The Effect of Spinal Fusion Versus Disc Replacement on Lumbar Motion

Surgery for degenerative disc disease has traditionally been discectomy (removal of the disc) and spinal fusion. But with the advent of the total disc replacement procedure, more patients are opting for this motion sparing technique. Fusion limits motion at the fused segments, whereas disc replacement tries to keep as much of the natural motion as possible. With either method, research has shown that total spinal motion is maintained, if not improved. How is that possible in the case of spinal fusion?

Evidently, the segments above and/or below the fusion increase their contribution to the total overall spinal motion. But where is this motion coming from? That's the subject of this study that looks not just at overall improvement of lumbar spine motion, but also at changes that occur at each spinal segment. Both quantity and quality of motion are measured.

Two groups of patients participated in the study. They came from three different centers in the northeast (Albert Einstein College of Medicine, Bronx-Lebanon Hospital Center, and University of Pennsylvania Department of Orthopedics). Everyone had at least one level of degenerative disc disease in the lumbar spine (either at L4/5 or L5/S1).

One group (155 patients) received a ProDisc-L replacement. The other group of 45 patients had a circumferential spinal fusion. Circumferential means the segment was fused from the front, sides, and back. X-rays and motion analysis were used to measure intervertebral motion segment by segment, including the operative level as well as two and three adjacent levels (above and below the fusion or disc replacement site).

The authors expected to find smoother motion in disc replacement patients that was evenly distributed at the operative segments; adjacent levels above and below the operative segment. And because the disc replacement is designed to maintain motion (whereas fusion is meant to stop motion), they expected to see more overall, total lumbar spine motion in the disc replacement group. These predictions were their hypotheses (what they expected to find).

What they actually found was that the disc replacement patients lost a little motion at the replacement site that was made up by the level above (L3-4 for patients who had an L4-5 disc replacement). No change was seen at the L5-S1 level. In the fusion group, the loss of motion at the fused site was made up a little bit by each of the levels above the fusion site. The immediately adjacent vertebral segment contributed the most.

A closer look at all of the measurements taken showed that patients in both groups started out (before surgery) with about the same amount of total lumbar motion. Two years after surgery, the disc replacement group had gained a significant amount of motion from before to after surgery. As expected, this was not the case for the fusion group -- they had the same total lumbar motion before and after surgery.

Comparing the two disc replacement groups (L4-5 versus L5-S1), they did find that the extra motion was made up at L4-5, above the segment (L3-4). The L5/S1 group gained back more of the total lumbar motion from the second level above the fusion (L4-5) than the L3-4. Overall, patients who received a disc replacement at the L4-5 level had better overall motion after surgery than those who received a disc replacement at the L5/S1 level. Changes were measured at the third and fourth levels above the L4-5 total disc replacement but these were not enough to be statistically significant. Likewise, in the fusion group, most of the motion at the first two levels above the fusion with some contribution at the third and fourth levels -- again, not enough at these further away segments to be counted as significant.

Studies like this are important because with new technology such as disc replacement, we don’t know what the long-term effects will be. Can total disc replacement prevent or slow down disc degeneration at the other spinal levels? How long does the protective role of the total disc replacement last? Will patients with disc replacement eventually end up needing the disc replacement taken out and a fusion after all? These are just a few of the many questions left unanswered regarding disc replacement versus spinal fusion.
Each procedure affects total lumbar spine motion and therefore biomechanical movement of the spine. Identifying how changes spinal motion and movement patterns may be helpful in measuring final, long-term outcomes. Clearly, the loss by spinal fusion, is made up by multiple adjacent levels above the fusion. The role of altered biomechanical stresses and to the adjacent levels is part of the ongoing investigation into the effects of these two procedures. This first-time look at first, second, and third adjacent levels is one important piece of the total picture.

The authors conclude by saying that a total disc replacement helps maintain lumbar mobility better than spinal fusion. placed with good alignment, then normal biomechanical motion is preserved. This reduces the risk of uneven stresses the load transmitted to adjacent vertebral segments above. If the goal of total disc replacement is to preserve spine motion patterns of movement and thereby prevent biomechanical strain on the rest of the spine, then the results of study support of this technique to manage degenerative disc disease in the lumbar spine.

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