Summary

Ophthalmic ultrasonography employs high-frequency sound waves that provide the high resolution required for ocular diagnosis. A lower frequency of 8 MHz is used to obtain the penetration needed to reach the orbital apex. The orbit is evaluated with A- and B-mode scanning.

Standardized A-scan ultrasonography provides uni-dimensional images of the orbital soft tissue characterized by a series of spikes of varying height and width that demonstrates the echogenic characteristics of each tissue. Two dimensional images of these tissues can be obtained with B-scan ultrasonography

Color Doppler imaging (CDI) is a useful adjunctive imaging study for evaluating the vascularity of orbital tumors. The absence or presence of intratumoral blood flow as demonstrated by CDI can help determine the nature of the orbital mass and can assist with surgical planning.

The operation of all ultrasound transducers is based on the piezoelectric effect. The materials used for making crystals for transducers are endowed with a property called the piezoelectric effect. This effect means that when the material is submitted to a voltage, the piezoelectric material deforms slightly. Inversely, if the material is deformed by external forces, a small voltage change results. In diagnostic ultrasound, short-duration electrical pulses are applied to the ultrasound crystals during the transmit phase giving rise to short-duration deformations of the crystals. These deformations result in an ultrasound transmit waveform being transmitted into the tissue with a rather constant velocity, estimated on average to be 1,540 m s −1 in human tissue.

Several orbital structures can be identified with US: the orbital wall appears as a hyper-echoic band with posterior acoustic shadowing, the retrobulbar fat is seen as a homogenous hyperechoic area behind the globe, the extraocular muscles are hypoechoic and have a fusiform configuration, and the optic nerve appears as a triangular hypoechoic band in the center of the retrobulbar fat.

Horizontal and vertical sections of the globe and normal orbit at the level of the optic nerve display Doppler signals along the course of the central retinal artery (CRA) and the central retinal vein (CRV). The CRA and the accompanying vein can be depicted within the anterior 2 mm of the optic nerve shadow.

A distinct distortion of the retrobulbar fat, optic nerve, or rectus muscles by any sort of abnormal contour ultrasonically indicates a mass lesion in the orbit. 4 types are identifiable with B-scan ultrasonography: 1- Cystic, 2- Solid, 3- Angiomatous and 4- Infiltrative.

1- Acoustically Cystic Tumors:

The contour of an orbital tumor may be smoothly rounded, sharply defined, and compressing adjacent normal structures. If the lesion has a good sound transmission, its posterior wall will also be clearly evident. Internally, the lesion may be devoid of echoes, indicating no significant tissue interfaces within the lesion. These findings are characteristics of a fluid-filled cystic lesion, such as mucocele or dermoid tumor.

This includes:

-Mucocele

-Dermoid tumors

-Cavernous hemangioma

-Hemangiopericytoma

-Cystic lymphangioma

2- Acoustically Solid Tumors:

A mass lesion may have a contour similar to a cystic lesion. However, its posterior boundary may be indistinct because of poor sound transmission through it, indicating a solid tumor. Low amplitude echoes within the substance of a solid tumor indicate minor tissue interfaces, characteristic of a homogenous solid tumor. These findings indicate a well circumscribed solid tumor, for example, neurogenic tumor, lacrimal gland tumor, and some metastatic tumors. Location of the lesion within the orbit gives further clues to identification. A lesion of this type within the muscle cone and involving the optic nerve is probably one of the neurogenic tumors. A similar lesion located in the upper temporal aspect of the orbit is more likely to be a lacrimal gland tumor.

This includes:

-Tumors of the optic nerve: *Optic nerve glioma, Neurofibroma, Schwannoma, Meningioma.*

-Lacrimal gland tumors: *Pleomorphic adenoma, Lymphoid Tumors of the Lacrimal Gland, Carcinoma of the Lacrimal Gland (Adenocarcinoma and Adenoid Cystic Carcinoma).*

3- Acoustically Angiomatous Tumors:

An orbital tumor with an irregular contour suggests a different group of tumors. Angiomatous tumors show finger like protrusions extending into the orbital fat pattern, usually with a larger mass more posteriorly. The tumor contour may or may not be well defined. The internal structure of angiomatous tumors presents many dense acoustic interfaces

from vessel walls and blood-filled spaces comprising the tumor. Ultrasonically, this heterogenous interior appearance as multiple, irregular, high amplitude echoes throughout the mass, with little sound attenuation. This irregular contour and heterogenous internal structure are distinctly different from the cystic and solid tumor patterns.

This includes:

- Diffuse lymphangioma.

4- **Acoustically Infilterative Tumors**:

Another irregular orbital tumor, having a more solid character, indicates a solid infiltrative tumor. Although the anterior lesion outline is jagged, it is also sharply defined and distinct. As with other solid tumors, low amplitude internal echoes are present and sound attenuation is marked, making the posterior tumor margins indistinct. This pattern is associated with infiltrative tumors, particularly lymphomas and sarcomas. Metastatic tumors may also show these characteristics. Idiopathic granulomas, or pseudotumors, often mimic invasive, solid tumors clinically and ultrasonically. Orbital hematoma may also appear ultrasonically as an infiltrative mass lesion, although it is non neoplastic.

This includes:

-Lymphomas

-Metastatic tumors

-Fibrous histocytoma

-Rhabdomyosarcoma

-Pseudotumors