

A Study of the Morphology of Lumbar Discs in Sitting and Standing Positions Using a 0.5T Open-Configuration MRI

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Introduction

The availability of open-configuration MRI systems with a vertical opening enables quantitative investigations of the morphology of lumbar discs with subjects standing in various vertical positions. Surface coils can be adapted to patient positioning devices in order to obtain adequate axial and sagittal views of the lumbar spine. Weights can further be supported by the subject in order to investigate the impact of an additional load on the spine. Dynamic changes in the shape of the discs can hence be studied as a function of standardized positions and measured quantitatively. We present here a prospective study designed to assess whether significant changes in the morphology of lumbar discs can be observed in subjects imaged in supine, seated and kneeling positions as well as to assess if differences can be observed when comparing subjects with degenerated abnormal discs to a population of normal controls.

Methods

Our subject selection considers a population of hospital personnel between 30 and 60 years of age. All candidates were first directed to a routine clinical examination in order to retain only asymptomatic subjects without history of low back problems. A routine 1.5T MRI examination of the lumbar spine was then acquired for each asymptomatic candidate. Candidates showing a normal MRI, as read by a senior radiologist, were retained to form a first group of normal control subjects. A second group was formed retaining asymptomatic subjects showing a moderate to severe L4-S1 disc degeneration on their 1.5T MRI. Altogether, 96 asymptomatic candidates had the 1.5T screening MRI in order to form the group of 25 asymptomatic control subjects without a degeneration, hereby termed the «normals». The first 25 candidates presenting a L4-S1 degeneration were also retained to form the group of «abnormals». Subjects from both groups were then imaged exploiting the central vertical opening of a 0.5T open-configuration SIGNA SP/i system. For each subject, 4 mm thick axial and sagittal T2W images centered on the L4-L5 and L5-S1 discs were acquired in the supine position, seated as well as kneeling with 0 and 30 degrees of trunk flexion. Positions were standardized using dedicated patient positioning devices adapting to the vertical opening of the SIGNA SP/i system as is shown on Figure 1.



For the seated and kneeling positions an additional set of images was also acquired loading the subject's shoulders with a vest of 40 pounds. For each subject, images were acquired in three successive appointments at the same time in the morning. Figure 2 below shows typical sagittal images in the supine (A), seated (B), kneeling without flexion (C) and kneeling at 30 degrees of flexion (D).



For each of the seven positions, measurements of the anterior-posterior and transverse diameters of the L4-L5 and L5-S1 discs were drawn from the axial images. Sagittal images were used to measure the

thickness of these discs at their anterior edge, center and posterior edge. Measurements were taken by two independent senior radiologists using a GE Advantage Window Workstation.

Results

Figure 3 shows typical results from our study. The figure presents the mean anterior, central and posterior thickness of the L5-S1 disc observed in sagittal images for each of the seven positions considered. Relative changes in the thickness of the disc from one position to the other are well displayed. Mean thickness values can also be compared for the «normal» (left) and «abnormal» (right) groups. Figure 4 presents results for the anterior-posterior and transverse diameters from the set of axial images of the L5-S1 disc.

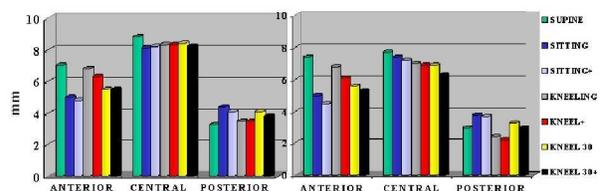


Figure 3

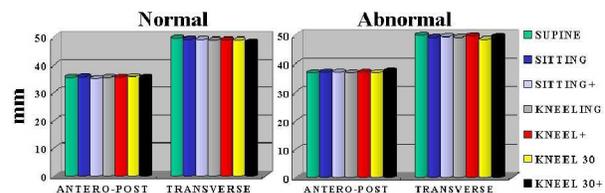


Figure 4

The results of Figure 3 show a statistical difference ($p < 0.05$) between normal and abnormal subjects when considering the central and posterior disk thickness in the kneeling position. From Figure 4, no significant changes in the disc anterior-posterior and transverse diameters can be noted between the different positions. Similar results are available for changes in the morphology of the L4-L5 disc.

Conclusions

From this study we conclude that the L4-L5 and L5-S1 discs have similar behaviors. As expected, the anterior portion of the disc gets thinner when passing from the supine to the seated position. This portion takes back its initial thickness in the kneeling position. When changing from the upright kneeling position to that of 30 degrees of flexion, the anterior portion of the disc is observed to decrease slightly. The central portion of the disc also becomes thinner from the supine to the sitting position. This loss is maintained in all vertical positions in the L5-S1 disc, while the L4-L5 disc regains part of its height in the kneeling positions. The thickness of the posterior portion of the disc increases from the supine to the sitting position. The thickness of the disc then decreases when going to the kneeling lordosis and increases again with flexion. No significant changes in disc morphology were noted between the different positions when considering anterior-posterior and transverse diameters on axial images of the L4-L5 and L5-S1 discs. The addition of 40 pounds in the sitting, kneeling, and 30 deg. of flexion positions did not change significantly the disc morphology. When comparing normal and abnormal subjects, the differences noted, even if significant, were found to be within one millimeter. No indication of disc pathology could be noted when considering images taken in the seated and kneeling positions with or without the 40 pound load. These results provide a comparative basis for further studies with symptomatic subjects.