Sonography of the Ear Pinna

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Objective. This study was undertaken to assess the scope of sonography for the diagnosis of diseases of the external ear. Methods. We developed a description of the sonographic anatomy of the normal ear pinna, including the thickness of the normal cartilage and lobule, through systematic scanning of the external ears of 11 healthy volunteers (2 male and 9 female), and reviewed clinical cases with pathologic entities. Results. Reproducible and recognizable images were collected from normal as well as pathologic cases of the external ear. Images are presented for reference. Conclusions. Sonography permits good visualization of the internal structure, including the cartilage, and it is possible to use sonography as a method of study to differentiate between inflammation, vascular lesions, and tumors. Key words: ear sonography; external ear imaging; pinna sonography; skin sonography; vascular tumor sonography.

The ear pinna is a highly specialized structure that serves to collect sound and conduct it to the middle ear. In broader terms, it is also a prominent aspect of the head and may be the seat of a number of diseases. Because the pinna is attached to the side of the head in a relatively visible position, it can be traumatized and exposed to sun damage easily. Although there is much medical information about complications associated with ear disorders and complications of hearing and the internal ear, there is not much written about complications of the outer ear, known as the pinna and auricle. The diagnosis of ear pinna diseases is done mainly through clinical examination and biopsy, and, to our knowledge, the possible benefit to physicians and patients of supplementary noninvasive real-time imaging techniques has not been evaluated. Before a more formal evaluation of such efforts, however, the scope of noninvasive sonographic imaging should be described.

With the appearance of high-frequency probes and high-resolution sonography machines, it is possible to visualize layers of the skin, and this technology may therefore aid in assessing the characteristics of the pinna’s internal structure, which is composed mainly of skin layers and cartilage. To our knowledge, the normal sonographic structure of the ear pinna has not previously been described.
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Sonographic Technique

To establish the normal sonographic anatomy of the ear pinna, we studied the external ears of 11 healthy volunteers (2 male and 9 female). Their mean age ± SD was 35.3 ± 7 years (range, 24–46 years). The pathologic images included in this article were acquired from 16 patients (11 male and 5 female) studied at the Department of Radiology in one of the hospitals. The mean age of the patients was 27.8 ± 25.9 (range, 1 month–80 years). All of the patients or one of the parents in the case of the children signed their informed consent before the inclusion in the study. Ethics Committee approval was obtained for this study.

The sonography equipment used was an HDI 5000 system (Philips Medical Systems, Bothell, WA) with compact linear array 15-7 MHz and linear array 12-5 MHz transducers. Extended field-of-view software was used to acquire images of the whole pinna length when needed. A copious amount of gel was used in patients to allow optimal visualization of the pinna. No standoff pad was necessary.

A piece of cotton inside the external meatus was used during the examinations to prevent entrance of the gel, and the patient was laid down and rolled over to the opposite side of the lesion in the decubitus lateralis position, leaving the lesion side closer to the operator.

Children younger than 4 years with a suspicion of vascular tumors required sedation with chloral hydrate (50 mg/kg), administered orally approximately 30 minutes before the examination, to prevent artifacts during flow detection by color Doppler spectral curve analysis.

Transverse, longitudinal, and extended field-of-view images were obtained. Color Doppler imaging and spectral curve analysis were used to describe the vascularity of the auricular lesions.

Measurements in the healthy volunteers were taken to establish the thickness of the cartilage in millimeters at the middle third of the antihelix in the transverse axis (Figure 1), and measurements of the lobule in millimeters were also taken from the anterior aspect of the epidermis to the posterior aspect of the epidermal layer in the transverse axis.

Normal Sonographic Anatomy

On sonograms, it is possible to distinguish 2 different zones of the ear pinna: an upper region and a lower region. The anatomic difference is mainly the presence or absence of cartilage inside the layers. The upper region corresponds to the higher two thirds of the ear pinna and consists of 3 layers: anterior and posterior, each depicted as echoic thin skin layers, and a middle layer containing cartilage, which is represented as a completely hypoechoic regular thin band that follows the different concavities and convexities of the ear pinna (Figures 2 and 3).

The cartilage is thick at the antihelix border of the auricula. The mean thickness in the normal cartilage at the antihelix border (middle third in the transverse axis) of the 11 healthy individuals was 0.8 ± 0.1 mm (range, 0.7–0.9 mm).

