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# An evaluation of the efficacy of ultrasound in the diagnosis of neck swellings

**Akriti Rastogi[1]*, Karan Sharma[1], Neelam Gauba[2]**

[1]Department of ENT, [2]Department of Radiodiagnosis, Govt. Medical College, Amritsar, India

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***Correspondence:**
Dr. Akriti Rastogi,
E-mail: akritirastogi@live.com



## ABSTRACT

**Background:** Neck swellings are a common cause of dilemma to clinicians. Accurate diagnosis of neck swellings is of paramount importance. This study evaluated patients with neck swellings to study their ultrasonographic features and correlated the ultrasound findings with the final diagnosis.
**Methods:** 100 patients with neck swellings were evaluated clinically and divided into four groups– congenital, inflammatory, benign and malignant. Thereafter, they underwent high-resolution Ultrasound (US) and the ultrasonographic features of each type of swelling were studied. A final diagnosis was established after further evaluation using FNAC, further imaging, surgical intervention in the form of incision and drainage or excision/incisional biopsy with histopathological examination or successful non-surgical treatment. Ultrasound findings were compared with final diagnosis.
**Results:** For swellings of inflammatory nature, this study showed the sensitivity, specificity, PPV and NPV of US to be 87.2%, 96.6%, 94.4%, 91.9% respectively. For benign swellings, sensitivity, specificity, PPV and NPV was 97.5%, 91.3%, 88.6% and 98.1% respectively. Sensitivity of US in diagnosing malignant lesions of the neck was 87.5% with a specificity of 98.7%, PPV 93.3% and NPV 97.5%. Sensitivity of US in detecting thyroid malignancy in the present study was 83.3% and in diagnosing malignant lymph nodes was 87.5%.
**Conclusions:** Ultrasound is the ideal modality for initial imaging for neck swellings. Later on, as per the need and Ultrasound findings, one can go in for further haematological investigations, Fine Needle Aspiration Cytology and Radiological investigations.

**Keywords:** Neck swelling, Congenital, Inflammatory, Benign, Malignant, Ultrasound

## INTRODUCTION

Neck masses are a common cause of dilemma to clinicians.[1] The differential diagnosis of swelling in the neck is broad and extensive and includes both malignant and benign aetiologies.[2]

Majority of the diseases which become manifest as a neck swelling, arise from two sources- pathologic changes in the thyroid gland and metastatic cervical lymphadenopathy.[3] Thyroid swellings constitute the most frequent single source of a mass in the neck and carcinoma that has metastasized to the cervical lymph nodes comprises the second most prevalent source of a presenting mass in the neck.[3]

The evaluation and management of patients who present with a neck swelling should have a systematic clinical approach.[1] This must include a thorough history and examination of the head and neck, followed by relevant investigations, which may include bloods tests and radiological imaging.[1]

Ultrasound (US) with or without fine needle aspiration cytology (FNAC) will make the diagnosis in majority of the cases.[4] Distinguishing normal structures from lymphadenopathy and non-nodal pathologies is an important step in differential diagnosis.[4] Additional cross-sectional imaging may be required to characterise deep-seated disease, markedly inflammatory or infiltrative processes, and stage malignancy[4]. High-resolution US is now the imaging modality of choice for the assessment of a vast majority of palpable swellings in the head and neck.[4] It is frequently the only imaging technique required for diagnosis since it can be performed rapidly, safely and permits accurate tissue sampling.[4]

In this study, we have examined patients with neck swellings, followed by high-resolution ultrasound and further evaluation using FNAC, further imaging, biopsy and histopathological examination (HPE) or incision and drainage or non-surgical management to establish a final diagnosis. The ultrasound findings were then correlated to the final diagnosis.

## METHODS

The present study was carried out in the Out-Patient Department, Department of ENT, Government Medical College, Amritsar and the Department of Radiodiagnosis, Guru Nanak Dev Hospital, Amritsar from January 2015 to October 2016.

