LETTER TO THE EDITOR
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Temporal Bone Imaging Opportunities With Ultra-High-Resolution Computed Tomography

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Dear Editor,

Ultra-high-resolution computed tomography (U-HRCT) is an emerging technology that has been recently introduced in the clinical setting. It offers more spatial resolution than conventional multidetector-row computed tomography (MDCT), demonstrating substantial potential for improving clinical imaging. The main advantages of U-HRCT scanners include smaller detector elements and focus size, more channels and detector rows, and a higher matrix display than MDCT scanners. These features enable U-HRCT to improve spatial resolution from nearly 400−450 μm to approximately 150−200 μm, the width of a human hair [1,2].

Particularly, U-HRCT exhibits considerable potential in temporal bone imaging because of its complex anatomy with submillimeter structures, often requiring optimal multiplanar reconstructions with a high degree of spatial resolution. In the last few years, several publications have demonstrated that U-HRCT considerably enhances the identification of small temporal bone structures compared to MDCT, such as the cochlea, incudostapedial joint, stapes footplate, stapedial muscle, and chorda tympani nerve (Fig. 1A and B) [1,3,4]. The anatomical information gained with U-HRCT may aid in the assessment of diseases of the middle and inner ear, such as otosclerosis and superior semicircular canal dehiscence (Fig. 1C and D). In otologic surgery, it may help to optimize patient selection, individualize surgical techniques, and improve postoperative evaluation [5]. Furthermore, the reduction of both "blooming" artifacts (from metallic materials) and partial volume effect gained with U-HRCT is especially beneficial for the precise evaluation of the position of metallic auditory implants (Fig. 1E-G), such as intravestibular stapes prosthesis protrusion and intracochlear electrode array position [6,7]. Recently, Heutink, et al. [8] reported the first in vivo detection of cochlear neo-ossification after cochlear implantation using U-HRCT, which had been previously described only on postmortem examination.

U-HRCT has some inherent challenges. The increased spatial resolution has the downside of either an increase in image noise or an increase in radiation dosage to maintain the same levels of image noise. As a result, noise-reduction strategies become essential, including optimized image acquisition protocols and improved iterative reconstruction techniques. By reducing image noise, these reconstruction techniques allow for substantial radiation dose reduction while preserving image quality [9]. In addition, as spatial resolution increases and slice thickness reduces, the number of slices that must be interpreted will increase considerably. This significant rise in data volume will necessitate greater workstation post-processing power, faster network speeds, and more clinical server storage space [7].

In conclusion, U-HRCT is a commercially available technological advancement that offers higher quality images than conventional computed tomography. Despite increased image noise, U-HRCT enables sharper and more distinct images of the temporal bone, which may allow more accurate visualization of anatomic landmarks, improved disease detection (particularly subtle abnormalities), and optimized preoperative and postoperative evaluation. Successive improvements in noise-reduction strategies will have the potential to positively impact image quality, thereby allowing for radiation exposure reduction. As advances in temporal bone CT continue to expand, future studies will be needed to comprehensively evaluate their impact on clinical practice.

