ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN — POLONIA
VOL. LV, 58 SECTIO D 2000

II Zakład Radiologii Lekarskiej Akademii Medycznej w Lublinie
II Department of Radiology, Medical University of Lublin

WITOLD KRUPSKI, GRAŻYNA ZŁOMANIEC,
JANUSZ ZŁOMANIEC

Virtual computed tomography in the evaluation of the vertebral canal

Wirtualna tomografia komputerowa w badaniu kanału kręgowego

In CT examination of the vertebral canal spatial pictures referred to as virtual ones are used side by side with two-dimensional and multi-planar reconstructions (3, 5, 9, 10).

The aim of the paper is to evaluate the diagnostic value of CT virtual reconstructions in visualizing different diseases of the vertebral canal.

MATERIAL AND METHOD

The material comprises 28 patients aged 17-78 years (10 women and 18 men). Examinations were performed with Somatom AR.T apparatus by Siemens. Axial CT sections were done in continuous layers 2 or 3 mm thick. Numerical information on axial sections contained in computer's memory were used for virtual reconstruction. For osseous pathology 150 H.u. threshold was used while in the diagnostics of discopathies reconstructions with the threshold slightly below the density of disc mass i.e. about 50-80 H.u. were used.

Vertebral canal was assessed in superior and inferior projections, perpendicular after cutting off in the fibular plane along spinous processes, oblique along the axis of intervertebral foramens. Cutting off of vertebral bodies enabled the evaluation of arches from the side of the vertebral canal whereas cutting off the arches made possible observations of posterior surfaces of vertebral bodies.

Fig. 1. Fracture of C5 vertebral body, anterior slip, partial stenosis of the vertebral canal with the tightening of intervertebral foramen C5-C6

Fig. 2. Anterior slip L5-S1 with the narrowing of intervertebral fissure and vertebral canal at this level

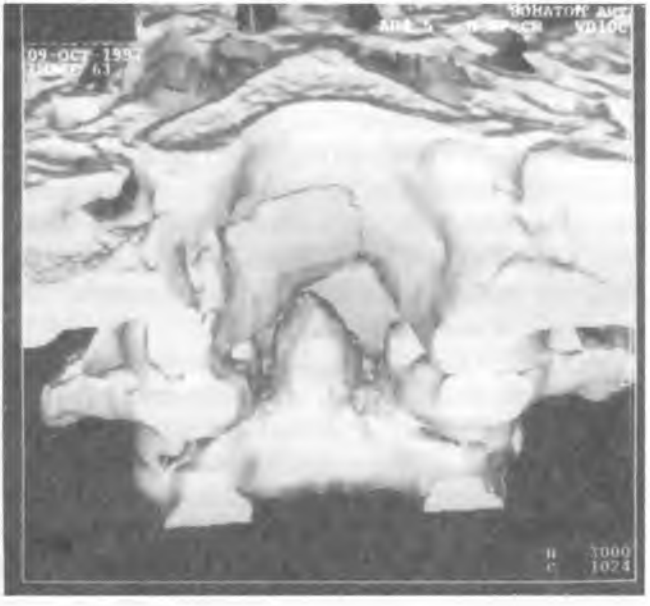

Fig. 3. A bone fragment of C1 anterior arch on the left side

Fig. 4. Osteophytary stratification of posterior margins of C5-C6 vertebral bodies with reduced intervertebral foramen. Degenerative stenosis of the vertebral canal.

RESULTS

In 8 cases of compressive fractures of vertebral bodies with fragmentation and displacement of fragments to the vertebral canal medial sections revealed the degree of deformation and extent of canal narrowing (Fig. 1). In 5 cases tightening of intervertebral foramens was considerable. However, in 2 patients with pathologic compressive fractures of vertebral bodies (angiomas) angular deformation and narrowing of the vertebral canal coexisted with only slight narrowing of intervertebral foramens. Fibular virtual reconstruction cut across the middle of the canal revealed intraspinal intussusceptions in posttraumatic dislocations of vertebral bodies (Fig. 1).

Narrowing of the vertebral canal and its backward displacement were the commonest manifestations of intraspinal intussusceptions of a comminuted vertebral body. Contours of vertebral canal were more distinct as compared to two-dimensional sections, sometimes without reconstructing totally fragmentation fractures. In 2 cases of L5-S1 slip virtual reconstructions revealed, side by side with partial stenosis of the vertebral canal and narrowing of the intervertebral foramen, also intussusceptions of the postero-superior S1 edge to the inside of the vertebral canal (Fig. 2). VR revealed fissures of fractures often imperceptible on axial sections and allowed to determine coexisting intussusceptions of posterior parts of vertebral bodies.

Intracanalar fragments were found in 11 patients. It was essential to determine their optimal position, horizontal and vertical displacements, rotation and inclination (banding). Cutting off of the dorsal part of vertebral bodies showed directions of intussuscepted fragments and their margins. In 3 cases full reconstruction of bone fragment of C1 arch was obtained (Fig. 3). In 3 cases VR showed arch defects at other levels coexisting with fractures of the spinous process or other arch elements.