### *Inclusion criteria*

For this study, 100 cases with clinically obvious swellings in the neck region were selected randomly.

### *Exclusion criteria*

1. Swellings caused by trauma or fracture were not included because clinical diagnosis of haematoma would not be a problem as there would be history of trauma and changes in skin colour and mucous membrane.
2. Swellings obscured by jaw bone were not included.

Patients with swellings in the neck region were included in the study. A prior informed consent from all patients was obtained. A detailed case history of all patients was recorded and clinical examination was carried out. General physical examination was done and local examination was done based on the criteria given in "A manual on clinical surgery" by Dr. S. Das. In case of multiple swellings, the largest swelling was considered for the study. In inspection- situation, colour, shape, size, border, surface and overlying skin over the swelling were noted. In palpation- consistency, tenderness, temperature, fluctuation, compressibility and fixity of skin over the swelling was recorded.

The data obtained was recorded in the structured proforma for recording clinical findings and a provisional diagnosis was made. Based on clinical diagnosis, swellings were divided into four groups:

1. Congenital swellings
2. Inflammatory swelling
3. Benign neoplasms
4. Malignant neoplasms

After provisional diagnosis, patients underwent preliminary investigations which consisted of haemoglobin, total leucocyte count, differential leucocyte count and erythrocyte sedimentation rate. Patients with thyroid swellings also underwent thyroid function tests (Serum T3, T4 and TSH). Ultrasound of neck was done in supine position with neck hyperextended using 7-12 Hz linear probe. The following features were considered in describing the US images of swelling in the head and neck in accordance with Shimizu et al.

- *Shape:* oval, lobular, round, polygonal, irregular;
- *Boundary:* very clear, relatively clear, partially unclear, ill defined;
- *Echo intensity:* anechoic, isoechoic, hypoechoic, hyperechoic, mixed;
- *Ultrasound architecture of lesion:* homogeneous, heterogeneous;
- *Presence of necrosis:* eccentric, central;
- *Presence of calcification:* macrocalcification, microcalcification;
- *Posterior echoes:* enhanced, unchanged, attenuated; and
- *Ultrasound characteristic of tissues:* cystic, solid, mixed.

Following clinical and ultrasound examination, an ultrasonographic diagnosis was made and patients were classified into 4 groups as mentioned above.

Finally, the patient was subjected to either FNAC or further imaging or surgical intervention was carried out by incision and drainage or excision/incisional biopsy with histopathological examination. A final diagnosis was made. In cases of inflammatory swellings, a blood picture was carried out and final diagnosis was established based on the response of either surgical intervention, i.e. incision and drainage, or successful non-surgical treatment.

The obtained results were tabulated and statistically analysed. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of ultrasound diagnosis of each group of neck swellings were calculated. As there were only 3 congenital swellings, the sensitivity analysis for such a small number is not valid.

## RESULTS

Patients of all age groups were included in our study; with a minimum age of 15 days and maximum age of 85

years and the mean age was 36 years (Table 1). 29 (29%) patients in our study were males and 71 (71%) were females (Table 2).

**Table 1: Age distribution.**

| Age group (in years) | No. | % age |
|---|---|---|
| **0-10** | 7 | 7.0 |
| **11-20** | 9 | 9.0 |
| **21-30** | 27 | 27.0 |
| **31-40** | 22 | 22.0 |
| **41-50** | 21 | 21.0 |
| **51-60** | 7 | 7.0 |
| **61-70** | 2 | 2.0 |
| **>70** | 5 | 5.0 |
| **Total** | 100 | 100.0 |

**Table 2: Sex distribution.**

| Sex | No. | % age |
|---|---|---|
| **Male** | 29 | 29.0 |
| **Female** | 71 | 71.0 |
| **Total** | 100 | 100.0 |

After thorough clinical examination and preliminary investigations including blood picture and thyroid function tests, the swellings were divided into four groups– 1 congenital, 25 inflammatory, 67 benign and 7 malignant.

