Ultrasound of the neck

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Purpose

The objective is to illustrate the sonographic findings and typical sonomorphology of the most common pathologic entities in the neck.

Methods and Materials

We illustrate the sonographic findings and typical sonomorphology of the most common pathologic entities in the neck.

Results


The majority of the normal lymph nodes in the head and neck show an axial diameter of 2 to 5 mm with the exception of jugulogigastric and jugulo-omohyoid lymph nodes, which are larger and reveal an axial diameter of 8 to 10 mm, and a longitudinal diameter of 15 to 20 mm. Diseases of the lymph nodes lead to an increase of fluid either by swelling of histiocytes in the sinus, by hyperplasia of lymph follicles, or by invasion of tumor cells. As consequence, this results nearly always in enlargement of the lymph nodes and a reduction of echogenicity.

1.1 Reactive lymph nodes.

Enlarged reactive lymph nodes are the most frequent sonographically encountered entities in the head and neck in non-selected patients. Reactive lymph nodes are found in nearly every patient, most commonly the submandibular and lateral cervical nodes. The reactive enlargement is the response to past inflammatory disease and is a reflected by histiocytosis in the lymph node sinus. The typical sonographic appearance shows a longitudinal to oval shape with rounded poles and a smooth border. The echogenicity is low and homogeneous with a hyperechoic peripheral or central band, consisting of the lymph node hilum with fat and small vessels. The axial diameter is usually less than 8 mm, whereas the longitudinal diameter is of 15 to 20 mm. (Fig.1). The longitudinal-transverse diameter ratio is less than 0.5.

1.2 Inflammatory lymph node disease.

In acute, non-specific lymphadenitis the lymph node are painful and markedly enlarged. Their shape is ovoid with round poles, smooth borders and a hypoechoic appearance.
The hilum is not always apparent. The differentiation from the surrounding soft tissues is easy. The enlargement of acute inflammatory lymph nodes ranges from 20 to 25 mm in longitudinal diameter; however, the absolute measurements of size of a lymph node, is not sufficient for differentiation of inflammatory from metastatic disease.

In subacute, non-specific lymphadenitis the lymph nodes tend to become smaller and the internal architecture is less hypoechoic because demonstrates small spot and central stripes. The shape remains longitudinal and the borders are smooth. (Fig.3)

In chronic, non-specific lymphadenitis (after weeks or months), when the patient is asymptomatic, the lymph nodes can still be detected by US. They are small, soft, movable, hypoechoic, longitudinal shape and smooth borders.

1.3 Specific Lymphadenitis (Tuberculosis).

The ultrasound appearances may vary with a spectrum ranging from large, round, non-echoic to cystic-necrotic nodes. The surrounding soft-tissue appears reactive and hyperplastic, edema is also present and the nodes borders are blurred. (Fig.4) Inflammation in surrounding tissues with formation of fistulas may ensue in cases with nodal necrosis, abscess formation, and perforation of the capsule of the lymph nodes.

1.4 Primary lymph node disease (Sarcoidosis. Lymphoma)

Sarcoidosis: Sarcoidosis is a benign multi-system non-caseating granulomatous disease. In nearly every case multiple lymph nodes are involved which result in conglomeration of the enlarged lymph nodes. In Sarcoidosis the involved bilaterally and most commonly located in lateral cervical chain, transverse supraclavicular and occasionally intra parotid lymph nodes. (Fig .5)

Hodgkin’s and non-Hodgkin’s lymphoma: Are aggressive malignant lymph node neoplasm. The involved lymph nodes are located most commonly posterior to the sternocleidomastoid muscle, whereas metastases from squamous cell carcinoma are localized more frequently in front on this muscle. In cases with aggressive growth of malignant lymphoma, perinodal edema may occur and in the early stages, extranodal expansion may occur late leading to deformation of the lymph nodes. In B- mode sonography echogenic lines or double lines are demonstrated between the enlarged lymph nodes, which represent encased, but not infiltrated, small vessels. (Figs. 6, 7 and 8)

Ultrasonographic appearances of both (sarcoidosis and Hodgkin´s and non-Hodgkin´s lymphoma) reveal similar and overlapping features: round to spherical shape, smooth borders with clearly differentiation between the involved lymph node and the surrounding tissue. Occasionally, very large lymph nodes reveal low echogenicity, simulating a cyst. Sometimes there are tiny echogenic foci, like punctate appearance.

1.5 Lymph node metastases.
In 80% of the cases, cervical lymph node metastases in the head and neck region are caused by squamous cell carcinoma. Sensitivity of US in the diagnosis of cervical lymph node metastases is 89% to 95% whereas specificity is about 80% to 95%. The lower percentage of specificity is based on the difficulties for differentiation inflammatory from metastatic disease. The shape of the nodes is the most important criteria in the diagnosis of metastatic lymph node disease.

