The approach of CBCT examination in the middle ear lesions

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Learning objectives

- The purpose of our educational exhibit is to:
  - become familiar with normal middle ear radiological anatomy on CBCT imaging studies;
  - illustrate cases of various diseases of the middle ear: describing their radiological features and pathological correlation.
Background

Recent studies [1,2] have shown that CBCT can be used in cholesteatoma surgery for preoperative diagnostics. CBCT imaging provides a surgical road map allowing more accurate counseling with respect to hearing loss and facial paresis.

In other studies CBCT is considered as a routine diagnostic method for cochlear implant [3,4].

Comparative studies of MSCT and CBCT showed absence of significant differences regarding the information related to the temporal bone morphology in both techniques. More accurate findings were shown in CBCT imaging for stapes, incudostapedial joint prior stapediovestibular joint and footplate with a significant reduction in radiation dose compared to MSCT [5]. Some studies consider the CBCT justified in preoperative diagnosis of middle ear diseases due to high sensitivity and specificity in detecting these lesions [6].

In [7] it is shown that CBCT when used for temporal bone imaging in otosclerosis is in many cases equivalent of MSCT technique with the advantage of exposing the patient to a considerably lower radiation dose than in conventional MSCT [8]. What they found was that discrepancies in visualizing anatomical structures were dependent on the evaluator. While retrofenestral lesions were equally diagnosed by MSCT and CBCT the fenestral lesions were found to a higher degree by MSCT.

In [9] is confirmed that temporal bone CBCT is a useful imaging method in the preoperative evaluation of histologically active fenestral otosclerosis and this technique can see an important improvement with the advance of CBCT technology.

All this studies are opening and establishing the road of CBCT techniques in the imaging of middle ear region showing the importance of educating and training the radiologist to select this technique for the benefit of the patient and without losing diagnostic accuracy.
Findings and procedure details

We analyze a total of 45 patients previously treated for middle ear disease, which have undergone CBCT of the petrous bone with a Planmeca ProMax 3D Mid and was applied a high resolution protocol.

Acquisition began with frontal and lateral location of the temporal bone region of interest. Tube voltage was 90kV, with 8 mA charge at the terminal. Total filtration was 2mm and pitch 200 microns, with field of view (FOV) corresponding to a 80x80 mm diameter cylinder. Acquisition time was 12-13 sec.

Images were reconstructed in 200 microns isometric voxels, in axial, coronal, sagittal and oblique plans, at our private practice between June 2013 and October 2014.

We reviewed the complex anatomy of the temporal bone and the CBCT imaging findings in the context of various diseases of the middle ear: cholesteatoma, chronic otitis media, otosclerosis.

We also compared the radiological and the histopathological findings in 15 cases, in order to find a better correlation between the radiological and histological aspects of the middle ear lesions.

Cholesteatomas of the pars tensa are more difficult to diagnosis [10] then pars flaccida lesions because the lateral epitympanic wall may be intact (Fig. 1-15). The CBCT common aspects of pars tensa cholesteatoma are:

· presence soft tissue mass in the middle ear (Fig. 1-7);
· erosion of long process of the incuss (Fig. 1-7);
· extension of the soft tissue mass in the epitympanum medial to the ossicles (Fig. 1-7);
· head of maleus and body of incus are displaced lateraly by the soft tissue mas of the cholesteatoma (Fig.10-11);

The most frequent complications of cholesteatomas [10] are

· erosion of the tegmen or sinus plate;
· erosion of the labyrinthine with fistula formation (Fig. 1-3, 9-11);
· extension of the cholesteatoma into the petreus piramid (Fig. 1, 9);
· erosion of the facial nerve canal (Fig. 6).
Cholesteatomas of the pars flaccida are easier to diagnosis because the lateral epitympanic wall is eroded.

The CBCT most common findings aspects of cholesteatoma of the pars flaccida are:

- erosion of the anterior portion of the lateral epitympanic wall (Fig. 15-18);
- erosion of the anterior tympanic spine;
- presence of a soft tissue mass in the epitympanum lateral to the ossicles.

Recurrent cholesteatoma [10] fill the medial portion of the mastoid cavity with or without the erosion of the tegmen or vestibule (Fig. 19-24).

For the patient with conductive hearing loss the CBCT exam allows a precise evaluation of the middle ear, presence of the suppuration or in inactive infections, the aeration of the middle ear.

In chronic adhesive otitis media CBCT demonstrates thickened portion of the tympanic membrane restricted to the promontory and the contracted middle ear space (Fig. 25-29).

CBCT was able to visualize the anatomic structures of interest in patients with otosclerosis (Fig. 30-35).
Fig. 1: Pars tensa cholesteatoma. Large cholesteatoma. Axial, CBCT reconstruction. The anterior portion of lateral epitympanic wall is eroded by a large soft-tissue mass extending into the mastoid with osticular erosion and of the lateral semicircular canal (1).

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Fig. 2: Pars tensa cholesteatoma. Large cholesteatoma. Coronal, CBCT reconstruction. The anterior portion of lateral epitympanic wall is eroded by a large soft-tissue mass extending into the mastoid with osticular erosion and of the lateral semicircular canal (1).

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Fig. 3: Pars tensa cholesteatoma. Large cholesteatoma. Sagital, CBCT reconstruction. The anterior portion of lateral epitympanic wall is eroded by a large soft-tissue mass extending into the mastoid with osticular erosion and of the lateral semicircular canal (1).

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Fig. 4: Cholesteatoma, pars tensa. Axial, CBCT reconstruction. Large soft-tissue mass in the middle ear extending into the epitympanum medial to the eroded osticles (2).