On US, 3 swellings were found to be congenital, 36 inflammatory, 44 were benign neoplasms and 15 were malignant in nature. 2 swellings which were diagnosed clinically as benign thyroid swellings were found to be normal variants with asymmetrical thyroid lobes on US. On final diagnosis, there were 3 congenital swellings, 39 inflammatory, 40 benign and 16 malignant neck swellings. Table 3 compares Ultrasound diagnosis to Final diagnosis.

**Table 3: Ultrasound diagnosis as compared to final diagnosis.**

| Type of swellings | US diagnosis | | Final diagnosis | |
|---|---|---|---|---|
| | No. | % | No. | % |
| **Congenital** | 3 | 3.0 | 3 | 3.0 |
| **Inflammatory** | 36 | 36.0 | 39 | 39.0 |
| **Benign** | 44 | 44.0 | 40 | 40.0 |
| **Malignant** | 15 | 15.0 | 16 | 16.0 |
| **No abnormality** | 2 | 2.0 | 2 | 2.0 |
| **Total** | 100 | 100.0 | 100 | 100.0 |

The study revealed that about two-third (66) of neck swellings were solid, 10 were cystic and 22 swellings had both solid and cystic components (Figure 1). Out of the solid swellings, majority i.e. 42 were thyroid swellings, 16 were lymph nodes and the remaining included lipoma, benign epithelial lesion and salivary gland lesions (submandibular sialadenitis and parotid tumours). Among cystic lesions, 4 were of thyroid origin, 1 was benign epidermal cyst, 1 was cervical ranula and the remaining were abscesses. In our study, 79% of clinically firm swellings were found to be actually solid, while the remaining were either purely cystic or mixed character.

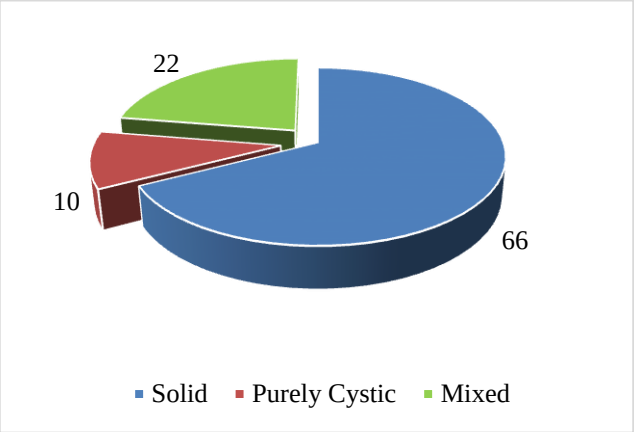


**Figure 1: Ultrasound character of neck swellings.**

For swellings of Inflammatory nature, this study shows the Sensitivity, Specificity, PPV and NPV of US to be 87.2%, 96.6%, 94.4%, 91.9% respectively. US correctly diagnosed all 7 paediatric abscesses and acute inflammatory neck swellings. Table 4 compares the sensitivity analysis of Clinical diagnosis and Ultrasound diagnosis for inflammatory swellings.

**Table 4: Sensitivity analysis of inflammatory neck swellings.**

| Sensitivity analysis | Clinical diagnosis (%) | US diagnosis (%) |
|---|---|---|
| **Sensitivity** | 56.4 | 87.2 |
| **Specificity** | 95.1 | 96.6 |
| **PPV** | 88 | 94.4 |
| **NPV** | 77.3 | 91.9 |

Our study showed a total of 40 benign lesions in the neck and US correctly diagnosed 39 of them. The Sensitivity, Specificity, PPV and NPV of US in this case was 97.5%, 91.3%, 88.6% and 98.1% respectively. Table 5 compares the sensitivity analysis of Clinical diagnosis and Ultrasound diagnosis for benign swellings.

