INTRODUCTION: Anterior spinal instrumentation has become popularized in the surgical management of thoracolumbar and lumbar scoliosis over the past three decades. So far a variety of instrumentation systems, both one- and two-rod systems, are available. However, very few attempts have been made at comparative biomechanical studies. The purpose of this study is to analyze the static and dynamic biomechanical stability of five anterior spinal instrumentation systems for scoliosis.

MATERIALS AND METHODS: Thirty calf spines (T10-L3) were subjected to static biomechanical testing, including flexion-extension, axial rotation, and lateral bending loading modes (0, ±3.2Nm, ±5.2Nm, and ±7.2Nm). After completion of intact testing, four levels of discectomy (T11/12, 12/13, T13/L1, and L1/2) were performed. Destabilized segments were instrumented with five different systems in each group (n=6): [1] Texas Scottish Rite Hospital system (TSRH); [2] Bad Wildungen Metz (BWM); [3] Anterior ISOLA (ISOLA); [4] Cotrel-Dubousset Hoph (CDH); [5] Kaneda Anterior Scoliosis System (KASS). Following static testing, cyclic mixed compressive force and bending moment were applied to the instrumented construct for 24,000 cycles by a MTS 858 Bionix system. After a cyclic loading test, the specimen underwent the static testing again. Initial and post-fatigue stability in FE and RT, due to the flexibility of the rod. Applying rigid rod could restore the stability, as shown in both of TSRH and ISOLA (Figure 1). It seems that the rigid rod plays an important role in stabilizing construct in FE and RT. The ISOLA system, using staple instrumentation, offered better stability in both initial and post-fatigue RT testing relative to structurally similar system of TSRH (Figure 2). This suggests the importance of the acquisition of the bone-screw interface strength by adding staples. In this study, no anterior support was inserted between intervertebral spaces to make biomechanically worst scenario model. From our results, it seems necessary to insert the strong anterior support to stabilize the unstable constructs in the one-rod system. The two-rod systems, especially KASS, demonstrated better stability than all other one-rod systems in all loading modes. These results may indicate that the two-rod system is biomechanically enough strong to restore the stability in conjunction with anterior support. From the biomechanical point of view, the two-rod system offers superior ability to stabilize unstable constructs and maintain the correction until solid fusion is achieved.

RESULTS: In flexion-extension (FE), all one-rod systems except BWM could restore the stability to the level of intact (p<0.05). Two-rod systems significantly decreased in ROM (p<0.001) (Figure 1). Under axial rotation (RT), all systems except BWM and TSRH showed significant decrease in ROM (p<0.05), especially KASS indicated 68% decrease (p<0.01). In lateral bending, all systems demonstrated significant decrease in ROM of less than 40% to the intact (p<0.001). After a cyclic loading test, all systems increased in ROM. The BWM showed significant increase in ROM than any other systems in FE and RT (p<0.05). The KASS demonstrated the minimum increase in ROM and superior stability in all loading modes (Figure 2). At both upper and lower adjacent segments, an increase in ROM was detected in all loading modes, although no significant differences were observed (p>0.05).

DISCUSSION: The BWM system had difficulty in restoring the initial and post-fatigue stability in FE and RT, due to the flexibility of the rod. Applying rigid rod could restore the stability, as shown in both of TSRH and ISOLA (Figure 1). It seems that the rigid rod plays an important role in stabilizing construct in FE and RT. The ISOLA system, using staple instrumentation, offered better stability in both initial and post-fatigue RT testing relative to structurally similar system of TSRH (Figure 2). This suggests the importance of the acquisition of the bone-screw interface strength by adding staples. In this study, no anterior support was inserted between intervertebral spaces to make biomechanically worst scenario model. From our results, it seems necessary to insert the strong anterior support to stabilize the unstable constructs in the one-rod system. The two-rod systems, especially KASS, demonstrated better stability than all other one-rod systems in all loading modes. These results may indicate that the two-rod system is biomechanically enough strong to restore the stability in conjunction with anterior support. From the biomechanical point of view, the two-rod system offers superior ability to stabilize unstable constructs and maintain the correction until solid fusion is achieved.

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