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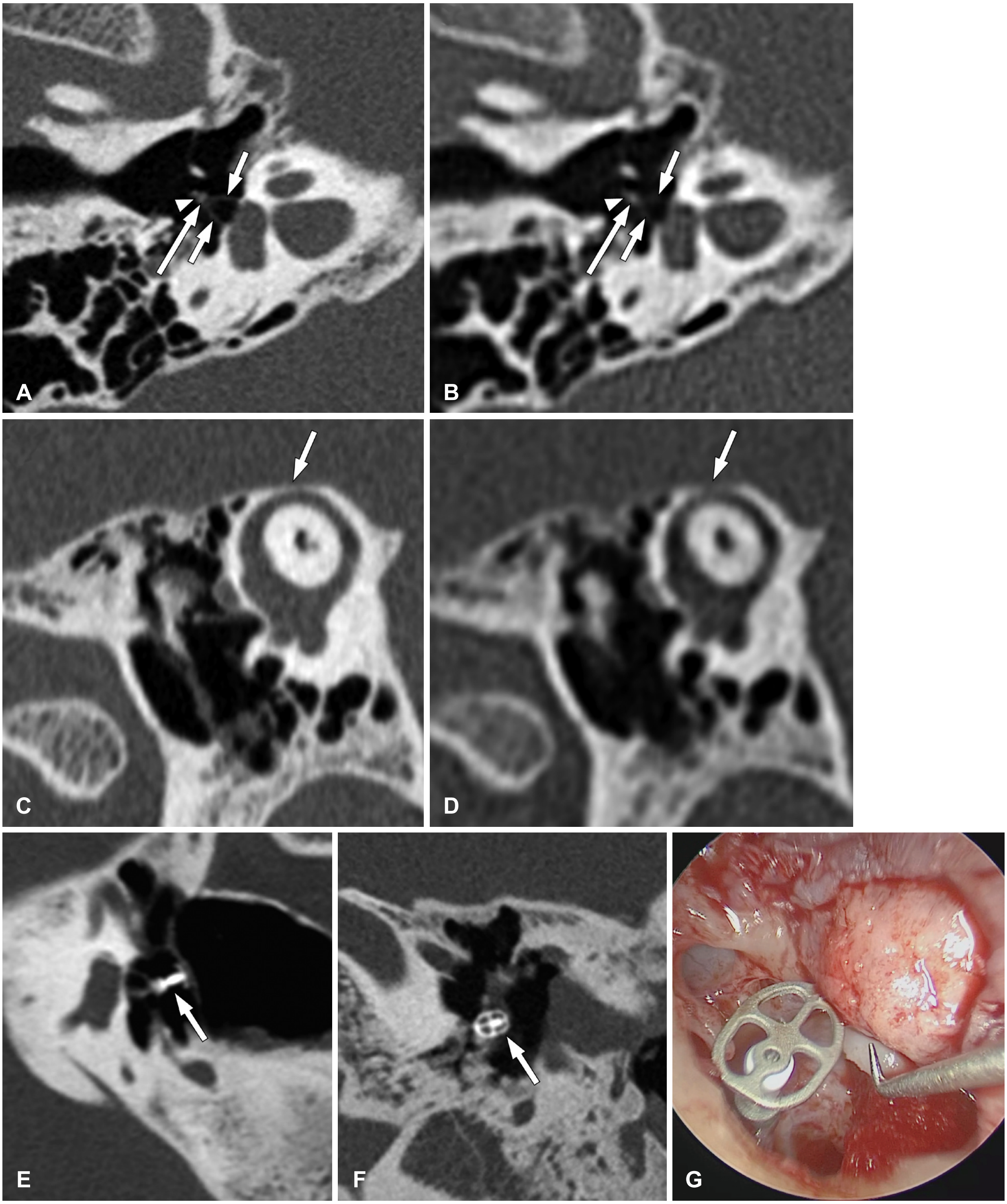

Fig. 1. Examples of improved image quality of ultra-high-resolution computed tomography (U-HRCT). A-D: Comparison between U-HRCT and multidetector-row computed tomography (MDCT). U-HRCT (A) and MDCT (B) oblique axial temporal bone images of the same patient show the head (long arrows) and crura (short arrows) of the stapes and the incudostapedial joint (arrowheads). Note that the U-HRCT image (A) has considerably higher spatial resolution than the MDCT image (B), better depicting these delicate anatomical structures (slice thickness, 0.25 mm vs. 0.5 mm). U-HRCT (C) and MDCT (D) Pöschl reformatted temporal bone images of the same patient show thinning of the bone covering the superior semicircular canal (arrows). This region is poorly visualized in MDCT image (D), which could be misinterpreted as superior semicircular canal dehiscence. E-G: U-HRCT and endoscopic images of an ossicular prosthesis. Oblique axial (E) and sagittal (F) U-HRCT temporal bone images show a partial ossicular replacement prosthesis (arrows) connecting the tympanic membrane to the stapes. The prosthesis components are clearly depicted on U-HRCT images owing to their high spatial resolution and reduced partial volume effect, with no significant metal artifacts. An endoscopic view (G) of the prosthesis is shown for comparison.

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Conflicts of Interest

The authors have no financial conflicts of interest.

Author Contributions

Conceptualization: Carolina Ribeiro Soares, Rafael Maffei Loureiro. Data curation: Rafael Maffei Loureiro, Carolina Ribeiro Soares. Investigation: Rafael Maffei Loureiro. Project administration: Rafael Maffei Loureiro. Supervision: Carolina Ribeiro Soares. Visualization: Rafael Maffei Loureiro. Writing—original draft: Rafael Maffei Loureiro, Daniel Vaccaro Sumi. Writing—review & editing: all authors. Approval of final manuscript: all authors.

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