DOES ANTERIOR SPINAL INSTRUMENT ROTATION CAUSE RETROLISTHESIS OF THE LOWER INSTRUMENTED VERTEBRA?

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ABSTRACT :

Background: *Dwyer and Zielke anterior instruments are widely used in spine deformities. Derotation of the scoliotic spine is possible with the special device of the Zielke instrument. However, new rigid systems don't need special devices in derotation maneuver. Retrolisthesis of the lower instrumented vertebra seem to occur as a consequence of rigid anterior instrument rotation.*

Aim: *We retrospectively evaluated the effect of derotation, especially retrolisthesis of the lower instrumented vertebra, of the Anterior Alıcı Spinal Instruments in the sagittal plane of lumbar spine.*

Materials and Methods: *There were 16 (13 females, 3 males) patients who underwent anterior instrumentation with Alıcı Spinal System. Average age was 14.6 years with a range of 10 to 29. Eleven curves were right thoracic and left lumbar, two left lumbar, two right lumbar, and one left thoracolumbar. Upper instrumented vertebra was T12 in two cases and L1 in 14 cases; and lower instrumented vertebra was L4 in 8 cases, and L5 in 8 cases. We identified 12 cases who underwent posterior instrumentation which the lower instrumented vertebra was L4 or L5. The average age of the control group was 14.1 years and there were 10 females and 2 males. Rod derotation maneuver was done in all posterior instrumentation group. We have measured vertebral corpus width on sagittal X-rays and noted any listhesis or retrolisthesis.*

Mann-Whitney Rank Sum and Wilcoxon Signed Rank Tests were used in statistical analysis.

Results: *We found 5 retrolisthesises of upper instrumented vertebra ranging from 1 to 3 mm (2.9% to 8.4 (Average: 1.7%) and 16 retrolisthesises of lower instrumented vertebra ranging from 1 to 5 mm, average: 3.4; median: 3.5 mm (2.3% to 19.1% (Average: 9.8%) of the anterior instrumentation group. Where as, on the control group 5 out of 12 cases showed retrolisthesis of the lower instrumented vertebra ranging from 1 to 5 mm average: 1.1; [median: 0.5 mm (3.4% to 13.2% (Average 3.5%) (p = 0.001)].*

Conclusion: *Our data, though limited, shows that the derotation of a rigid anterior system creates a retrolisthesis of the lower instrumented vertebra. This effect seem to be increased if the principles of Zielke system is followed.*

Key words: *Retrolisthesis, anterior instrumentation, spine, rod derotation.*

INTRODUCTION

Anterior surgery to the spine has gained popularity in recent years for the treatment of spinal deformity and trauma.

Dwyer (4, 5, 6) described a method of correcting scoliosis using a flexible anterior instrumentation composed of titanium cable and screws applied to the vertebral bodies on the convexity of the scoliotic curve. This system was followed by the Zielke VDS system which substituted threaded rod and nuts for the cable (15, 16, 17). Screws should be placed parallel to the Posterior Longitudinal Ligament, and placed more posterior at the apex of the curve as described by Zielke. If performed correctly positioning of the screws describe a curve which is open anterior and encourages the spine to derotate at the final phase of correction. Derotation of the scoliotic spine is possible with the special device of the Zielke VDS instrumentation. However, rigid systems (i.e. Alıcı, TSRH, CD-H) don't need special devices in derotation maneuver (1, 2, 8, 16). By precontoured rigid rod derotation apical correction is aimed, however a counter forced is also applied inadvertedly to upper and lower instrumented vertebrae as well (Fig. 1). Retrolisthesis of the lower instrumented vertebra has been observed in patients instrumented to L3 to L5 by

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posterior Harrington distraction rods (3, 7). Rod breakage and problems with the fixation of vertebra were observed by many authors and have also been described by Zielke (11, 12, 14, 17, 18, 19). However, to best of our knowledge, there is no article describing the retrolisthesis of the lower instrumented vertebra after anterior spinal instrumentation with any of the anterior spinal instruments. We retrospectively evaluated the effect of derotation of Alıcı anterior spinal instrumentation on the lower instrumented vertebra and retrolisthesis of the lower instrumented vertebra seem to occur as a consequence of anterior instrumentation.

