COMPARING OF IMAGE QUALITY OF AXIAL AND CORONAL CT SCAN OF TEMPORAL BONE

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Abstract - *CT image quality has been affected by many factors such as KVP, ma, exposure time, alogorithm and section thickness. Gantry tilt has the main role in visualization of the temporal bone anatomic structures. In this study, we tried to optimize these factors to determine the best gantry tilt. This study was performed on the human skull phantom and then extended to 15 patients. The phantom was made by inserting a normal human dry skull into a water - filled radiolucent cylandrical container. A lateral scout view was obtained and the OMBL (orbitomeatal baseline) was used as the anatomical landmark.*

The phantom was scanned in 9,15,30,45,60,75,90,105,120 degrees in relation to OMBL and 24 important anatomical structures were evaluated in each. Kilovoltage of 80, 120, 140 millimeters of 40,70,100, 120, 140, 170, 200, 240, exposure time of 2,3,4 seconds, algorithm of smooth, soft, standard, detail, bone adge and section thickness of 1.5, 3,5 millimeter were studied seperately. In general, most of the anatomical structures are well demonstrated in 0 or 30 degrees of axial scans and 90 or 105 degrees in coronal scans. The best imaging techniques is Kv=140, Ma=100, S=2 seconds, algorithm of edge or bone, section thickness of 1.5 millimeter for small structures and 3 millimeters for greater ones.

The best 3-D image is provided by 3 millimeter slice thickness without overlapping but they couldn't assist in diagnosis of our patients' diseases. In indirect sagital reformated images, the greater anatomical structures such as vestibule and cochlea are also shown, but they are not recommended due to the slight degradation of the images and some loss of resolution.
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INTRODUCTION

At present, CT scan is the most accurate method for evaluation of the petrous bonr (1). Development of CT scan in imaging of the temporal bone and severe potential requirements to depict the detailed anatomical structures of this region are two factors which make the images well optimized (2).

Therefore, in this research the important factors in image formation were investigated and a struggle had been made to optimize them. These factors include exposure factors such as Ma, exposure time, gantry tilt, reconstruction algorithm and section thickness. In this study, three dimensional images and indirect sagital slices of temporal bone have also been investigated.

MATERIALS AND METHODS

In this study, third generation CT scanner model G.E.9800 located in Imam Khomeini Hospital was utilized. First of all, an intact human skull of a 30 years old man was chosen. Then the dried skull was inserted into a radiolucent cylandrical container. Imaging of the temporal bone were carried out in nine stages, and each image has been given to 3 radiologists to classify them into 3 groups according to thier visualization and image quality: good, intermediate and poor. In first stage, a lateral scout view was taken to localize the external auditory canal and other bony landmarks. The orbito-meatal baseline was selected as a standard zero line and the other lines were drawn, according to it. In this stage 24 anatomical structures in zero 15, 30, 45, 60, 75, 90, 105, 120 degrees according to O.M.B.L were studied. In the second exam, the other factors were fixed and kilovoltages of 80, 120, 140 were examined. In the stage, slice thickness of 1.5, 3 and 5 millimeter and in the fourth stage, standard, soft, smooth, datail, bone and edge reconstruction algorithm, in the fifth stage, 40, 70, 100, 140, 170, 200, 240, and 270 milliamperes, in the sixth stage, exposure factors of 2,3 and 4 second and in the seventh stage indirect sagital sectons of the temporal bone were investigated and best of them were selected. In the eighth stage, 15 patients were examined and in the ninth stage a recconstructed 3-dimensional image of each patient was obtained. In each stage, window width of 3000 to 4000 and the best window levels were chosen.

RESULTS

The results obtained from stage one showed that the best gantry tilt in axial section are zero and 30

degrees since most of the anatomical structures of temporal bone would be visualized in these angles.

Zero angle will also depict the lower portion of the temporal bone as well. Therefore for evaluation of carotid canal, jagular foramen, eustation tube and cochlea this angle would be appropriate. Gantry tilt of 30 degrees is the most suitable one in which anatomical elements of inner ear do not distort and structures such as horizontal protoin of facial nerve canal, oval and round windows are observed. In this angle, most of the ear anatomical structures and all of the semicircular canals are also observed. In coronal section the best gantry tilt which were able to depict most of the anatomical elements of the temporal bone were 75, 90 and 105 degrees. The oval and round windows were observed in 30 degrees in axial view and 75 and 90 degrees in coronal section. The connection between oval windows and eustation tube was also visualized at 105 degrees. For demonstration of the descending portion of the facial nerve canal the gantry tilt of 105 degrees and for visualization of scutum the tilt of 90 and 105 degrees were the best ones. Even though the external auditory canal was observed in zero and 15 degrees but the best gantry tilt were 90 and 105 degrees. Cochlea is demonstrable in most of the gantry tilt in axial and coronal sections, however, all of it's loops are observed in 75 degrees as well.

In this research, the definition of images was better in 140 Kv than 120 Kv and 80 Kv. The results also showed that the milliampers had not any considerable effect on image quality but the images which were obtained with 100 ma and more, were rather good.

The exposure time of 2, 3 and 4 seconds had no effect on the images. It was shown that the slice thickness of 1.5 millimeter was the best one to observe all of the temporal bone sturctures. But if the small amount of detail is not to be considered, slice thickness of 3 millimeter would be sufficient.