The lower region is depicted by the ear lobule, which is a 1-layer structure and consists of only skin because of the absence of cartilage in this area. Sonographically, it is possible to recognize the echoic epidermal and dermal layers as well as the hypoechoic fatty tissue of the subcutaneous

Figure 1. Normal surface anatomy of the pinna.
component, comparable with the normal sono-
graphic anatomy of skin elsewhere on the body
(Figure 4). The mean thickness of the lobule in
the healthy individuals was 6.9 ± 1 mm (range,
5.9–8.1 mm).

The blood supply could be traced to branches
of the external carotid artery.

**Sonography of Pathologic Entities in the
Ear Pinna**

The pinna has many features that render it partic-
ularly amenable to evaluation with sonography.
Its inherent superficial location, concavities, and
skin-cartilage compound structure make it diffi-
cult to study with other ionizing radiation imaging
modalities such as radiography and computed
tomography. The multiplanar and real-time
capabilities of sonography without the necessity
of using intravenous contrast agents can play an
advantage over magnetic resonance imaging.

Diseases that affect the ear pinna include a
complex range of entities that can be classified as
congenital malformations, inflammatory dis-
eases, benign tumors, and malignant tumors.

**Congenital Malformations**

Congenital malformations of the pinna are relat-
ed to developmental defects of the first and sec-
ond branchial arches and the branchial groove,
which joins the first pharyngeal pouch to form
the external ear canal.

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Defective closure of the first branchial cleft or
failure of fusion of the primitive ear hillocks may
result in formation of a small pit, sinus, or fistula
in front of the pinna. These deformities can vary
from a small dimple (preauricular pit) to a larger
sinus (preauricular sinus). Preauricular pits are
shallow invaginations in the skin of the face
located just in front of the anterior border of the
anterior crus of the helix. A foul-smelling cheesy
discharge of desquamated keratin debris can be
encountered. A preauricular sinus is deeper than
the pit and is lined with stratified squamous ker-
atinizing epithelium. Preauricular pits and
sinuses can become infected, and if they do, the
infection frequently recurs. If the opening of a
preauricular sinus is occluded, the sinus will be

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**Figure 2.** Transverse image of the pinna showing a hypoechoic
band of cartilage (C).

**Figure 3.** Longitudinal image at the upper two thirds of the
pinna showing the different skin and cartilage layers.

**Figure 4.** Transverse image showing the skin layers at the lobe
segment of the pinna. Note that there is absence of cartilage in
the middle zone.
converted into a cyst, which slowly becomes enlarged. With sonography, it is possible to follow the tracts to deeper planes and to establish the real extension in the thickness of these lesions, even before any clinical inflammation is noticed. Inflamed preauricular sinuses can involve the cartilage and also can lead to inflammation of deeper structures in the vicinity such as the parotid gland (Figures 5 and 6).

**Inflammatory Diseases**

Several inflammatory disorders may appear on the external ear. Some are identical to skin diseases seen elsewhere on sun-exposed skin, whereas others are unique to the ear.\(^2\) The causes of inflammation can be mainly divided into traumatic, infectious, autoimmune, and allergic types.

Acute or chronic friction that irritates the perichondrium of the auricular cartilage can induce a subperichondrial serous or serosanguineous effusion. Blunt trauma encountered in boxing, rugby, football, and other physical activities in which the skin of the pinna is exposed to twisting or shearing forces can produce hematomas. Fluid collections are easy to identify with sonography as in any other segments of the human body. They are depicted as anechoic areas, and sonographically guided puncture or drainage of these collections is also possible.

**Chondritis or Perichondritis**

Acute perichondritis of the auricle is a bacterial infection of the perichondrium and underlying cartilage. This type of acute bacterial infection is potentially serious because if untreated, the underlying auricular cartilage will become infected and ultimately necrotic with the collapse of the pinna. Gram-negative bacteria, especially *Pseudomonas aeruginosa* and *Proteus*, are the usual causative organisms. In the presence of inflammation, the cartilage increases in thickness and echogenicity. At advanced states of inflammation, the cartilage can appear beaded (Figures 7 and 8).

Sonographically, it is possible to detect the presence of dissecting fluid collections of the cartilage because these may divide the normally uniform 1-layer hypoechoic cartilage into a 2-layer structure (Figures 9 and 10).

