VERTEBRAL SLIPPAGE AND DEFORMITY IN RAT IMMATURE SPINE MODEL AFTER POSTERIOR DESTABILIZING SURGERY.

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Purpose Wedging of L5 vertebral body and rounding of the surface of the sacrum are well-documented deformities associated with spondylolytic spondylolisthesis. The contribution of such deformities to vertebral slippage has been a matter of controversy, although the results of many follow-up clinical studies have indicated that the deformities are a consequence of the slippage rather than the causative factors (2, 6). In order to develop an appropriate model to prevent such deformities, their pathogenesis must be elucidated. Establishment of an appropriate experimental model would be a key step in this direction. The purpose of this study was, thus, to examine vertebral deformities secondary to posterior destabilizing surgery in rats, and to compare them with the morphological changes of the lumbar-sacral spine in patients with spondylolytic olisthesis in children and adolescents.

Methods Five female Wistar rats (5 weeks old) were used in this study. Under general anesthesia, posterior destabilizing surgery, i.e., laminectomy of L5 and bilateral facetectomy of L5/6, was undertaken. Before surgery, and one-, two- and three-weeks after surgery, lateral radiographs were taken. Then, the rats were killed and the lumbar spine was harvested for histological examination. For radiographical analysis, percent slip of L5 and lumbar index (L1) of L6 were measured according to the method described by Osterman et al. (3). Five adult female rats (24 weeks old) were used as controls. Student t-test was used for statistical analysis, and a p value of less than 0.05 was taken as significant.

Results Neither slippage nor vertebral deformities were observed in the control rats, although kyphotic deformity developed. Figure 1 shows typical lateral radiographs presenting the time course of young rats following posterior destabilizing surgery. One week after surgery, anterior slippage of L5 and rounding of the upper endplate of L6 were observed in all young rats. The slippage and deformities worsened with time. The %slip was 30.8 at 1 week, 34.4 at 2 weeks, and 40.1% at 3 weeks after surgery, while the adult group never showed any slippage. The differences in %slip between the groups were significant (p<0.05). The lumbar index of L6 as an indicator of rounding of L6 was 93.5 before surgery; and it decreased to 90.2, 85.6, and 75.5 at one, two, and three weeks after surgery, respectively. The histological examination showed significant differences (p<0.05) were found between the groups at 2 and 3 weeks after surgery. The normal growth layer had disappeared (Fig. 2).

Discussion & Conclusion In pediatric patients, spinal slippage and deformities such as wedging of the vertebral body develop following defects of the pars interarticularis (2, 6). The pars defects were made to affect the lumbar segment unstable and biomechanically abnormal (1, 5). Thus, it was suggested those deformities were caused by the biomechanical failure due to pars defects (5). In the present study, posterior destabilization of the lumbar spine in young rats led to both spinal slippage and deformities. This model reproduces the slippage and rounding surface of the anterior corner of the endplate, observed in adolescent patients. Therefore, this model could be appropriate to examine the usefulness of potential treatments for pediatric spinal deformities secondary to spondylolysis. Slippage and deformity were induced only in the young group, not in the adult group in the present study. The growth plate was reported to be biomechanically weak in immature spine (4). Thus, it was indicated that such disorder may be progressed by the involvement of endplate which includes growth plate. The histological results supported this hypothesis. Clinically, the relationship between slippage and deformity has been controversial. The present results suggested that the deformity was not a cause nor a result of slippage, rather, they seem to be concomitant disorders consequent to biomechanical failure due to spondylolysis.

In conclusion, posterior destabilizing surgery in young rats can reproduce the vertebral slippage and deformities observed in young patients with spondylolytic olisthesis. The spinal deformity and slippage observed in pediatric patients with spondylolysis were suggested to be closely related with the chronic growth plate failure due to biomechanical failure caused by pars defects.

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