On gray-scale sonography, metastatic nodes are usually hypoechoic, round and without echogenic hilus. Eccentric cortical hypertrophy is a useful sign to indicate focal tumor infiltration. Lymph nodes with cystic necrosis are suggestive of malignancy, and intranodal cystic necrosis is common in metastatic nodes from squamous cell carcinoma. Metastatic nodes from papillary carcinoma of thyroid may be hyperechoic and have punctate calcifications referred to Psammoma bodies. In cases of extranodal spread with infiltrative growth, the borders are poorly defined. (Fig.9)

On color Doppler sonography, metastatic and lymphomatous nodes usually show peripheral or mixed vascularity. On spectral Doppler sonography, malignant lymph nodes tend to have high resistance index.

2. Primary soft tissue tumors.

2.1 Hemangiomas and Lymphangiomas.

Hemangiomas and lymphangiomas occur most commonly in the first two years of life. Large hemangiomas and lymphangiomas can be diagnosed prenatal by US. Hemangiomas are multicystic. Echogenicity is dependent on the size of cystic cavities. (Fig. 10) Typically, hemangiomas are highly compressible. Color Doppler helps to detect the perfusion in hemangiomas and confirm the vascular nature of the lesion.

Cystic hygromas or lymphangiomas are predominantly cystic, with multiple septation and loculations that can be variable in size. (Fig. 11) Hygroma can be firm and elastic, so that palpation often suggests lipoma.

2.2 Lipoma.

Lipomas are typically localized in the subcutaneous tissues, are soft and elastic. Most lipomas have an ovoid shape and are iso or hyperchogenic with a striated or feathery appearance. Pure fat containing lipomas are rare and are relatively hypoechoogenic. (Fig. 12).

2.3 Neural tumors.

Neurofibromas and schwannomas are commonly located in the dorsolateral parts of the neck behind the sternocleidomastoid muscle. They show a hypoechogetic pattern with a smooth capsule. Sometimes degenerative cystic changes occur. In some cases it is
possible demonstrate the continuity of the neurinoma with the nerve, which shows a spindle-shaped thickening at the junction between the nerve and the tumor.

3. Tumors of the carotid body.

Carotid tumors are typically localized within the carotid bifurcation or adjacent to the carotid arteries with displacement of them. The diagnosis is based on the sonographics findings of a mass at the carotid bifurcation with increased vascularity. (Fig.13).

4. Abnormalities of the cervical vessels.

Aneurysm, elongation, and tortuosity of the carotid arteries can cause tumor-like swelling in the neck that can be mistaken for tumors.

5. Cystic Lesion.

5.1 Thyroglossal duct cyst.

The thyroglossal duct cyst accounts for the majority of cystic cervical lesion. The cyst may occur anywhere along the course of the duct remnant, from the base of the tongue to the suprasternal region. Most are located in the midline of the hyoid bone. Sometimes the thyroglossal duct cyst is closely related to the hyoid bone abutting the bone surface.

The sonographic appearance may vary from anechoic mass with posterior acoustic enhancement, to hypoechoic structure containing internal debris to a complex heterogeneous pattern (following infection). The cysts are well defined. (Figs. 14 and 15)

The presence of a solid component is suspicious for papillary carcinoma. Carcinomatous changes occur in 1% of cases.

5.2 Branchial cleft cyst.

These congenital cysts arise from the first and second branchial cleft. Cervical cysts from the first branchial cleft can be found in the parotid region. The first branchial cleft cysts arise along the residual embryologic tract of the first branchial cleft or arch extending from the external auditory canal through the parotid gland to the submandibular triangle. It is characteristically found medial to the concha of the ear in a parallel course with the external auditory canal but may extend into the retroauricular area. (Fig. 16)

The second branchial cleft cysts are located in the submandibular space, along the anterior surface of the sternocleidomastoid muscle, lateral to the carotid space, and posterior to the submandibular gland.

At US, the echogenicity of the branchial cleft cyst varies. Some of them are anechoic but most, however, contain homogeneous echogenic material, cholesterol crystals aggregates and finely dispersed internal echoes. The presence of a solid component is suspicious for carcinoma.
5.3 Dermoid and epidermoid cyst.

Are usually located at or near the midline around the floor of the mouth. These cysts have an echogenic and pseudosolid appearance due to the high acoustic impedance of the contents of hair, skin and sebaceous material.

5.4 Ranula:

Is a truly an epithelium lined cyst. The ranula occurs in the floor of the mouth in the region of sublingual gland.