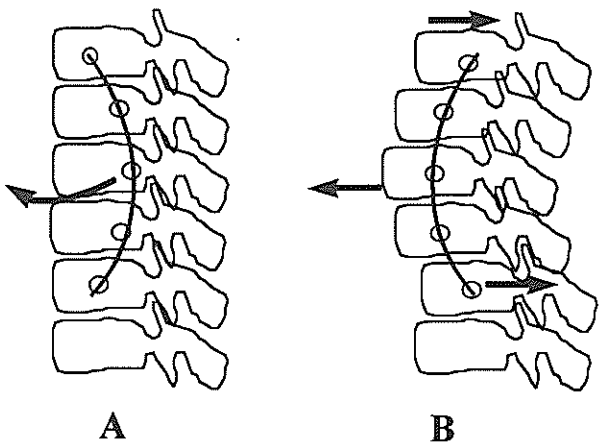

Figure 1. A. If performed correctly positioning of the screws describes a curve which is open anteriorly. This encoureges the spine to derotate during the final phase of correction. **B.** By precontoured rigid rod derotation, while exerting a corrective force more over apical vertebra a counter force is applied to lower and upper instrumented vertebrae as well.

MATERIALS and METHOD

We have identified 16 (13 females, 3 males) pateints who underwent anterior instrumentation with Alıcı Spinal System between 1989 and 1995 in Dokuz Eylül University, School of Medicine, Department of Orthopaedic Surgery. All operations were performed by senior one of us (EA). Average age was 14.6±2.83 (median: 14) years with a range of 10 to 29. All patients fulfilled the inclusion criteria such as: having an instrumented anterior surgery with rod derotation, early postoperative (within postoperative 7 days) standing lateral X-ray and retrolisthesis of lower instrumented vertebra.

Eleven curves were right thoracic and left lumbar, two left lumbar, two right lumbar, and one left thoracolumbar. Upper instrumented vertebra was T12 in two cases and L1 in 14 cases; and lower instrumented vertebra was L4 in 8 cases, and L5 in 8 cases.

We selected 12 cases (10 females and 2 males) as controls who were instrumented to L4 or L5 by Alıcı posterior spinal system and rod derotation maneuver was done. The average age of the control group was 14.1±1.7 years (median: 15; range: 11-17) (Table 1).

Vertebral corpus width was measured on sagittal X-rays and any retrolisthesis was noted. Slip percentage was used (Fig. 2) to overcome magnification variability's between serial X-rays.

Mann-Whitney Rank Sum and Wilcoxon signed rank tests were used in statistical analysis.

Inter and intra observer variability was also assessed On a separate set of X-rays using Pearson correlation test.

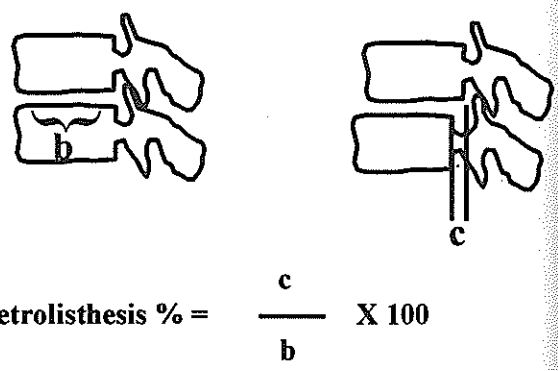

Figure 2. Measurement of the retrolisthesis percentage. b is the vertebral width, and c is the amount of retrolisthesis.

RESULTS

Upper Instrumented Vertebra:

We identified 5 retrolisthesises ranging from 1 to 3 mm [2.9% to 9.4% (Average: 1.7%)] of upper instrumented vertebra in anterior surgery group and no retrolisthesis in posterior surgery group.

Lower Instrumented Vertebra:

There were 16 retrolisthesises of lower instrumented vertebra ranging from 1 to 5 mm average: 3.4±0.94; median: 3.5 (2.8%-19.2%). Eight ouf of 16 (50%) revealed greater than 3 mm

retrolisthesis. On the contrary there were 5 retrolisthesises among posterior surgery group, however only one revealed retrolisthesis greater than 3 mm (Fig. 3, 4). The difference between anterior and posterior surgery groups were statistically significant ($p = 0.001$).