**Table 5: Sensitivity analysis of benign neck swellings.**

| Sensitivity analysis | Clinical diagnosis (%) | US diagnosis (%) |
|---|---|---|
| **Sensitivity** | 94.6 | 97.5 |
| **Specificity** | 50.8 | 91.3 |
| **PPV** | 53.3 | 88.6 |
| **NPV** | 94.1 | 98.1 |

In this study the sensitivity of US in diagnosing malignant lesions of the neck in 100 patients with neck swellings was 87.5% with a specificity of 98.7%, PPV 93.3% and NPV 97.5%. Sensitivity of US in detecting thyroid malignancy in the present study was 83.3%. The sensitivity of US in diagnosing malignant lymph nodes in this study was 87.5%. Table 6 and Figure 2 compare the sensitivity analysis of clinical diagnosis and ultrasound diagnosis for malignant swellings.

**Table 6: Sensitivity analysis of malignant neck swellings.**

| Sensitivity analysis | Clinical diagnosis (%) | US diagnosis (%) |
|---|---|---|
| **Sensitivity** | 43.8 | 87.5 |
| **Specificity** | 100 | 98.7 |
| **PPV** | 100 | 93.3 |
| **NPV** | 90.3 | 97.5 |

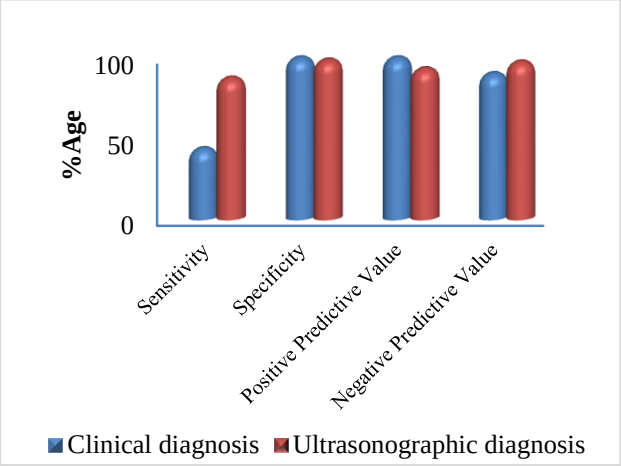


**Figure 2: Sensitivity analysis of malignant neck swellings.**

## DISCUSSION

The clinician must be able to determine the aetiology of a neck mass using organized, efficient diagnostic methods.[5] The primary concern in adults with a persistent neck mass is malignancy hence the first goal is to determine whether the mass is malignant or benign.[5] Malignancies are more common in adult smokers older than 40 years.[5] If the history and physical examination do not find an obvious cause, imaging and surgical tools are helpful.[5] US with or without FNAC will make the diagnosis in majority of the cases.[4]

100 patients of all age groups were included in our study; with a minimum age of 15 days and maximum age of 85 years. The mean age was 36 years. 29% patients in our study were males and 71% were females. After thorough clinical examination and preliminary investigations including blood picture (Haemoglobin, TLC, DLC) and thyroid function tests (T3, T4 and TSH), the swellings were divided into four groups– 1 congenital, 25 inflammatory, 67 benign and 7 malignant.

On US, 3 swellings were found to be congenital, 36 inflammatory, 44 were benign neoplasms and 15 were malignant in nature. 2 swellings which were diagnosed clinically as benign thyroid swellings were found to be normal variants with asymmetrical thyroid lobes on US.

9 out of 13 paediatric patients had inflammatory masses while 2 had congenital masses and 2 were benign neoplasms. In this study, inflammatory lesions were the commonest followed by congenital lesions among paediatric neck masses. This correlates well with previous such studies.[6,7]

When compared to the final diagnosis, all 3 congenital lesions were correctly diagnosed by US. 2 were thyroglossal cysts and 1 was a well-defined congenital cystic lesion on US thought to be a cystic hygroma clinically but was eventually found to be a Killian-Jamieson lesion. In our study both the thyroglossal cysts were homogenous and anechoic with one of them showing posterior echoes.

