Introduction

Conventional Temporal Bone CT scan is a standard diagnostic tool for evaluating the inner ear anatomy, though its limitations in evaluating cases of inner ear anomalies have been well documented. The purpose of this study was to evaluate the role of 3D reconstructions of CT scans in the evaluation of inner ear anomalies.

Methods

Subjects: This retrospective study examined the temporal bone CT scans of 20 patients (20 ears) who had undergone complete clinical evaluation. None of the scans did not have abnormalities of the inner ear identified on the initial scan, while the other 10 scans had a variety of abnormalities. The three structures examined were: cochlea, semicircular canals, and internal auditory canal (IAC). The scans were obtained on a 4 channel multidetector CT (SOMATOM Definition AS). All subjects were adults (age range 15 to 75 years).

Scanning Protocols: The 2D and 3D reconstructions were performed in the following manner. All the scans were obtained using 0.6mm collimation at 320 mAs and 120 kVp. Pediatric scans were obtained using 0.5mm collimation at 320 mAs and 120 kVp. Reconstructions were performed on a GE HiSpeed Advantage CT scanner (General Electric, Milwaukee, WI) using a 1024 x 1024 image matrix with a bone algorithm (320 mAs, 120 kVp). The remainder of the scans were obtained on a 4 channel multidetector CT (SOMATOM Plus or Volume Zoom). Siemens, Erlangen, Germany). These scanners were equipped with a bone algorithm and a 320 mAs and 120 kVp. Pediatric scans were also performed using 0.5mm collimation at 200 mAs and 120 kVp. Radiologic data were collected using a 1024 x 1024 image matrix. All cases were reviewed by a neuroradiologist and a radiology resident respectively.

Image Analysis: Two methods of image analysis were performed. The first step was reviewing the 2D scans first with axial and coronal views. The readers then added value of the 3D reconstructions. The second step was reviewing the 3D reconstructions first and then adding the value of the 2D scans.

Results

For each structure examined (cochlea, cochlear nerve, semicircular canal), 2D reconstructions improved detection of malformations of the inner ear. In two cases of severely malformed inner ear, 3D reconstructions did not improve agreement with the expert reader.

Tables 1 and 2 show the percent improvement of volume-rendered, semi-automated 3D reconstructions over 2D scans. A total of 12 scans were performed on the 3D reconstructions. Of these 12 scans, 7 were from patients with inner ear anomalies and 5 were normal. The 3D scans were reviewed by four radiologists who have been working on 3D reconstructions for the past two years. The four readers were blinded to the clinical data. The four readers independently reviewed the 3D reconstructions and then added the value of the 2D scan. Rankings were then compared to an expert reader's.

Table 1 shows the percent of abnormalities correctly identified for each reader. The 2D scans and the 3D scans had a sensitivity of 27% and 77%, respectively for cochlear anomalies. The 2D scans had a sensitivity of 22% and the 3D scans had a sensitivity of 67% for semicircular canal anomalies. The 2D scans had a sensitivity of 22% and the 3D scans had a sensitivity of 67% for IAC anomalies.

Table 2 shows the average percent of structures correctly identified for each reader. The 2D scans and the 3D scans had a specificity of 77% and 67%, respectively for cochlear anomalies. The 2D scans had a specificity of 77% and the 3D scans had a specificity of 67% for semicircular canal anomalies. The 2D scans had a specificity of 77% and the 3D scans had a specificity of 67% for IAC anomalies.

Discussion

In our study, we demonstrated that the use of 3D reconstructions can improve detection of malformations of the inner ear. The four readers were blinded to the clinical data. The four readers independently reviewed the 3D reconstructions and then added the value of the 2D scan. Rankings were then compared to an expert reader's.

Conclusions

Our study design with rankings of “likely abnormal” and “definitely abnormal” did not allow for a sensitive test of the clinical or educational application of 3D reconstructions. Further validation studies should be performed with a comparison to histological sections.

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Summary and Discussion

- 3D reconstruction of CT scans can be rapidly and reliably improved.
- Our methods describe a rapid and reliable method of performing 3D reconstructions of the inner ear. The potential clinical or educational application of 3D reconstructions requires that they are economical as well as reliable. Further validation studies should be performed with a comparison to histological sections.

- 3D reconstructions improved between the addition of the 3D reconstructions to the 2D scan. In cases of severe malformations, the addition of the 3D reconstruction did not improve agreement with the expert reader.

References