原 著

Comparison of Two and Three Dimensional CT with Regard to the Diagnosis of Musculoskeletal Lesions

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Abstract

A comparative study between conventional CT, 2D-MPR CT and 3D-CT was performed on 50 patients with bone lesions in order to evaluate which method of imaging provides a better understanding of musculoskeletal disorders and also to determine which is more useful in the detection and characterization of bone lesions. The results of our study indicate that 2D-CT scans readily demonstrated fractures and the presence of intra-articular fragments. With their accurate display of the bone defect, three-dimensional images helped in understanding the precise plane of the fracture, the degree of disruption of the articular surface and the spatial relationships of fragments[1]. Although the present 3D-CT is not without its limitations, we believe that the technique is both valuable and clinically feasible, especially in the stage of preoperative planning.

Key words : two and three dimensional CT, bone, image quality

Introduction

Abnormalities in regions of complex musculoskeletal anatomy such as the pelvis, shoulder, and face are often difficult to interpret by means of standard radiography. Two-dimensional CT provides excellent bone detail with soft tissue appreciation. However, in order to get the three-dimensional appreciation necessary for optimal surgical correction, the observer has to mentally integrate numerous two-dimensional images with extreme accuracy. This can be particularly difficult in areas of anatomical complexity such as the craniofacial skeleton, and especially in the presence of traumatic deformity. While multiplanar reformations of data are available in any plane, these images lack the spatial resolution of the original images from which they are created. Computer software for 3D-CT reformation allows the reconstruction of the bony skeleton from axial images and presentation of the images for display and filming in rotational projections[2-6]. The merits and limitations of 3D-CT images, in addition to conventional images including MPR-CT, in fulfilling the increased demand for a more detailed and comprehensive diagnosis of bone lesions, are discussed in the present study.

Materials and Methods

From July 1, 1991 to July 1, 1993 we examined 50 patients with bone lesions. The details of the sample are shown in **Table 1.** All patient examinations were performed on a Hitachi W200 CT scanner. The following scanning parameters were used : 2 and 3mm thick slices with serial 3mm table incrementation, no gantry angulation, 1-second scanning time at 450mA and 125kVp. The multiplanar reconstructed images were performed in the coronal, axial and sagittal planes. The 3-D images were performed at a 360° axis of rotation in virtually any plane. CT slice images were recorded on film hardcopy with a 12 on 1 format on 14×17 in sheets of film. The 3D reconstruction technique used in this study provides a method of producing geometrical surfaces from serial cross-sectional contours. These surfaces can then be graphically

Table 1. Breakdown of the cases

Bone	lesions	(n= 50)
	pelvic fracture	11
	craniofacial fracture	18
	femoral fracture	9
	P.O.* craniofacial bone defect	8
	vertebral fracture	2
	miscellaneous	2

*P.O.: postoperative

Table 2. Comparison of CT scan quality in bone lesions

Diagnosis	Superior	Equivalent	Inferior
Craniofacial fracture	3/18	5/18	10/18
Pelvic fracture	4/11	2/11	5/11
Femoral fracture	1/9	3/9	5/9
Vertebral fracture	1/2	1/2	0/2
P.O. craniofacial bone defect	8/8	0/8	0/8
Miscellaneous	2/2	0/2	0/2
Total	19/50	11/50	20/50

"Superior" means that on 3D CT the bone lesion was easier to recognize than on 2D CT.
"Equivalent" means that there was no difference between 3D CT and 2D CT on the identification of the bone fracture.
"Inferior" means that the bone fracture could not be recognized on 3D CT, but was easier to recognize than on 2D CT.

displayed and viewed from any desired direction. It provides a way to appreciate the three-dimensional shapes of anatomical structures and the spatial relationships between different structures.

Diagnostic Criteria : Conventional CT, MPR CT and 3D CT were compared with regard to the assessment of displaced and undisplaced bone fractures and the spatial location of the bone fragments. Evaluation was conducted by three radiologists. Nine of the bone fractures were displaced and comminuted.