For demonstration of mastoid air cells, internal auditory canal, petrous tip and foramina of skull base, the slice thickness of 3 millimeter could also be utilized.

Edge algorithm and bone algorithm were accepted as best reconstruction algorithm respectively. However it should also be noted that adge algorithm has some amount of aliasing artifact than bone algorithm. In a three-dimensional image of temporal bone, all of the skull base foramina, petrous pyramid and arcuate eminence are also observed in norma cranialis. The connection of temporal bone with adjacent bones such as foramen magnum and clivus are observed but three-dimensional images of all the patients showed no finding to confirm the disease. In reformation technique, external auditory canal, mastoid antrum, semicircular canal, vestibule and malleus were observed.

DISCUSSION

Clinical application of tomographic slice of zero angle in glomus tumors, jugular bulb divérticula (3), carotid artery anommalies (4) and aneurysm, acoustic neuroma, eustation tube dysfunction and dislocation or destruction of ossicles were approved. In this tilt, cochlear aqueduct and horizontal portion of facial nerve canal are observed which is contrary to Chacker's results. The best views for demonstration of carotid canal in axial section is zero or 30 degrees and then coronal section in 90 degrees which is not quite compatible with Chacker's results which suggest 70 degree. Because of the observation of malleus in coronal sections in 75, 90 artd 105 degrees and descending portion of facial nerve canal in 105 degrees and scutum in 90 and 105 degrees it is clinically suggested that these angles could be utilized in cholesteatoma, anomalies of auditory ossicles, fractures, disturbance of facial nerve and congenital anomalies such as aural atresia. For demonstration of middle ear congenital anomalies, the coronal section is recommended by Charsdorfer et al. (5) without any attention to it's tilt.

Viraponze et al (6). compared low kilovoltage with high kilovoltage technique, and concluded that the detail is improved in highkilovoltage technique. In thier survey, the milliamperes were not fixed at the two tecnique, so the effect of kilovoltage on image resolution could not be approved. But in our study all imaging factors were fixed and kilovoltage alone was altered in order to show it's effect on the image quality. Chackers et al. used 192 ma to 1152ma and concluded that maximum mas was not necessary for better image quality (7). In their study, since the multiplication of millimpers and exposure time is used, the effect of each one has not been approved independently. However their recommendation for reducing the exposure time is quite compatible with our study.

Taylor and co-workers suggested 5 millimeter slice thichness for extensive pathologies such as tumors. But these kinds of pathologies were not included in our study. However it is assumed that in order not to miss the diagnostic information it is better to use the minimum slice thickness of 3 millimeter.

Taylor and coworkers utilized the algorithm in which raw data was reconstructed on a 25 millimeter pixel size then displayed on a 320 ×320 matrix size (8). In our study window width of +3000 to +4000 is used and the pixel size is smaller than Taylor's study. Therefore it is assumed that the resolution of our images are better than Taylor's because "edge" computer programe is used. In Chacker's study, bone algorithm is used to reconstruct the raw data (7).

In our CT scanner, a very good reconstruction programme (edge) in which the spatial resolution of 0.16 or even less is accessible, can be used to image the anatomical structures with high inherent contrast such as temporal bone.

Sprinzle (9) in his study investigated the possibility of 3-D image reconstruction of temporal bone without disputing it's clinical application. In kawana study the role of 3-D CT scan of temporal bone in diagnosis and treatment of the cholesteatoma is approved (10). With respect to kawana and Shamsolahrar (11) it is recommended that in some cases of petrous fractures and other extensive malformations, the 3-D images can probably be helpful.

In an indirect sagital reformated reconstruction image of temporal bone, the thin structures were close together so that the motion artefact deteriorated their definitions. The quality and resolution of these images are inferior and in our patients doesn't help to determine their lesions.

REFERENCES

1. Swartz J. High resolution computed tomography of middle ear and mastoid. Radiology 148: 42-54; 1983.

2. Virapongse C.Computed tomographic anatomy of the temporal bone. AJR. 139: 739-749; 1982.

3. Graham M.D The jugular bulb: it's anatomic and clinical considerations in contemporary otology"; Laryngoscope, 87: 105-125; 1977.

4. Anderson RD, "Aneurysm of the internal carotid canal of the petrous temporal boen"; Radiology, 102: 639-642; 1972.

5. Kioyd T.V; "Aberrant jugular bulb presenting as a middle ear mass", Radiology 131: 139-141; 1979.

6. Virapongse. C, sawar, et al: "The role of high resolution computed tomography in evaluation disease of the middle ear"; J.Comput. Assist. Tomogr, 6: 711: 1982.

7. Chakers, DW, RK. spiegel; "A systemic technique for comprehensive evaluation of the temporal bone by computed tomography"; Radiology, 146: 97; 1983.

8. Taylor; "The petrous temporal bone". Radiologic clinics of north America, 20: 67; 1982

9. Sprinzl, G.M., "The temporal bone'; HND, 40 (6): 206-14; 1992.

10. Shaffer K.A.: High resolution computed tomography of the temporal boen"; Radiology, 134: 409-14; 1980.