ACCURACY OF RADIOGRAPHIC INTERVERTEBRAL KINEMATICS AS A DETERMINANT OF LUMBAR FUSION

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INTRODUCTION

Multiple fusion techniques are available for reconstruction of lumbar spinal degeneration. In the review of literature, segmental sagittal motion of less than 5 degrees has been reported as an indication for fusion. The appearance of robust fusion mass in the posterolateral gutters and bridging bone in the disc space have also been recognized as indication of solid fusion. Unfortunately, routine radiographs are not sensitive enough to accurately measure the postoperative segmental motion and the quality of fusion mass is best seen on CT scan and can be deceiving on radiographs.

Radiostereometric Analysis (RSA) is a precise technique in measuring segmental motion and can be used to examine kinematics following lumbar fusion. The purpose of this study was to precisely measure the *in vivo* motion of the lumbar spine over time following lumbar fusion procedures with particular interest in changes seen over time as a result of the type of fusion and instrumentation.

METHODS

This study was approved by the institutional review board and all subjects received informed consent. Eight patients (3 males & 5 females, ages: 56.8 ± 12.0 yrs) with lumbar spondylosis were scheduled to undergo lumbar fusion with or without decompression at L3/L4, L4/L5 and/or L5/S1 and enrolled in the study. The patients were followed post-operatively at 1 month, 1 year and 2 year.

Anterior lumbar interbody fusion (ALIF) with posterior facet screw fixation (ALIF/PF), posterior lumbar interbody fusion with posterior pedicle screw fixation (PLIF/PF), posterior lumbar fusion with pedicle screw fixation (PLF/PF), stand alone ALIF (ALIF/NF) and posterior lumbar in situ fusion without fixation (ISF/NF) were performed on this cohort by three spine surgeons. During the operation, 3-4 tantalum beads (0.8 or 1.0 mm diameter) were implanted into each vertebra.

At each post-operative follow-up, biplanar standing (ST)/supine (SU) neutrals and flexion (FL)/extension (EXT) radiographs were obtained and 3-D segmental motions were calculated using the RSA software. At the same time, the plain radiographs were obtained to grade the progress of fusion. Oswestry Disability Index (ODI) was also collected at each time point to determine the clinical outcome.

Sagittal rotation (SR), superior/inferior (SIT) and anterior/posterior (APT) translations were measured for each movement (ST to FL, ST to EXT, ST to SU, and EXT to FL). Twelve dependent variables (the amount of each motion in each movement) were submitted to three different non-parametric median tests with the group based on time category (1 month, 1 year, 2 year), fusion category 1 (Circumferential fusion (CF: ALIF/PF + PLIF/PF), PLF/PF, ALIF/NF, ISF/NF), and

fusion category 2 (ALIF/PF, PLIF/PF, PLF/PF, ALIF/NF, ISF/NF).

RESULTS AND DISCUSSION

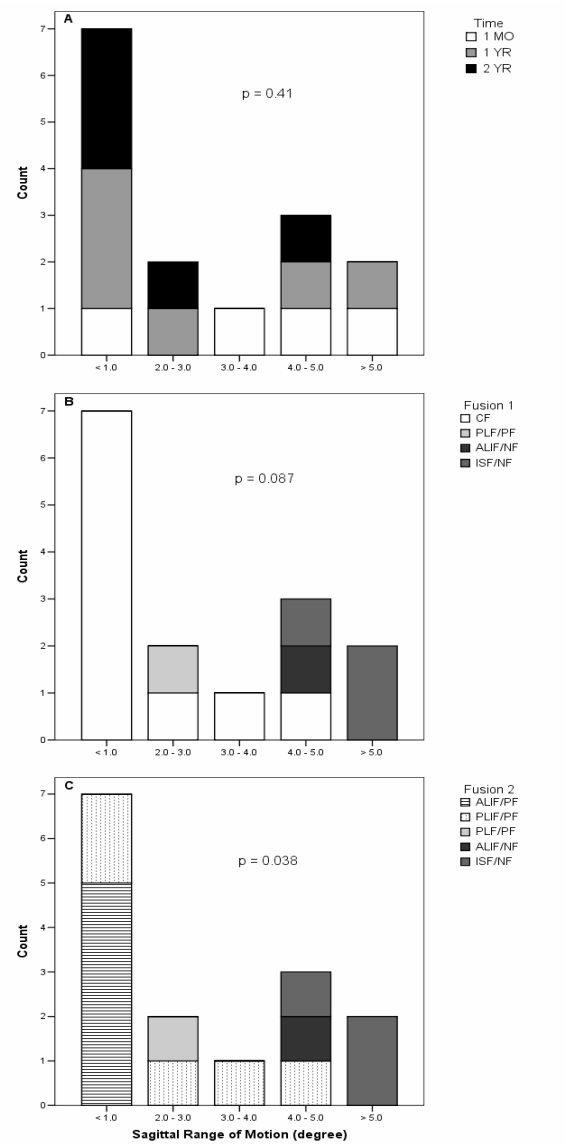

Figure 1: Sagittal ROM (SR from EXT to FL) of each group in time category (A) and fusion category 1 (B) show more even distribution along each degree of motion. However, in fusion category 2, each procedure demonstrated a significantly specific distribution (C).

There was no significant difference in any dependent variables (in frequencies between higher than median and less than median) with respect to time; it appears that the amount of stability provided by the construct at 1 month does not diminish overtime nor is there any additional stability provided with bony fusion up to 2 years in this small cohort.

In fusion category 1, a significant difference was noted with SR from ST to FL ($p = 0.029$). In fusion category 2, there was a significant difference in SR from ST to FL ($p = 0.017$) and ST to SU ($p = 0.008$). Additionally, there was a significant difference noted with SR ($p = 0.038$), SIT ($p = 0.038$), and APT ($p = 0.038$) from EXT to FL.

The amount of motion seemed to be lowest with the ALIF/PF and PLIF/PF although the PLF/PF was slightly more mobile than ALIF/PF. On the other hand, ISF/NF and ALIF/NF allowed the largest amount of motion. PLIF/PF showed more variable distribution than the other techniques. In one case (PLIF/PF), the sagittal ROM was measured to more than 5° despite strong radiographic (AP + Flex/Ext X-rays) evidence of fusion and good clinical outcome.

SUMMARY/CONCLUSIONS

The analysis of our limited data demonstrates that the motion of the fused spinal segment was dependent on the construct. Circumferential fusion seems to be most stiff construct followed by PLF/PF. Longer follow up did not add any additional stability to the spinal segment. A larger cohort is needed to confirm these findings.

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