In 14 cases bone stratifications of posterior margins of vertebral bodies and surfaces of articular processes caused generative stenosis of the vertebral canal (Fig. 4). They were always accompanied by different degree narrowing of the intervertebral foramen which was easy to recognize due to the possibility of comparing the diameter of intervertebral foramens at different levels. Tissue threshold reconstructions projected from the above revealed the mass of vertebral pulp nucleus prolapsed into the canal.

DISCUSSION

VRs visualize the internal space of the vertebral canal letting evaluate its narrowings. They revealed the presence of bone fragments determining their position and posttraumatic dislocations of vertebral bodies. The degree of canal stenosis is defined as slight when it is 20%, moderate at 50% and severe over 50% (4, 8).

Displacements of three bone fragments into the vertebral canal and defects of its bone walls were visualized in a beneficial projection using cutting function, change of illumination direction and rotations of the reconstructed picture (2).

VRs are the technique of choice in the precise assessment of degenerative narrowings of the vertebral canal revealing intussuscepting osteophytes and stratifications of vertebral body margin. Similarly, evaluation of degenerative narrowings of intervertebral narrowings is beneficial in VR (7).

In degenerative spondylolisthesis VR spatially reconstruct vertebral arches, degree of vertebral canal narrowings and intervertebral foramens. In real spondylolisthesis VRs reveal defects of arch isthmus.

VRs visualize calcifications and fragments of pulpy nucleus prolapsed into the canal.

VRs are a qualitatively different way of vertebral canal imaging enabling the insight into its lumen (6). They enable the simultaneous assessment of the complex pathology of the vertebral canal at different levels. Similarly, virtual CT mielotomography gives new possibilities of imaging meningeal sack and nervous roots (1).

The possibility of cutting off of fragments of a reconstructed canal enables revealing its subsequent levels covered by bone structures. Permanent observation of a reconstructed picture during the manipulation allows to choose an optimal projection.

CONCLUSION

1. Traumatic VR of vertebral canal narrowing caused by the prominences of the posterior parts of vertebral bodies, dislocations of vertebrae and three bone fragments in the canal reconstruct narrowings of intervertebral foramens enabling the comparison of their diameter at different levels.

2. VR can be used to assess the presence of disc mass in the vertebral canal.

REFERENCES

1. Becker H: New aspects in spinal diagnostics with 3D computed tomography. Neurosurg. Rev., 16, 179, 1993.
2. Billet F. et al.: Computed tomography in traumatology with special regard to the advances of three-dimensional display. Arch. Orthop. Trauma Surg., 111, 131, 1992.
3. Bryc S. et al.: Trójwymiarowe rekonstrukcje TK w badaniach zmian urazowych kręgosłupa. Pol. Przegl. Radiol., 62, 203, 1997.

4. Haaga J. et al.: Computed Tomography and Magnetic Resonance Imaging of the Whole Body. 3rd edn. Mosby, 1994.
5. Mackey S.: Use of three-dimensional CT scanning in the lumbar spine. Radiogr. Today, 57, 17, 1991.
6. Payrin F. et al.: 3D display of high resolution vertebral structure images. Comput. Med. Imag. Graph., 17, 251, 1993.
7. Smith G. et al.: Measurement of vertebral foraminal dimensions using three-dimensional computerized tomography. Spine, 18, 629, 1993.
8. Vogel W. et al.: Preliminary results for CT examinations of spinal fractures with a Somatom Plus 3D Sowtware Program. Advances in CT. Zurich, ed. Fuchs W. 144, 1990.
9. Zinreich S. et al.: Three-dimensional CT Imaging in Postsurgical "Failed Back Syndrome". J. Comput. Assist. Tomogr., 14, 574, 1990.
10. Złomaniec J. et al.: Wartość opcji przestrzennej 3D TK w ocenie otworów międzykręgowych. Neur. Neurochir. Pol., 33, 825, 1999.

Otrz.: 2000.09.30

STRESZCZENIE

W grupie 28 chorych z różnorodną patologią kanału kręgowego analizowano wartość diagnostyczną rekonstrukcji wirtualnych (RW) TK. Oglądano w czasie rzeczywistym zrekonstruowany obraz wnętrza kanału kręgowego w dowolnym rzutowaniu, skręcając i nachylając struktury kręgosłupa pod dowolnym kątem i w każdej osi. Przy rzutowaniach bocznych odcinano części przesłaniającego obrazu, co umożliwiało oglądanie poszczególnych ścian kanału w sposób izolowany. Manipulując obrazem przestrzennym, uwidaczniano geometrię uszkodzeń drogą otworzenia głębi przestrzennej. Ujawniano wyrośla kostne wnikające do wnętrza kanału kręgowego oraz otworów międzykręgowych. W zmianach urazowych odtwarzano stopień zniekształcenia i zwężenia kanału kręgowego, obecność i położenie fragmentów kostnych łącznie z przemieszczeniami dokanałowymi zwichniętych trzonów.