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**Fig. 5:** Cholesteatoma, pars tensa. Coronal, CBCT reconstruction. Large soft-tissue mass in the middle ear extending into the epitympanum medial to the eroded osticles (2).

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**Fig. 6:** Cholesteatoma, pars tensa. Coronal oblique, CBCT reconstruction. Large soft-tissue mass in the middle ear extending into the epitympanum medial to the eroded osticles (4) and a little erosion of the tympanic segment of facial nerve (3).

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Fig. 7: Cholesteatoma, pars tensa. Intraoperator otoscopic imaging. Large white soft-tissue mass in the middle ear.

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Fig. 8: Cholesteatoma, pars tensa: Histology revealed a cystic lesion covered by a multilayered squamous keratinized epithelium. Adjacent to the lesion there is a small part of the periosteum (H-E, x200).

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Fig. 9: Pars tensa cholesteatoma. Axial CBCT reconstruction. The cholesteatoma fills the entire middle ear with erosion of the posterior semicircular canal (5) and the ossicular bone.

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**Fig. 10:** Pars tensa cholesteatoma. Coronal CBCT reconstruction. The cholesteatoma fills the entire middle ear with erosion of the posterior semicircular canal (5) and the ossicular bone.

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**Fig. 11:** Pars tensa cholesteatoma. Sagital CBCT reconstruction. The cholesteatoma fills the entire middle ear with erosion of the posterior semicircular canal, the tympanic segment of CN7 and the ossicular bone.

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**Fig. 12:** Pars tensa cholesteatoma. Coronal oblique CBCT reconstruction. The cholesteatoma fills the entire middle ear with erosion of the posterior semicircular canal and the ossicular bone.

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Fig. 13: Pars tensa cholesteatoma. Otoscopic finding of a thin foil of cholesteatoma.

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Fig. 14: Histologically, surgically removed cholesteatoma specimens demonstrate cystic formation covered by keratinized stratified squamous epithelium, the so called matrix, laying on a dense connective tissue of varied thickness - the perimatrix. The perimatrix presented lympho-plasmocytic infiltrate and foreign body type reaction because of the lesion rupture. The cystic content was made up of keratin lamellae and debris (H-E, x100).

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Fig. 15: Pars flaccida cholesteatoma. Coronal CBCT reconstructions, right. Erosion of the inferior margin of the lateral epitympanic wall by a small soft tissue mass extending into the attic lateral to the ossicles.

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Fig. 16: Pars flaccida cholesteatoma. Coronal CBCT reconstructions, right. Erosion of the inferior margin of the lateral epitympanic wall by a small soft tissue mass extending into the attic lateral to the ossicles with erosion of the long process of the incus.

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Fig. 17: Pars flaccida cholesteatoma. Otoscopic findings of a nodular white pars flaccida cholesteatoma.

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**Fig. 18:** Cholesteatoma, pars flaccida. The thick perimatrix presented lympho-plasmocytic infiltrate and foreign body type reaction around cholesterol clefts because of the lesion rupture (H-E, x200).

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Fig. 19: Recurrent cholesteatoma post right simple mastoidectomy. Axial CBCT reconstruction.

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Fig. 20: Recurrent cholesteatoma (6) post right simple mastoidectomy. Coronal CBCT reconstruction.

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Fig. 21: Recurrent cholesteatoma (6) post right simple mastoidectomy. Sagital CBCT reconstruction.

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Fig. 22: Recurrent cholesteatoma post right simple mastoidectomy. Oblique coronal CBCT reconstruction.

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Fig. 23: Recurrent cholesteatoma post right simple mastoidectomy. Otoscopic intraoperator aspect.

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**Fig. 24:** Cholesteatoma: The cystic content was made up of keratin lamellae and debris (H-E, x100).

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Fig. 25: Chronic adhesive otitis media. Axial CBCT reconstruction demonstrates thickened portion of the tympanic membrane retracted on the promontory.

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Fig. 26: Chronic adhesive otitis media. Coronal CBCT reconstruction demonstrates thickened portion of the tympanic membrane retracted on the promontory.

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**Fig. 27:** Chronic adhesive otitis media. Sagital CBCT reconstruction demonstrates thickened portion of the tympanic membrane retracted on the promontory.

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**Fig. 28:** Chronic adhesive otitis media. Coronal oblique CBCT reconstruction demonstrates thickened portion of the tympanic membrane retracted on the promontory.

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**Fig. 29:** Nonspecific (bacterial) chronic otitis media - bone lamellae delimiting a collection of polymorphonuclear and mononuclear inflammatory elements and newly formed capillaries (H - E, x200).

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**Fig. 30:** Otosclerosis lesion. CBCT axial reconstruction with fenestral otosclerotic lesion (7) lateral to the basal turn of the cochlea.

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**Fig. 31:** Otosclerosis lesion. CBCT coronal oblique reconstruction with right fenestral otosclerotic lesion lateral to the basal turn of the cochlea.
Fig. 32: Otosclerosis lesion. Otoscopic intraoperator aspect.

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**Fig. 33:** Otosclerosis lesion. CBCT axial reconstruction with left pre stapedial otosclerotic lesion.

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**Fig. 34:** Otosclerosis lesion. CBCT coronal oblique reconstruction with left pre stapedial otosclerotic lesion.

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Fig. 35: Otoscopic aspect of stapedial prothesis.

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Conclusion

CBCT data allow a proper exploration of the various diseases of the middle ear and provide essential information necessary during different stages of medical or surgical treatment.
References