Nowadays, with the advent of antibiotics, the incidence of neck abscess has decreased.[8] On US, an abscess appears as ill-defined, irregular fluid collection with thick walls and internal debris.[8] The adjacent soft tissue and subcutaneous layer may appear oedematous.[8] In this study, the US picture in cellulitis showed ill-defined hyperechoic heterogenous mass while neck abscesses showed smooth well defined hypoechoic lesions with posterior echoes similar to a study done by Mukhi and Mahindra.[9] Out of 7 acute inflammatory swellings, clinically 4 swellings presented as abscess out of which 2 were found to be abscesses on US and were subsequently drained while the other 2 were proven to be cellulitis on US. 1 swelling which presented as cellulitis was actually diagnosed as an abscess on US. Thus, US could confirm the presence of abscess formation and helped in detecting the stage of infection surpassing clinical examination in differentiating cellulitis from abscess. This avoids unnecessary drainage of cellulitis which can be treated conservatively by antibiotics.[9-11]

Out of 40 benign neoplasms, 35 were benign thyroid nodules, 2 were benign epidermal cysts, 1 was a benign cystic lesion, 1 was a benign epithelial lesion and 1 was a lipoma. In our study, most benign neoplasms had very clear boundaries, hypoechoic echo intensity and solid nature which correlates well with the study by Chandak et al.[2] However, our study showed most benign lesions to be heterogenous while the same study stated above showed the US architecture of majority of the benign neoplasms was homogeneous.[2] 15 of the benign neoplasms showed calcification and 4 showed posterior echoes.

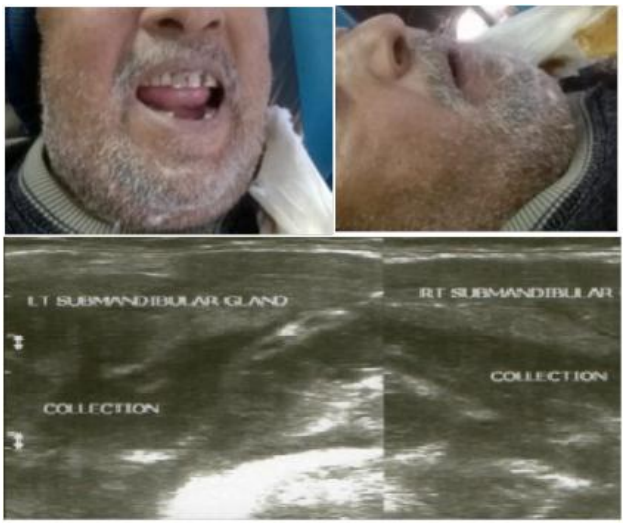


**Figure 3: Ludwig's angina.**

A 55-year old male presented with bilateral submandibular and submental region swelling, pain and fever. The patient had preceding history of toothache and was a known diabetic. Ultrasound showed ill-defined collection around both submandibular salivary glands with internal echoes suggestive of pus. Bilateral Submandibular salivary glands were enlarged with bilateral superficial cervical lymphadenopathy. When correlated clinically, US was suggestive of Ludwig's angina.

16 swellings were finally diagnosed as malignant. 6 were thyroid malignancies, 7 were metastatic lymph nodes, 1 was Hodgkin's lymphoma and 2 were malignant tumours of parotid. For patients with suspected head and neck cancer, one must evaluate the entire neck including nodal drainage sites, assessment of lymph nodes to identify often subtle features indicative of abnormality, appreciation of typical features of common non-nodal pathologies, and recognition of normal structures which may mimic neck lumps.[4]