6.1 Acute and chronic sialadenitis.

Acute bacterial sialadenitis often affects older patients. Viral salivary gland infections are the most common in children. In acute inflammation, salivary glands are enlarged and hypoechoic with increased blood flow; they may contain multiple small, oval, hypoechoic areas. In chronic inflammation, salivary glands are normal sized or smaller, hypoechoic, and inhomogeneous.

In acute inflammation, salivary glands are enlarged and are mainly hypoechoic. In chronic sialadenitis the gland is less swollen and the most common sonographic pattern have been described as showing multiple small, round or oval, hypoechoic areas or lesions distributed throughout glandular parenchyma. Duct dilatation may be detected. (Fig. 17).

6.2 Sjögren Syndrome.

Is a chronic autoimmune disease. It is characterized by intense lymphocytic and plasma cell infiltration and destruction of salivary and lacrimal glands. Major clinical symptoms include a dry mouth and eyes.

US features of advanced Sjögren syndrome include inhomogeneous structure of the gland with scattered multiple small, oval, hypoechoic or anechoic areas, usually well defined, and increased parenchymal blood flow. (Fig. 18) During the fibrous stages of the disease the blood flow decrease.

6.3 Sarcoidosis:

Sarcoidosis is a multi-system non-caseating granulomatous disease. Parotid glands are involve (1%- 6%) of cases. The ultrasound appearances of sarcoidosis in the parotid are non-specific. A variety of manifestations may be seen ranging from multiple hypoechoic foci to diffuse hypoechoic glandular enlargement. May be associated lymphadenopathy. (Fig. 19).

6.4 Sialolithiasis.
Salivary stones are most often located in the submandibular gland (83%), parotid gland (13%) and sublingual gland (4%). About 20% of sialolithiasis are radiopaque. Sialolithiasis causes partial or total mechanical obstruction of the salivary duct, which results in recurrent swelling of a salivary gland during eating. The stones could be present within the main duct salivary gland or within the gland parenchyma.

US features of sialolithiasis include strongly hyperechoic lines or points with distal acoustic shadowing, which represent stones. (Fig. 23) In case of very small stones, < 2 mm, the posterior shadowing may be absent. Lemon juices make it easy sonographic evaluation of main salivary duct.

7. Salivary gland neoplasms

7.1 Benign Tumors.

Pleomorphic Adenoma (mixed tumor): Pleomorphic adenoma is the most frequent tumor of the salivary glands. Pleomorphic adenomas occur most often in the parotid gland (84%), submandibular gland (8%), minor salivary glands (6.5%) and sublingual gland (0.5%). Approximately 90% of pleomorphic adenomas are located in the superficial lobe. Pleomorphic adenomas are usually solitary and unilateral. (Figs. 20 and 21).

At US, are hypoechoic, homogeneous, well-defined and lobulated. Rarely, cystic changes and calcifications can be identified. The possibility of malignant transformation is (1.5%-4.5%); the absence of either sharp margins or homogeneity may suggest malignancy.

Whartin’s Tumor (Cystadenolymphoma): Warthin’s tumor is the next most common benign salivary neoplasm. In about 30% of cases, tumors may occur bilateral. Histologically, the tumor is composed of epithelial glandular tissue with prominent associated lymphoreticular tissue.

Ultrasound shows a well-defined, anechoic mass or a mass with multiple anechoic cystic areas, however, the pattern may vary. (Fig. 22).

7.2 Malignant Tumors

The most common malignant neoplasms occurring in salivary glands are mucoepidermoid carcinoma and adenoid cystic carcinoma. Squamous cell carcinoma, acinic cell carcinoma, and adenocarcinoma are less common. There are no consistent ultrasound criteria to differentiate between malignant and benign lesion. Malignant tumors and also lesion > 2 cm may often show a polygonal shape, irregular borders, blurred margins, and a hypoechoic inhomogeneous structure. High vascularization and high systolic peak flow velocity should raise the suspicion of malignancy.

7.3 Non-epithelial tumors of salivary glands.
Among non-epithelial lesions as hemangiomas, lipomas, and neurinomas or schwannomas may be found in salivary glands.

8. **Intraglandular Metastases.**

Salivary glands are very uncommonly sites of metastases. Melanoma, spinocellular cancer, breast cancer, and lung cancer may produce metastases to intraparotid lymph nodes. Salivary glands may also be affected by lymphoma.

9. **Pseudotumours.**

Edema, lipomatosis, hematoma, and low-grade infection, can cause tumorlike swelling in the neck that can be mistaken for a tumor. Ultrasonography evaluation in conjunction with palpation could help for the diagnosis. (Fig. 23)

10. **Hypertrophy of masseter muscles.**

Hypertrophy of the masseter muscle can occur on one or both sides. Clinically, it may be misinterpreted as a tumor of the salivary glands. The differentiation is easily made by US.

