *et al*.(1991).Comparing the clinical diagnosis with final diagnosis one patients clinical diagnosis did not match with the final diagnosis and on comparison off in al diagnosis with sonographic diagnosis all the sonographic diagnosis was in agreement with the final diagnosis

The sensitivity73%and specificity78% of sonographic diagnosis of lymphnodes in differentiating benign and malignant enlargements but the accuracy increased on combining sonography with FNAC to sensitivity of 85%and specificity of 100% SumiMisa. *et al*. (2001)[30]

In our study, the sensitivity and specificity of sonographic diagnosis was 100%. which could be attributed to bias in the sample selection, as we included only patients with the swelling or fullness in that region, which on sonogram was morethan 10 mm, which were considered as malignant according tothe previous studies by SumiMisa *et al*. (2001)[30], Yuasa K *et al*. (2000), Takashima S *et al*. (1997), Quetz JU *et al*. (1991) and Atula T S *et al*. (1996).

Benign neoplasms

Ten (16.66%) were benign neoplasms which included Pleomorphic adenomas (5), lipomas (2) Neuroma (2), Haemangioma (1) and one extra nodal lymphoma Pleomorphic adenomas on sonogram appeared as being rounded, circumscribed and hypoechoic, with distal acoustic enhancement. Larger lesions may develop more atypical features, with a heterogeneous internal architecture, cystic changes, loss of clarity of margins and may mimic malignancy.

Longstanding tumoursmay calcify and are at risk of malignant degeneration.[12,24-26,31,44]

In the present study, 3 Pleomorphicadenomas (72%) had clear borders their shape was lobular in 2(45%) and polygonal in 3(54%). 4 (90%) patient shad Heterotrophic characteristic without and few of them had calcifications (Table 11)

Of the 5 Pleomorphic adenomas, only 3 clinically diagnosed cases were corresponding with final diagnosis, where as so no graphically three cases did not correlate with the final diagnosis. This could be because of the ultrasonographic features, which depends on the grade of tumour. Low-grade, small lesions can appear well defined and appearance, including irregular and poorly defined margins and heterogeneous internal architecture.[12] Similar to Pleomorphic adenoma. Larger lesions develop as more overtly malignant Lipomassonographically appeared as oval or elliptical masses with regular margins and a typical striped or feathered internal echotexture HowlettDC(2003),Alyasetal.(2005), TraxlerM *et al*.(1992)[31]**.** Similar findings were observed in all the four cases of our study.

Haemangioma appeared as multiple hypoechoicareas with some amount of vascularity on Doppler study**,** in our study of one case haemangioma showed similar findings as described by the Howlett D C (2003)and Alyas *et al*.(2005).[12]

Malignantneoplasms

Out of 60 cases with head and neck swellings,8 were malignantneoplasms (16.66%).All the cases reported with rapidly growing swelling, which were diagnosed clinically as malignant lesions. The ultrasound features may depend on the grade of tumour. Low-grademalignantneoplasms were similar to Pleomorphicadenoma. Largerlesions develop more overtly malignant features, including irregular and poorly defined margins, heterogeneous internal architecture. Howlett D C (2003) and Alyas *et al*. (2005)

In our study all the case shad relatively clearborder 70%, Polygonal 70% Hypo echoic 50% and Heterotrophic without characteristics in 50% these findings were consistent with the Alyas *et al*, Howlett *et al*.

The sensitivity and specificity of sonographic and clinical diagnosis was100% Extensive studies invarious literature in evaluating soft tissue and central lesions causing head and neck swellings have been done by several researchers, The present study depended on the methodology used by these researchers and evaluated the use of sonogramin diagnosing various groups of lesions individually.

Although ultrasonographic pictures of various lesions were consistent and did correspond withgreat degree of accuracy in all the groups of the lesions, it should only be used as an additional diagnostic tool rather than as the only investigative method in arriving at final diagnosis.

CONCLUSION

1. Patient discomfort is minimal or none in Ultrasonographic examination of head and neck swellings.
2. Ultrasonography is a valuable and accurate diagnostic tool in diagnosis of head and neck swellings.
3. Ultrasonographic pictures do vary in different groups of head and neck swellings, but a consistent echo pattern can be derived as a criteria in describing the particular group of lesions.
4. The sensitivity and specificity of ultrasonography in inflammatory swellings was 96.5 %. For cystic swellings, swellings of muscular origin, lymph node swellings and malignant neoplasms it was 100%. and for benign neoplasms it was 92.86%
5. The reliability and accuracy of ultrasonographic diagnosis increases when combined with guided FNAC.
6. Even though Ultrasonographic pictures were consistent and are reliable they should be used only as an added informative investigation tool in diagnosing benign neoplasms, malignant neoplasms and swellings of lymph node origin.
7. Since the literature review did not support the usefulness of ultrasonography in evaluating the bony lesions we did not use this modality for the same.
8. The images that were acquired by using 7.5-11 MHz transducer in this study did reveal quality images and may be recommended for use in centers.

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