



## RESULTS OF POSTERIOR-ONLY ALL PEDICLE SCREW INSTRUMENTATION IN THE SURGICAL TREATMENT OF SCHEUERMANN'S KYPHOSIS

### SCHEUERMANN KİFOZU'NUN CERRAHİ TEDAVİSİNDE SADECE POSTERİOR PEDİKÜL VİDALARI İLE İMPLANTASYONUN SONUÇLARI

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#### ABSTRACT:

The aim of this retrospective study was to evaluate our clinical and radiographical results with the posterior-only all pedicle screw instrumentation in the surgical treatment of Scheuermann's Kyphosis. Sixteen patients who underwent posterior-only all pedicle screw instrumented spine fusion in our institute were selected and the clinical and radiographical data of them were analyzed retrospectively. The mean follow-up period was 47,5 months. The mean preoperative thoracic kyphosis was 80.4°. The final kyphosis correction rate was 43.3 %

respectively. There was a spontaneous reduction in lumbar lordosis up to 26.5 %. One hemothorax case which was managed with tube drainage and one proximal junctional kyphosis which did not affect the clinical outcome were the only complications noted. Posterior-only all pedicle screw instrumentation is a safe and effective modality of treatment in the surgical management of Scheuermann's Kyphosis.

**Key words:** Scheuermann's Kyphosis, pedicle screw, instrumentation

**Level of Evidence:** Retrospective clinical trial, Level III

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**ÖZET:**

*Bu geriye dönük çalışmanın amacı, Scheuermann kifoza nedeniyle sadece posterior yaklaşımla pedikül vidaları kullandığımız implantasyonun klinik ve radyolojik sonuçlarını değerlendirmektir. Kliniğimizde ameliyat edilmiş 16 hastanın klinik ve radyolojik incelemeleri yapılmıştır. Ortalama takip süresi 47.5 aydır. Ortalama ameliyat öncesi torakal kifoz  $80.4^{\circ}$  iken son takipteki düzeltme oranı ortalama % 43.3 olarak tespit edilmiştir. Lomber lordozda % 26.5'e varan spontan düzeltme tespit edilmiştir.*

*Komplikasyon olarak bir hastada tüp drenaj ile iyileşen hemotoraks ve bir hastada klinik sonucu etkilemeyen proksimal kavşak kifoza saptanmıştır. Sadece posterior yaklaşımla pedikül vidaları ile implantasyon Scheuermann kifozunun cerrahi tedavisinde güvenli ve etkili bir tedavi yöntemidir.*

**Anahtar kelimeler:** Scheuermann kifoza, pedikül vidası, enstrümantasyon

**Kanıt düzeyi:** Retrospektif klinik çalışma, Düzey III

## INTRODUCTION:

Scheuermann's Kyphosis (SK) is an idiopathic condition of the spine, which is usually seen in adolescents representing hyperkyphosis of the thoracic spine <sup>(7)</sup>. It is the most common cause of severe thoracic kyphosis in adolescence <sup>(14)</sup>. In the immature adolescent, conservative treatment such as bracing or casting can be tried for moderate curves <sup>(1,12)</sup>. For severe curves or pain over the deformity in adults surgical management takes place instead of conservative therapy.

Operative treatment for SK has traditionally been apical anterior release and fusion followed by posterior spinal fusion <sup>(13)</sup>. In 1975, Bradford et al. <sup>(3)</sup> reported their first experience with the posterior spine arthrodesis using Harrington instrumentation in 22 patients having hyperkyphosis due to SK and they mentioned an extraordinary high incidence of complications, but to date, popularization of pedicle screw instrumentation in the thoracic spine favored the posterior only spinal arthrodesis in the surgical treatment of SK <sup>(1,3,5-</sup>

<sup>7,11,13,17)</sup>. Additionally there are many reports in the literature supporting combined surgery for circumferential fusion especially in the correction of severe and rigid curves in adults with SK <sup>(2,8,10,14-16,18)</sup>.

In this retrospective study, we aimed to evaluate our clinical and radiographical results with the posterior only all pedicle screw instrumentation in the surgical treatment of SK.

## PATIENTS AND METHODS:

Between 2002 and 2008, patients who were treated surgically for thoracic hyperkyphosis (thoracic Cobb > 60° and pain) due to SK in our institute were reviewed. Sixteen patients (3 females, 13 males) who underwent posterior only all pedicle screw instrumented spine fusion were selected and the clinical and radiographical data of them were analyzed retrospectively. Mean age of the patients was 18.1 (range 14-25 years). Patient demographics are given in Table-1.