Results

Table 2 shows the results of 2D axial, MPR-CT and 3D-CT with regard to the assessment of bone defects and both complicated and non-complicated bone fractures. Conventional CT and MPR CT were 100% accurate in diagnosing the displaced and undisplaced bone fractures and the presence of intra-articular fragments, as compared with 60% accuracy on 3D CT. Axial and MPR CT scans readily demonstrated the fractures and presence of intra-articular fragments. Three-dimensional images helped in understanding the precise plane of the fracture, as well as the bone defect, the degree of disruption of the articular surface, and the spatial relationships of fragments.

In the matter of a complicated bone fracture, 3D-CT was superior to 2D-CT in all the cases of displaced and comminuted bone fractures (9/9, 100%). The 9 bone fractures involved included 3 of the craniofacial region, 4 of the pelvis, one of the femur and one of a lumbar vertebra. It showed more clearly the exact extension of the bone fracture in a few rotational views. Also, the spatial location of the bone fragments was easily understood from 3D-CT images **(Fig.1,2)**.

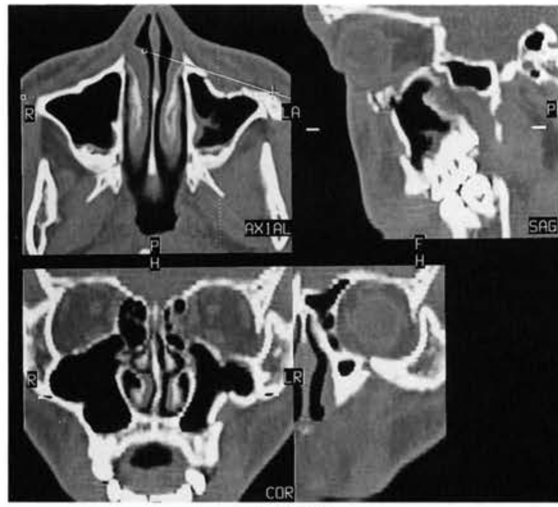

Fig.1 A-D

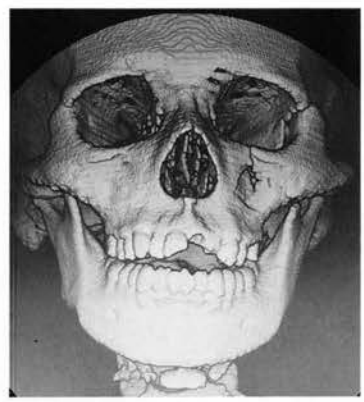

Fig.1 E

Figure 1.
This is a case of a left zygomaticomaxillary complex (triploid) fracture. On axial conventional CT (A) and on sagittal and coronal MPR-CT (B-D) fracture of the anterior wall of the left maxillary sinus with downward displacement is noted. The left zygomatic arch fracture can also be visualized clearly. On 3D-CT the whole fracture is visualized in only one rotational view (E).

With a non-complicated bone fracture, 3D-CT failed in detecting most of the cases of undisplaced bone fracture (20/31, 64.5%) which may be explained in

Fig.2 A-D

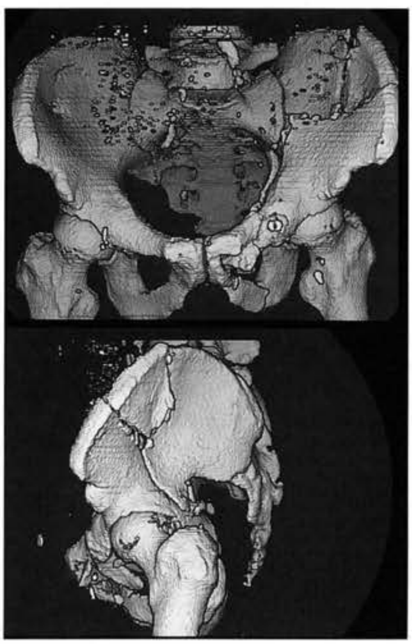

Fig.2 E-F

Fig.2 G

Figure 2.
This is a case of an acetabular fracture at the left anterior column. Numerous axial 2D-CT (A) and MPR-CT images (B-D) demonstrated on separate scan levels that the fracture extends from the ischiopubic ramus through the acetabular fossa and into the anterior aspect of the iliac crest. 3D-CT on the pelvic outlet and inlet rotational views show the precise plane of the fracture (E,F).

part by the surface reconstruction technique used and poor spatial resolution **(Fig.3)**. These non-complicated bone fractures included 10 of the craniofacial area, 5 of the pelvis and 5 of the femur.