11. **Infection of the neck.**

Ultrasound is useful for the evaluation of the extent and location of inflammatory process and the search for an abscess cavity. An abscess presents as a very painful circumscribed hypoechogenic or anechoic space-occupying lesion. (Figs. 24 and 25) The central area of an abscess contains fluid, like pus, and can be echo free. The borders are irregular and blurred. The demonstration of gas within an abscess is another feature characteristic of aerobic infection. Small bubbles of air may be seen as bright reflexes.

**Images for this section:**
Fig. 1: Figure 1: Reactive lymph node. Echoic oval structure with an echoic central hilum.
Fig. 2: Figure 2: Submandibular lymph node with oval shape, rounded poles. The hilus is not detected. Acute lymphadenitis.
**Fig. 3:** Infectious mononucleosis in a 15 years old boy. Enlarged and oval shape lymph nodes.

**Fig. 4:** Lateral cervical right mass in a 25 year-old male with fever, weight loss and Mantoux (+). US image shows enlarged lymph node with regular border and partial necrosis, due to cystic-necrotic changes in specific lymphadenitis (tuberculosis).
**Fig. 5:** Figure 5: Ultrasound images of systemic sarcoidosis. Conglomerate of enlarged submandibular lymph nodes.
**Fig. 6:** Figure 6: Hodgkin’s lymphoma. Supraclavicular lymph node with spherical shape, smooth borders, and clearly differentiation between the lymph node and the surrounding tissue.
Fig. 7: Figure 7: Hodgkin’s lymphoma in 20 year-old woman. Conglomerate of enlarged supraclavicular and hypoechoic lymph nodes. Peripheral vessels.
**Fig. 8:** Figure 8: Enlarged lymph nodes, with tiny echogenic foci, like punctate appearance, in Hodgkin’s lymphoma in 70 year-old man, treated seven years ago.
**Fig. 9:** Lymph node metastasis from tonsillar carcinoma. Color Doppler sonogram shows spherical node with peripheral vascularity that runs along periphery of node, with perforating branches into lymph node. Lymph node also shows areas of intranodal cystic necrosis.
**Fig. 11:** Hemangioma: Doppler sonography shows inhomogeneous lesion consisting of large sinuses seen as tubular anechoic structure with flow inside.
**Fig. 10:** Lymphangioma in 16 year-old girl. Hypoechoic, septated, compressible cervical lesion with no detectable flow on color Doppler.
Fig. 12: Lipoma. An ovoid isoechogenic lesion with striated appearance.

Fig. 13: Chemodectoma in the left carotid bifurcation, 16 year-old girl. Ultrasound shows a solid inhomogeneous, hypoechogetic lesion at the carotid bifurcation.
Fig. 14: Midline cystic ovoid lesion at the level of the hyoid bone. Is predominantly anechoic but containing internal debris. Thyroglossal duct cyst.
Fig. 15: Anechoic cervical lesion seen at the level of the hyoid bone and slightly right off midline. Thyroglossal duct cyst.
**Fig. 16:** First branchial cleft cyst in a 30-year-old man. Cystic mass in the left parotid region that involves the external auditory canal. A. Ultrasound: Cystic parotid lesion with internal echoes that communicates with a complex retroauricular cyst (sinus tract).
**Fig. 17:** US image shows a chronic sialadenitis of parotid gland.
**Fig. 18:** Sjögren syndrome.

**Fig. 19:** Systemic sarcoidosis. Multiple and bilateral hypoechoic nodules with blood flow in color Doppler, distributed throughout parotid glandular parenchyma.
**Fig. 20:** US image shows the typical appearance of a pleomorphic adenoma. The lesion is hypoechoic and lobulated with distinct borders and posterior acoustic enhancement.
**Fig. 21:** Pleomorphic adenoma in submandibular right gland. US image of a hypoechoic and poli-lobulated mass in submandibular right gland.
Fig. 22: Warthin’s tumor. Bilateral well-defined masses with multiple anechoic areas and poor signal of color Doppler located in parotids glands.
Fig. 23: Lipomatosis left parotid region in a 50 year-old woman. Ultrasound: An ovoid hypoechoic lesion with striated appearance.
**Fig. 24:** Soft-tissue mass, red, swollen in 70 year-old woman with fever, following facial trauma seven days ago. Sonogram shows a large complex lateral cervical mass with irregular and blurred borders. The mass was drained: Hematoma with focal abscessification.
**Fig. 25:** Submandibular right abscess in a 57 year-old man with fever and septic mouth and important periodontal disease.
Conclusion

High-resolution ultrasound is now the primary imaging modality for evaluation of the soft tissues of the head and neck region. On the basis of clinical presentation and the sonographic findings, selection of additional imaging modalities including CT and MR imaging can be applied more judiciously for the assessment of pathologic entities in the neck.

References


Personal Information