Metastatic lymph nodes in our study were round in shape with hypoechoic echo intensity as also suggested by Khanna et al.[12] Most tuberculous lymph nodes were hypoechoic and heterogenous with presence of necrosis on US in agreement with study of 79 patients in Korea.[13] The main distinguishing feature of lymph nodes in a case of lymphoma in our study was homogeneous pattern as reported in previous studies.[12]

In this study majority of the malignant neoplasms of the thyroid were hypoechoic which correlates well with other studies.[14,15] Surgery is the mainstay of treatment for malignant thyroid disease hence establishing the benign or malignant nature of thyroid disease preoperatively improves the surgical outcome. In addition, high-resolution sonography also provides guidance for FNA/biopsy and guidance for percutaneous treatment of non-functional or hyperfunctioning benign thyroid nodules and lymph node metastases from papillary carcinoma.[16] Table 7 shows ultrasonographic features of malignant neck swellings.

**Table 7: Ultrasound features of malignant neck swellings.**

| US features | No. | % age |
|---|---|---|
| **Shape:** | | |
| • Round | 5 | 33.3 |
| • Oval | 5 | 33.3 |
| • Lobulated | 0 | 0.0 |
| • Irregular | 5 | 33.3 |
| **Boundary:** | | |
| • Smooth | 8 | 53.3 |
| • Irregular | 3 | 20.0 |
| • Ill defined | 4 | 26.7 |
| **Echo-intensity** | | |
| • Hypoechoic | 12 | 80.0 |
| • Isoechoic | 1 | 6.7 |
| • Hyperechoic | 0 | 0.0 |
| • Mixed | 2 | 13.3 |
| • Anechoic | 0 | 0.0 |
| **Architecture** | | |
| • Homogenous | 3 | 20.0 |
| • Heterogenous | 12 | 80.0 |
| **Necrosis** | | |
| • Present | 5 | 33.3 |
| • Absent | 10 | 66.7 |
| **Calcification** | | |
| • Present | 5 | 33.3 |
| • Absent | 10 | 66.7 |
| **Posterior echoes** | | |
| • Present | 1 | 6.7 |
| • Absent | 14 | 93.3 |
| **US character** | | |
| • Solid | 10 | 66.7 |
| • Purely cystic | 0 | 0.0 |
| • Mixed | 5 | 33.3 |

Ninety per cent of parotid tumours originate from the superficial lobe, and sonography is considered to be the method of choice for imaging these lesions.[17] In a study by Wittich et al, the sensitivity of sonography in detecting intraparotid tumours approaches 100 per cent, as was also revealed in our study.[17] Sonography of the salivary glands helps in diagnosing tumours, abscesses, sialectasia and salivary calculi.[18]

The study revealed 66 solid swellings, 10 cystic and 22 swellings with both solid and cystic components. Out of the solid swellings, majority i.e. 42 were thyroid swellings, 16 were lymph nodes and the remaining included lipoma, benign epithelial lesion and salivary gland lesions (submandibular sialadenitis and parotid tumours). Among cystic lesions, 4 were of thyroid origin, 1 was benign epidermal cyst, 1 was cervical ranula and the remaining were abscesses. In our study, 79% of clinically firm swellings were found to be actually so, while the remaining were either purely cystic or mixed

character. In a study done on 30 patients with neck swellings, among single clinically firm/solid swellings only 60% were found to be actually so, as in 40% of such cases complementary US evaluation helped in determining their true cystic nature.[19] In our study, on US cystic lesions presented as homogenous anechoic purely cystic lesions which correlates well with previous studies.[2]

**Figure 4: Follicular Adenoma of thyroid.**
A 25-year old female presented with a midline neck swelling, which moved with deglutition. Ultrasound showed a well-defined hyperechoic benign appearing nodular lesion in right lobe of thyroid gland. It was finally diagnosed as follicular adenoma.