Depending on the density of the material, collections can be anechoic or echoic. During an
examination, it is important to study the dynamic properties of any collection by compressing it with the probe to confirm that it contains free fluid without inner septa. Drainage or puncture of these collections under sonographic guidance is also possible if needed for diagnosis or therapy.

**Postpiercing or Earring Inflammation**

Because of the wide use of earrings and piercing in different parts of the body, it is not uncommon to see complications from the use of these items. As shown in a study by Fisher et al., cartilage piercing may produce serious consequences because of the high risk of infections. *Pseudomonas aeruginosa* is commonly involved, and ear piercing in the upper two thirds of the auricle is inherently more risky than piercing located at the lobe because of the possibility of cartilage damage.4

The tract of the earring or piercing is detectable on sonography as a hypoechoic area that follows the axis of installation (Figures 11 and 12). If there is inflammation at the ear pinna, both the dermal layer and the cartilage increase in thickness and echogenicity. The cartilage has a beaded shape (between arrows), which is compatible with chronic perichondritis.

**Figure 9.** Chronic enlargement and suppuration of the pinna in a 59-year-old male patient.

**Figure 8.** Transverse image from the patient in Figure 7 showing that the cartilage is increased in thickness and echogenicity.

**Figure 10.** Transverse image of the patient in Figure 9 showing a dissecting fluid collection of the cartilage, not suspected by clinical observation (between arrows), that produces a double hypoechoic cartilage band. The high viscosity and debris present in the fluid produce an appearance that is more echogenic than usual. Also note the increase in thickness and echogenicity, secondary to the edema at the skin layers, compared with the normal pinna echo structure.
If there is any doubt about the presence of inflammation, it is necessary to make a right-to-left side comparison at the pinna. A color Doppler scan will show an increase in the vascularity of the affected area.

**Tumors**
The most frequently encountered tumors and tumorlike lesions of the ear pinna that can be characterized on sonography are epidermal cysts, vascular tumors, cartilage tumors, and skin tumors.

**Epidermal Cysts**
Epidermal cysts are slow-growing round, firm intradermal cysts that arise most commonly from the infundibula of hair follicles. They are the result of proliferation of epidermal cells within a circumscribed space of the dermis and subcutaneous tissue. The most common sites for development of epidermal cysts are along the postauricular sulcus and the medial aspect of the lobule at its junction with the face. They contain cheesy debris composed of keratin. If an epidermal cyst becomes infected, the lining of the cyst may rupture, and the keratin squames within the cyst can spill out into the surrounding soft tissue. An acute foreign body granulomatous reaction can develop in response to the keratin squames that infiltrate the tissue surrounding an infected epidermal cyst.

**Sonography**
Sonography shows a hypoechoic round or oval structure that produces acoustic posterior enhancement. The presence of cheesy dense material inside the cyst can produce a misdiagnosis of a solid mass by inexperienced operator, but the presence of acoustic posterior enhancement and the possibility of compression in this thick fluid-filled cystic structure can help avoid this pitfall. At later stages of inflammation, the shape of the cyst becomes irregular because of rupture of the cyst and spillage of keratin into the surrounding tissue.

Color Doppler imaging can show a scant presence of vascularity in noninflamed cysts, but with progression of inflammation, the vascularity is increased in the periphery of the lesion (Figure 13).

**Vascular Tumors**
Hemangiomas and vascular malformations can be present in the ear pinna. The external ear is the second most common site for extracranial arteriovenous malformations in the head and neck. The sonographic characteristics are not different from those seen in vascular tumors in other parts of the body. Hemangiomas are benign tumors consisting of numerous vessels that frequently resolve spontaneously during the first decade of life. It is important to differentiate hemangiomas from vascular malformations because the latter do not resolve spontaneously. Also, it is important to know the depth of the involvement of the pinna and adjacent structures, which can complicate regression and lead to potential aesthetic consequences in a child.

