Evaluation of degenerative diseases of the lumbar spine with reformatted and 3-dimensional computed tomography images

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ABSTRACT

Objectives: To evaluate the identification of degenerative lesions of the lumbar spine with multiplanar reformatted images and 3-dimensional computed tomography (3DCT).

Methods: Fifty-three patients with degenerative spinal disease findings on lumbar CT scanning were reviewed in this retrospective study at the Department of Radiology, Medical Faculty, Sutcu Imam University, Kahramanmaras, Turkey between January 2006 to January 2009. Two-dimensional multiplanar reformatted and 3DCT images were obtained. First, the axial CT images, and then 2-dimensional multiplanar reformatted images (2DMPR) were evaluated. The findings seen on reformatted CT images that were not visualized, or visualized only in retrospect on axial images were recorded. Finally, the 3D images were evaluated by the same team. The results were again recorded in the same manner.

Results: When 53 patients were taken into account, the 2DMPR provided better visualization of lateral neural foraminal stenosis in 62%, bulging of the disc in 32%, degenerative retrolisthesis in 15%, and spondylolysis in 15% as compared to axial images. The 3DCT images clearly revealed the presence of lateral neural foraminal stenosis in 41%, degenerative retrolisthesis in 13%, lateral spondylolisthesis in 15% as compared to axial and 2DMPR.

Conclusion: The 2DMPR and 3DCT images provide significant anatomic and diagnostic information not readily derived from axial CT. It is useful in detecting the degenerative diseases of the lumbar spine and their complications.
Methods.

Results.

Table 1
Table 1 - C

<table>
<thead>
<tr>
<th>Cases</th>
<th>n (%)</th>
<th>(2DMPR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervertebral disc herniation</td>
<td>B</td>
<td>17 (32.0)</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>6 (11.0)</td>
</tr>
<tr>
<td>Spinal stenosis</td>
<td>C</td>
<td>7 (13.0)</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>33 (62.0)</td>
</tr>
<tr>
<td>Spondylolisthesis</td>
<td>S</td>
<td>3 (5.6)</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>3 (5.6)</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>8 (15.0)</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>8 (15.0)</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>6 (11.0)</td>
</tr>
<tr>
<td>3D are more informative over 2D MPR images</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal stenosis</td>
<td>C</td>
<td>4 (7.5)</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>22 (41.0)</td>
</tr>
<tr>
<td>Spondylolisthesis</td>
<td>S</td>
<td>3 (5.6)</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>2 (3.7)</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>7 (13.0)</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>3 (5.6)</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>8 (15.0)</td>
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</tbody>
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Discussion. S
Reformatted CT in degenerative lumbar spine condition is the preferred algorithm for all 3D musculoskeletal imaging applications, because it allows utilization of the entire CT data set in the creation of the 3D images, avoiding the extensive loss of information that is inherent in shaded surface rendering. The VR images also maintain the original anatomic spatial relationships of the CT data set and have a 3D appearance, facilitating the display of complicated anatomic information to clinical colleagues.

MR imaging is ideally suited in identifying pathology related to the soft tissues, including the disk, nerve roots, spinal cord, and ligaments, which are most often involved and causing symptoms in degenerative condition. Although no well-designed study has been performed, which conclusively proves the superiority of MR imaging over CT, most spinal radiologists consider this to be a fact, especially in more complex cases. However, CT scans still have some advantages over MRI for the imaging of osseous lesions. The CT imaging with multiplanar reformation capability allows for bony detail, which is a limitation with MRI.

The most common indication for lumbar CT examination is low back pain, with radicular pain to the lower extremity suggestive of disc pathology. Sagittal MPRs can be helpful to distinguish disc herniation from disc bulges and extruded disc fragments that may migrate caudad or cephalad in the epidural space. We found sagittal CT reformatted images to be very useful in the diagnosis of annulus bulging, disc herniation (especially in spondylolisthesis patients), and migration of disc herniations. Degenerative spondylolisthesis with an intact neural arch is caused primarily by severe degeneration of facet joints and discs, and results from intervertebral joint instability in combination with progressive disc narrowing. Focal stenosis of the canal below the pseudo-bulging disc may be present, along with a decrease in cross-sectional diameter of the neural foramina.

The pseudo-bulging disc is a major CT finding in spondylolisthesis. When there is minimal slippage, a pseudo-bulging disc can be misinterpreted as a herniated disc if one evaluates axial CT images alone. We avoided misdiagnosing herniated discs by closely analyzing our sagittal reformatted images. The use of reformatted sagittal scans can help evaluate the degree of foraminal and spinal stenosis caused by spondylolisthesis.

On axial CT scans, pars defects often simulate the adjacent facet joints because both the joints and defects are oriented in similar planes and separated by only a small distance. The sagittal plane is the optimal plane for evaluating the entire pars inter-articularis, because the obliquity in this plane is minimal. Our results showed that sagittal MPRs can clearly demonstrate very small degrees of slippage of a vertebral body that are not clearly recognized on axial CT. The type and severity of spondylolisthesis can also be classified more accurately, and the entire pars interarticularis visualized more completely with sagittal reconstructions.

Degenerative spinal stenosis of the lumbar spine is caused by many factors, some of which include disc bulging and herniation, ligamentum flavum hypertrophy, facet joint hypertrophy, and spondylolisthesis. In this study, the outline of the

**Figure 3 - R**

A) 2D sagittal reformatted images (bone windows) demonstrate anterior displacement of S1 on L5 with progressive disc narrowing (arrow). Note the foraminal stenosis due to the upward displacement of the superior articular process. Osteophytes in the narrowed disc space further compress the foramen. Minimal retrolisthesis of L4 on L5 is also visible.

B) This 3-dimensional sagittal image clearly shows severe foraminal stenosis (arrow) at the L5-S1 level.
The limits of CT resolution of soft tissues could make it difficult for surgeons to confirm the surgical level when the intraoperative anatomy is complex. However, we believe that 3DCT imaging improves the correlation of the images and allows more accurate evaluation of affected neural foramens in patients with scoliosis. Obtaining 3D images in scoliosis patients enables us to evaluate lateral neural foraminal narrowing, one of the most common causes of surgical failure. For many years, the intervertebral foramen, the intervertebral foramen, has been a major concern in spine surgery, especially in patients with degenerative conditions.

In our study, 2D sagittal reformatted images and 3DCT imaging were used to evaluate lateral neural foraminal compromise better than the axial images. While CT images in many patients who have spondylolysis at L5-S1, but not obvious on axial images. This encroachment of the inferior recess of the neural foramina is detected mainly on reconstructed images. Encroachment of the exiting spinal nerve root is significant because of the usual anatomic configuration of the neuroforamina are more easily visualized in the sagittal plane.

However, the size and configuration of the neuroforamina are more easily visualized only in the sagittal plane, the entire bony margin of the vertebral pedicles and lamina, where the dural sac is flattened. The most common cause of surgical failure is neural foraminal compromise. Stenosis mainly results from hypertrophy of the superior root of the exiting spinal nerve root. The descending nerve that has just exited the dural sac may be significant because of the usual anatomic configuration of the neuroforamina. The CT can show narrowing of the lateral recess and foramen.

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