For swellings of Inflammatory nature, this study showed the sensitivity, specificity, PPV and NPV of US to be 87.2%, 96.6%, 94.4%, 91.9% respectively. US correctly diagnosed all 7 paediatric inflammatory neck swellings. This correlates well with previous studies which show sensitivities of 97.6% in paediatric patients and 92.3% in all age groups respectively.[9,20] Our study showed a total of 40 benign lesions in the neck and US correctly diagnosed 39 of them. The Sensitivity, Specificity, PPV and NPV of US in this case was 97.5%, 91.3%, 88.6% and 98.1% respectively. Similar results were seen in a study by Chandak et al with a sensitivity and specificity of 100% and 98% respectively. US can predict malignancy in 89% of cases but various forms of malignancy cannot be differentiated.[2]

In this study the Sensitivity of US in diagnosing malignant lesions of the neck in 100 patients with neck swellings was 87.5% with a Specificity of 98.7%, PPV 93.3% and NPV 97.5%. The results correlate well with a study which reviewed the US reports of 42 patients with malignant neoplasms in the head and neck region showing sensitivity, specificity, PPV and NPV of 96.8%, 93.3%, 96% and 93% repectively.[21] Among thyroid swellings, 6 were malignant. Out of these 5 were diagnosed as malignant by US. Sensitivity of US in detecting thyroid malignancy in the present study was 83.3% which was similar to a study of 203 patients from September 2009 to August 2010 where the overall sensitivity of thyroid US for diagnosing a malignant nodule was 81.8%.[22] Among cervical lymphadenopathy, out of 8 malignant lymph nodes, US correctly diagnosed 7. Out of these, 7 were metastatic lymph nodes and 1 was Hodgkin's lymphoma. The sensitivity of US in diagnosing malignant lymph nodes in this study was 87.5%. A sensitivity of 92.6% for the same was seen in a study comparing clinical, US, and histological findings for 100 patients.[23]

Thus, US has a high sensitivity and specificity in diagnosing all types of neck swellings - congenital, inflammatory, benign and malignant. It correctly diagnosed 89 out of 100 neck swellings in this study. Thus, it is superior to clinical examination in diagnosing all types of neck swellings. The use of ultrasonography helped not only to determine the true nature of the swellings but also their relation to vital adjacent structures.[24]

## CONCLUSION

US can differentiate solid from cystic and malignant from benign neck swellings. It can diagnose lesions of thyroid, salivary glands and lymph nodes as well as distinguish between abscess and cellulitis. It is superior to clinical examination in diagnosing all types of neck swellings. US findings correlate well with histopathology.

US of neck has several advantages over other imaging modalities. It is harmless, radiation free, widely available, accessible, non-invasive, affordable, and it is not affected by metal artefacts. It does not need heavy sedation. It has no long-term side effects and it may be repeated as often as necessary.

Based on the ultrasound findings and clinical picture, one can go in for further haematological investigations, FNAC and radiological investigations. Hence, US is the ideal initial investigation for neck swellings for guiding management and further investigations.

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## REFERENCES

1. Simo R, Jeannon JP. Benign Neck Disease. In: Bradley P, editor. Stell and Maran's Textbook of Head and Neck Surgery and Oncology. 5th ed. London: Hodder Arnold; 2012:217-38.
2. Chandak R, Degwekar S, Bhowte RR, Motwani M, Banode P, Chandak M et al. An evaluation of efficacy of US in the diagnosis of head and neck swellings. Dentomaxillofac Radiol. 2011;40:213-21.
3. Skolnik EM, Loewy A, Ferrer J. Swellings of the Neck. Arch Otolaryngol Head Neck Surg. 1965;81(2):150-2.
4. Bhatia K, Quigley S, Richards Ps. Imaging of Palpable Masses in the Head and Neck: A Practical