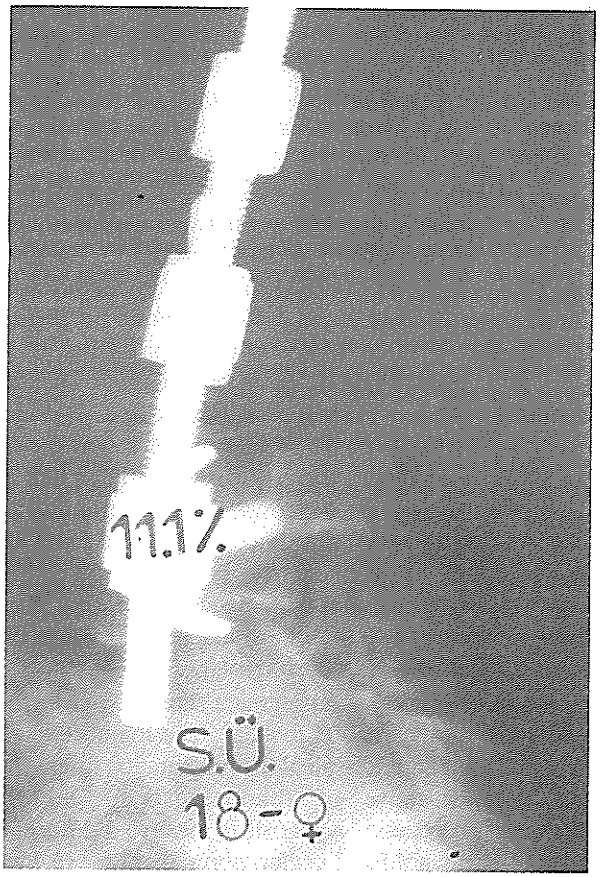

Figure 3. 18 years old female patient. 11.1% retrolisthesis is clearly observed.

In the anterior surgery group there was a statistically significant difference in the retrolisthesis between cases with lower instrument at L4 and lower instrument at L5 ($p = 0.016$; Wilcoxon signed rank test).

Kyphosing effect of anterior instrument was also observed in anterior surgery group. Instrumented segment (segment between the upper and lower instrumented vertebrae) revealed an average kyphosis of $+10.6 \pm 7.25$ degrees (range -5 to $+25$ degrees). Inter observer variability was 0.799 and intra observed variability was between 0.846-0.971.

DISCUSSION

Since the advent of Dwyer system, anterior spinal instrumentation and fusion for scoliosis has had a gradual acceptance for the correction of thoracolumbar and lumbar scoliosis. By leaving more lumbar segments unfused anterior spinal instrumentation seemed to be more promising than posterior systems. Previous studies of Harrington instrumentation in the lumbar spine have demonstrated an increased incidence of low back pain when instrumentation and fusion are extended into the lower lumbar spine (3, 7).

