INFLUENCE OF AUTOMOBILE SEAT LUMBAR SUPPORT PROMINENCE ON SPINE AND PELVIS POSTURES: A RADIOLOGICAL INVESTIGATION

Diana E. De Carvalho 1, Jack P. Callaghan 1
1Department of Kinesiology, University of Waterloo, Waterloo, ON
email: ddecarva@uwaterloo.ca

INTRODUCTION

Sitting in a vehicle has been identified as a cause of mechanical low back pain in the literature [1]. In sitting, the pelvis rotates posteriorly and the lumbar lordosis flattens. This places increased pressure on the posterior aspects of the intervertebral discs and is recognized as a risk factor for disc herniation [1]. Maintaining the lumbar lordosis of the low back with a built in lumbar support has been suggested to decrease injury risk and relieve low back pain associated with sitting in a car seat. It is presently unknown whether this intervention actually causes a change at the level of the spine. While past studies in the literature have presented radiographic data in sitting, to date only one has investigated lumbar spine radiographic measures in the automobile seat specifically [2]. Hazard and Reinecke [2] found that a pneumatic continuous passive motion lumbar support was able to cycle lumbar lordosis angle between 21° and 41° for two participants sitting in an automobile seat. In this study, plain film radiographs are used to measure changes in lumbar spine and pelvic posture between standing and sitting in an automobile seat with varying amounts of lumbar support. The prototype lumbar support used in this study provides a horizontal excursion of 4.0cm, twice the current industry standard of 2.0cm. The study received ethics approval from both the University of Waterloo and the Canadian Memorial Chiropractic College.

METHODS

Eight male subjects, recruited from a student population, were included in this study. Participants were radiographed in four postures: standing, sitting in an automobile seat with 0% lumbar support prominence (LSP), 50% LSP and 100% LSP. In all conditions, shoulder angle was kept constant by having the participants lightly grip a steering wheel at the 10 o’clock and two o’clock positions. Subjects maintained each posture for two minutes to ensure a consistent adaptation time before exposures were taken. Radiographs were taken by radiology technicians at the Canadian Memorial Chiropractic College and average exposure values were 100 KVP and 40 MAS. Digital copies of the plain film radiographs were made with a high resolution scanner (Kodak LS75 Film Digitizer, Eastman Kodak Co., Rochester, NY). Radiographic measures of lumbar lordosis, intervertebral disc angles L1/L2 – L5/S1, lumbosacral angle, lumbosacral lordosis and sacral tilt were completed using eFilm Workstation™ software (Merge Healthcare, Milwaukee, USA). A 1-way ANOVA (standing/seated condition) with a value for significance of $p \leq 0.05$ were conducted. Tukey’s Studentized Range Test post hoc was used on all significant effects.

Figure 1: Lateral lumbar radiographs of the same participant standing (left) and sitting in an automobile seat with 0% LSP (right).
RESULTS

All measures, with the exception of the L5/S1 intervertebral disc angle, were significantly different between standing and sitting with 0% LSP (L1/L2 angle p=0.045 all else p<0.001). Lumbar lordosis angle decreased by an average of 63° (SE 5°) from standing to sitting with 0% LSP indicating an increase in lumbar flexion.

Intervertebral joint angles, which normally become larger and more lordotic (extended) throughout the lumbar spine (on average 5° at L1/L2 increasing to 14° at L5/S1), all decreased in sitting with 0% LSP. Specifically the intervertebral angles decreased to neutral or even -1° (kyphotic or flexed) from L1/2 to L4/5 with 10° of extension remaining at L5/S1. Intervertebral joint angles at L5/S1 were not significantly different between all postures tested.

Pelvic measures indicated posterior rotation in sitting with respect to standing with the lumbosacral angle decreasing from 40° to 13° and sacral tilt decreasing from 43° to -2°.

Two measures specifically, intervertebral joint angles between L1/L2 and L2/L3 were returned to angles not significantly different from standing with both 50% and 100% LSP (p=0.044 and p<0.001 respectively). All other radiographic angles demonstrated a return towards standing angles in response to increasing levels of lumbar support from 0% LSP to 100% LSP (Table 1).

DISCUSSION AND CONCLUSIONS

The radiograph measures in this study provide a comprehensive summary of the effect of sitting in an automobile seat with varying amounts of lumbar support. The results of this study suggest that the prototype lumbar support tested is capable of affecting spine posture, especially at the upper lumbar segments. Increasing lumbar support from the current industry standard of 2cm to 4cm resulted in a trend of returning radiographic measures closer to standing values. While these improvements may be slight, it is possible that the change imparted is enough to minimize injury risk and discomfort.

The significant differences in radiographic measures from standing to sitting presented in this paper further emphasize the range of motion experienced at different vertebral levels in car seat sitting and the importance of returning the spine and pelvis to a less flexed posture with a lumbar support. Further investigation will determine if these postural changes are enough to reduce risk of injury and low back discomfort during a prolonged driving situation.

REFERENCES


ACKNOWLEDGEMENTS

AUTO21, CIHR, FCER and Schukra of North America.

Table 1: Radiographic lumbar spine and pelvis measures resulting from the four conditions tested.

<table>
<thead>
<tr>
<th>Average Angle in Degrees (Standard Error of the Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar Lordosis</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Standing</td>
</tr>
<tr>
<td>0% LSP</td>
</tr>
<tr>
<td>50% LSP</td>
</tr>
<tr>
<td>100% LSP</td>
</tr>
</tbody>
</table>