Approach Using High Resolution Ultrasound. Imaging. 2013;22(1):20-9.
5. Haynes J, Arnold KR, Aguirre-Oskins C, Chandra S. Evaluation of neck masses in adults. Am Fam Physician. 2015;91(10):698-706.
6. Showkat SA, Lateef M, Wani AA, Lone SA, Singh K, Yousuf I. Clinicopathological profile of cervicofacial masses in paediatric patients. Indian J Otolaryngol Head Neck Surg. 2009;61(2):141-6.
7. Ragesh KP, Chana RS, Varshney PK, Naim M. Head and neck masses in children: A clinicopathological study. Indian J Otolaryngol Head Neck Surg. 2002;54(4):268-71.
8. Wong KT, Lee YY, King AD, Ahuja AT. Imaging Features of Common Non-Nodal Neck Masses in Children. Hong Kong J Paediatr. 2008;13(4):260-6.
9. Mukhi PU, Mahindra UR. The use of Ultrasound in diagnosis and management of superficial fascial space infections. Indian J Dent Res. 2012; 23:313-9.
10. Narendra PL, Vishal NS, Jenkins B. Ludwig's angina: need for including airways and larynx in ultrasound evaluation. BMJ Case Rep. 2014: 2014206506.
11. Peleg M, Heyman Z, Ardekian L, Taicher S. The use of Ultrasound as a diagnostic tool for superficial fascial space infections. J Oral Maxillofac Surg. 1998;56(10):1129-31.
12. Khanna R, Sharma AD, Khanna S, Kumar M, Shukla RC. Usefulness of Ultrasound for the evaluation of cervical lymphadenopathy. World J Surg Oncol. 2011;9(1):29-32.
13. Park JH, Kim DW. Sonographic Diagnosis of Tuberculous Lymphadenitis in the Neck. J Ultrasound Med. 2014; 33(9):1619-26.
14. Goyal A, Tiwari RS, Desai AA. Diagnostic role of Ultrasound in neck swellings. Indian J Otolaryngol Head Neck Surg. 1999;51(4):67-71.
15. Yuen HY, Ahuja AT, King AD, Wong KT. Sonography of the thyroid gland. Australas J Ultrasound Med Bulletin, 2003;6(2):6-19.
16. Solbiati L, Charboneau JW, Osti V, James EM, Hay ID. The Thyroid Gland. In: Wilson SR, Charboneau JW, Rumack CM, editors. Diagnostic Ultrasound. 4th ed. Philadelphia: Elsevier Mosby; 2011: 708-49.
17. Wittich GR, Scheible WF, Hajek PC. Ultrasound of the salivary glands. Radiol Clin North Am. 1985;23(1):29-37.
18. Gritzmann N. Sonography of the salivary glands. Am J Roentgenol. 1989;153(1):161-6.
19. Ahmad R, Lateef M, Jeelani G. Ultrasound of non-endocrine neck masses. Indian J Otolaryngol Head Neck Surg. 2001;53(2):105-7.
20. Rozovsky K, Hiller N, Koplewitz BZ, Simanovsky N. Does CT have an additional diagnostic value over Ultrasound in the evaluation of acute inflammatory neck masses in children? Eur Radiol. 2010;20(2):484-90.
21. Hwang HS, Perez DA, Orloff LA. Comparison of positron emission tomography/Computed Tomography imaging and Ultrasound in staging and surveillance of head and neck and thyroid cancer. Laryngoscope. 2009;119(10):1958-65.
22. Popli MB, Rastogi A, Bhalla PJ, Solanki Y. Utility of gray-scale ultrasound to differentiate benign from malignant thyroid nodules. Indian J Radiol Imaging. 2012;22(1):63.
23. Bruneton JN, Roux P, Caramella E, Demard F, Vallicioni J, Chauvel P. Ear, nose, and throat cancer: Ultrasound diagnosis of metastasis to cervical lymph nodes. Radiology. 1984;152(3):771-3.
24. Ahmad R, Lateef M, Jeelani G. Ultrasound of non-endocrine neck masses. Indian J Otolaryngol Head Neck Surg. 2001;53(2):105-7.

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