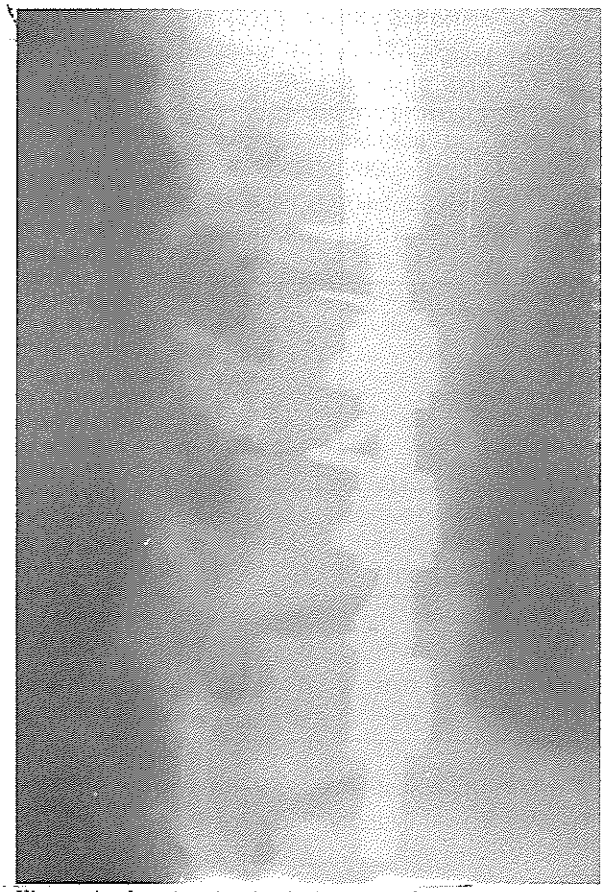

Figure 4. Lumbar kyphosis is seen after anterior spinal instrumentation.

Experiences with the Dwyer instrumentation has defined its limitations and forced modifications in the system. By removing intervertebral discs and compressing anterior by tensioning the cable, kyphosis has inevitably occurred within the instrumented segment. High rates of pseudoarthrosis, losses of correction and implant failure has occurred (9, 10, 12).

Table 1. Demographic data of both groups.

	Anterior	Posterior
n	16	12
Age (range)	14.9 (10-29)	14.1 (11-17)
Gender		
Male	3	2
Female	13	10
UIV*	T12:2	T2:1
	L1:14	T4:3
		T5:5
		T9:1
		T11:2
LIV**	L4:8	L4:11
	L5:8	L5:1
Curve types		
Thoracic-Lumbar	11	8
Thoracolumbar	1	2
Lumbar	4	2
Retrolisthesis		
(av mm±SD)	3.4±0.94	1.1±1.3
(p = 0.001)		
Retrolisthesis n (%)		
<3 mm	3 (18.7%)	9 (75%)
3 mm	5 (31.3%)	2 (16.7%)
>3 mm	8 (50%)	1 (8.3%)

* UIV : Upper Instrumented Vertebra
** LIV : Lower Instrumented Vertebra

Zielke introduced his ventral derotation spondylodesis (VDS) system to overcome these drawbacks. Zielke VDS system introduced an temporarily applied outrigger which facilitated derotation and lordosating effect. Though investigators found impressive curve correction of 75-82%, there was 29% of screw pull-out, 9% of rod breakage and 9-23% of pseudoarthrosis rate (13, 15, 16).

Kyphosis has remained a problem. Love and Peters (11) describe 36 cases of idiopathic scoliosis treated with a single anterior VDS instrumentation which showed an average decrease in thoracic kyphosis from 31 to 24 as well as an decrease in lumbar lordosis of 8.3%. The stiffer rod facilitates correction of the scoliotic deformity by rotation, but at the same time imposes a lordosis on the instrumented segment. The kyphosing effects of anterior compression are minimized when a stiff rod that has been appropriately contoured for lordosis is used.

Cochran et al (3) has shown that fifteen of the 24 patients with distal hook insertion in L4 or L5 using Harrington distraction rods demonstrated a previously not described finding of retrolisthesis. This finding is a posterior displacement of 3 mm or more of the vertebra of distal hook purchase on its counter part vertebra below (3).

However, retrolisthesis as a consequence of anterior spinal instrument rotation, even with the systems using rigid rod like TSRH and CDH, has not been published (8, 16). The insertion of the screws should be placed parallel to the posterior ligament, thus apical vertebra screw is more posterior than adjacent vertebrae and if placed properly positioning of the screws of the screws describes a curve which is open anteriorly. Thus the systems would exert more correcting force over the most rotated vertebra and a counter force over the upper and lower instrumented vertebrae. After derotation, since a contoured rod will assume a lordotic segment, this counter force might cause a retrolisthesis due to the backward thrust. Our results reveal that 13 out of 16 patients had 3 mm or more retrolisthesis after the rod rotation.

Instrumented vertebral segment shows kyphosis of +10° with a range of -5° to +25°. The kyphosis that occurred after anterior spinal instrumentation might be the second cause of reholisthesis of lower instrumented vertebra. Kyphosis in the area of lordosis exerts a backward force vector, normally non-existing at that level.

This observation should be verified by other studies looking at the other systems using rigid rod.

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