As for bone defects, 3D-CT showed better than 2D-CT the eight cases of post-operative craniofacial bone defects and two cases of bone cysts associated to aberrant submandibular gland tissue **(Fig.4)**.

Discussion

Our experience with 50 patients with musculoskeletal lesions indicates the feasibility of using 3D-CT as an adjunct to other imaging techniques. Some physicians believe that the method does not provide new data but rather presents standard data in a different manner. This premise, however, is not entirely accurate. In evaluations of spinal trauma and failedback syndrome, 3D displays enhanced the detection of an additional pathology, not perceived on two-dimensional images. The application of this method has a similar effect on the detection of craniofacial, head and neck pathology[7]. In the current study, conventional CT and MPR-CT were 100% accurate in diagnosing the bone fractures and the presence of intra-articular fragments, as compared with 60% accuracy on 3D imaging. Three-dimensional images

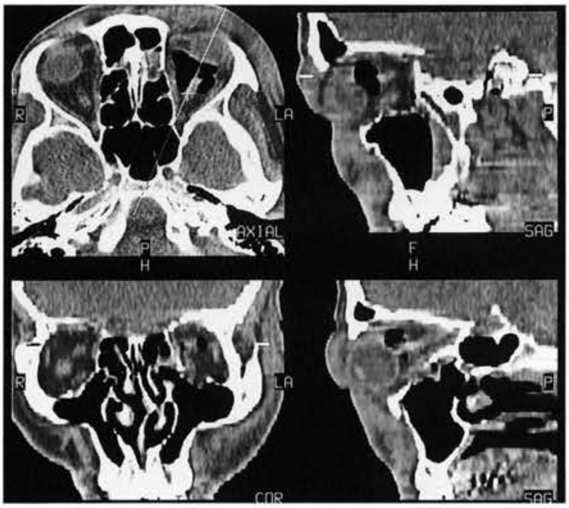

Fig.3 A-D

Figure 3.
This is a case of a left blow out fracture. On axial conventional CT air collection is noted in the left retro-orbital region (A). On sagittal and coronal MPR-CT fracture of the left orbital floor is clearly visualized (B-D). On 3D CT this undisplaced fracture could not be identified.

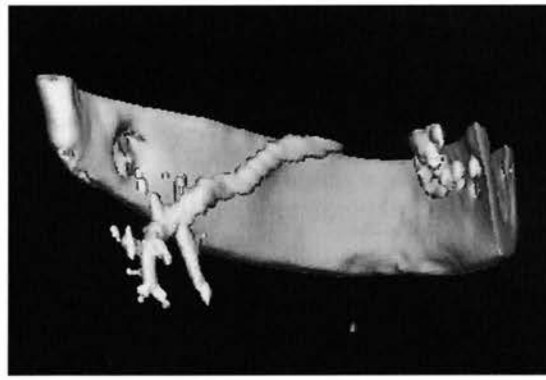

Fig.4

Figure 4.
This is a case of a mandibular bone cyst, due to right hypertrophoid submandibular gland tissue. A three dimensional CT combined sialogram, with a view from the bottom, demonstrates the topographic relation with the cortical bone defect of the right mandible.

helped in understanding the precise plane of the fracture, the degree of disruption of the articular surface, and the spatial relationships of fragments[2]. The failure of 3D CT to assess undisplaced fractures successfully may be related to the use of surface-rendering reconstruction programs. These programs preserve only the surface boundaries of a given object. This drawback in the use of 3D imaging in the evaluation of undisplaced bone fractures and such thin bony structures as the ethmoid sinus and the nasal cartilage had been already overcome by using volumetric rendering programs. This differs from surface rendering in that all the imformation from the CT scans is preserved, not just surface boundaries. Volume rendering can preserve such subtle surface details as nondisplaced fractures that can be less than 1 pixel wide[8]. 3D reconstructions were performed from data obtained during the initial CT evaluation. This data was taped and transferred to a separate computer for further analysis.

Multirotational views of the structure of interest provide views previously unavailable with other methods. We conclude that 3D-CT is a valuable diagnostic tool that complements two-dimensional CT in providing a more detailed and comprehensive pre-operative diagnosis.

Finally, it is worth noting that since the complete examination took only a few minutes, patients were not subjected to spending additional time in the radiology department.

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