Color Doppler sonography shows highly vascular components that include arterial and venous flow between solid hypoechoic areas. It is also possible to detect involvement of cartilage and surrounding structures such as the parotid gland and sternocleidomastoid muscle (Figures 14 and 15). Vascular malformations are errors in the morphogenesis of the vessels. They can be divided into arterial, venous, capillary, lymphatic, or mixed types according to the nature of the vessels involved. They persist without change throughout life. Sonographically, they appear as numerous tortuous and serpiginous vessels frequently without solid hypoechoic areas in the middle. On color Doppler sonography with spec-
tral curve analysis, the type of flow, mean thickness, and velocity of the vascular components can be detected (Figures 16–18). This fact could be important in terms of planning or deciding on a cosmetic or surgical procedure; for example, arterial vascular malformations containing high-velocity vessels are not good candidates for laser procedures, as are capillary flow malformations. Lymphatic malformations appear as cystic or complex multiseptated masses without any detectable flow. It is important to observe whether there is a feeding vessel susceptible to embolization in cases of arterial or venous malformations and to determine the whole extension of the lesion, including any possible cartilage or adjacent structure involvement, for which other imaging modalities such as magnetic resonance imaging and angiography can be required.

Cartilage Tumors
Chondromas are tumors derived from the cartilage matrix. Extraosseous presentations of chondromas are uncommon compared with osseous presentations. They may appear bilaterally on the ears.6 On sonography, they appear as nodular solid hypoechoic enlargements of the cartilage (Figures 19 and 20).

Malignant Skin Tumors
Skin cancers such as basocellular and squamous carcinomas are more frequent in persons who have had long exposure to sunlight. The objective of sonography in these cases is to determine the amount of involvement of the pinna layers and adjacent structures and not to perform a histologic diagnosis of the neoplastic lesion. Malignant
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lesions generally appear as hypoechoic and heterogeneous areas with irregular borders. Sometimes ulcerations at the epidermal layer are recognizable. The vascularity is increased inside and in the periphery of the tumor, mainly in the subtumoral zone. Invasive growth of a tumor can be detected and measured, which can help in planning surgery or further deep imaging studies (Figures 21–23).

Discussion

Until now, the ear pinna has only been studied by clinical observation, occasionally supplemented with biopsies. Imaging has rarely been done or needed. Using an additional imaging modality, however, may have several advantages: it may provide structural information noninvasively, without the need for an intravenous contrast agent; it may provide data for posterior longitudinal studies of biological processes; and it may provide new data because the images are generated by principles that are different from those of visible light (eyesight of a clinician) and histologic biopsy.

Sonography permits imaging of the known structures of the ear pinna and provides real-time helpful information about common abnormalities. The appearance of sonographically visible cartilage may be useful for development of therapeutic procedures. Similarly, quantification of structural components in vivo not only allows better preoperative planning but also may be of diagnostic help.

Figure 15. Transverse gray scale (A) and color Doppler (B) images of a lesion showing a heterogeneous mass (between arrows) containing high vascularity (between arrows), compatible with a hemangioma.

Figure 16. Erythematos lesion on the helix of the pinna (arrows) in a 9-year-old female patient.

Figure 17. Transverse color Doppler image from the patient in Figure 16 showing a highly vascular arterial lesion with tortuous vessels, compatible with an arterial vascular malformation. There is no evidence of a solid tumor.
Current state-of-the-art technology makes it possible to establish differential diagnoses between lesions and to characterize them by diameter, thickness, whether they are solid or cystic in nature, and the amount and type of vascularity and to provide reliable presurgical information. The development of sonography as a standalone technology for diagnosis of skin and cartilage lesions is currently under study, but the technology already provides a guide for achieving better precision in procedures such as punctures, drainages, and biopsies.

Previously, simpler 20-MHz sonographic devices have been used to evaluate the thickness and state of the cartilage in reconstructed ears.

Additional information about diseases, however, may also be obtained with more modern sonography machines. Some skin diseases have an established sonographic profile, as shown in previous studies in dermatology, whereas, to our knowledge, other entities, such as chondritis and piercing complications, have not been described previously. It may be speculated that early recognition of a condition such as chondritis would allow for more precise interventions and fewer complications, although this obviously requires specific prospective investigations.
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It is suggested that sonography, as a widely available imaging technology, can provide clinically relevant information for studying the ear pinna. The composite images obtained provide real-time information about tissue characteristics, which otherwise would either remain hidden or require biopsies.

Figure 22. Transverse image from the patient in Figure 21 showing a hypoechoic solid lesion in the dermal and subcutaneous tissue at the posterior aspect of the pinna with an ulceration at the center, which is close but does not involve the cartilage layer (C).

Figure 23. Transverse color Doppler image from the patient in Figures 21 and 22 showing high vascularity inside the lesion, which after surgery was histologically confirmed as a squamous carcinoma.

References