**Table - 1.** Patient demographics.

| patient | gender | age | level  | apex    | blood loss (units) | follow-up (months) |
|---------|--------|-----|--------|---------|--------------------|--------------------|
| Ş.G.    | male   | 21  | T3-L1  | T(T9)   | 3                  | 63                 |
| G.İ.    | male   | 16  | T1-L2  | TL(T10) | 2                  | 39                 |
| M.Z.    | male   | 22  | T3-L4  | T(T9)   | 9                  | 28                 |
| D.K.    | female | 24  | T2-L2  | T(T9)   | 3                  | 70                 |
| B.Ş.    | female | 18  | T4-L1  | T(T9)   | 3                  | 66                 |
| P.G.    | female | 14  | T3-L1  | T(T8)   | 4                  | 62                 |
| M.K.    | male   | 19  | T2-L3  | T(T9)   | 4                  | 22                 |
| M.E.    | male   | 17  | T3-L4  | TL(T11) | 5                  | 58                 |
| F.K.    | male   | 25  | T2-L2  | T(T7)   | 5                  | 40                 |
| E.E.    | male   | 14  | T1-T12 | T(T7)   | 4                  | 66                 |
| S.B.    | male   | 17  | T3-L1  | T(T8)   | 4                  | 65                 |
| E.Ö.    | male   | 17  | T2-L1  | T(T8)   | 4                  | 65                 |
| A.K.    | male   | 15  | T3-L2  | T(T9)   | 4                  | 62                 |
| M.A.    | male   | 16  | T4-L4  | TL(T11) | 5                  | 17                 |
| B.İ.    | male   | 17  | T3-L1  | T(T7)   | 4                  | 18                 |
| C.Z.    | male   | 17  | T2-L3  | T(T9)   | 5                  | 19                 |

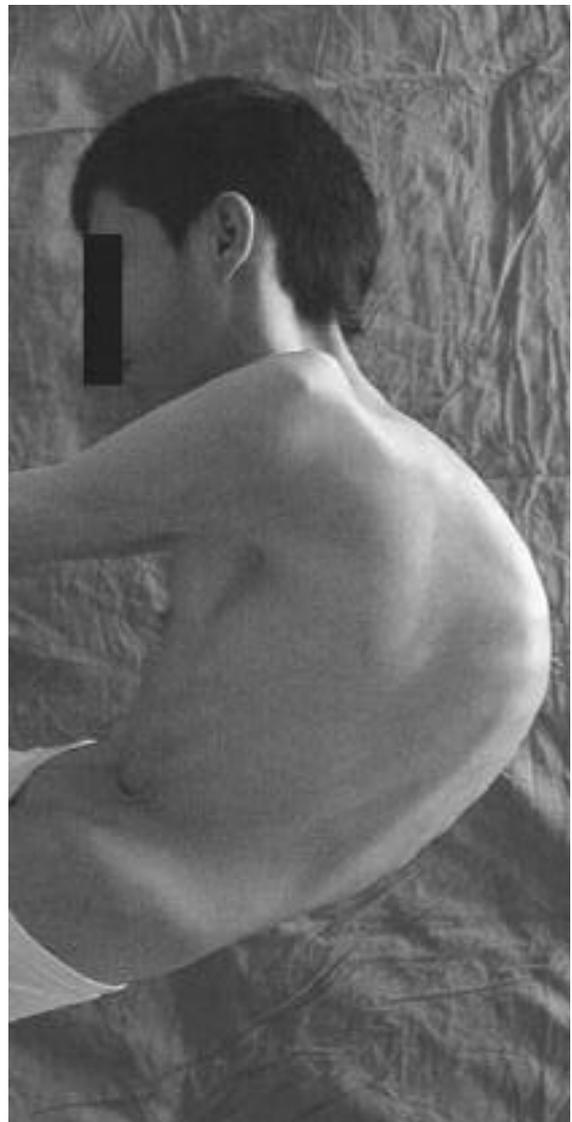
The retrospective clinical data consisted of; SRS-30 questionnaires of the patient interviews and the complications in the perioperative and postoperative period noted. Pain, self image, functional activity, mental health and satisfaction with management were the components of the SRS-30 questionnaire. Loss of blood during the procedures was also reported.

The radiographical data consisted of Cobb angle measurements of preoperative, postoperative and final follow-up thoracic

kyphosis. On the lateral standing digital radiographs, global sagittal balance was measured as the distance from the C7 plumb line to the perpendicular line drawn from the superior posterior endplate of S1 vertebral body (sagittal sacral vertical line-SSVL). If the C7 plumb line fell behind SSVL, global sagittal balance was negative. If the C7 plumb line fell in front of SSVL, global sagittal balance was positive. Lumbar lordosis was measured from the lower endplate of T12 to the upper endplate of S1 (Figure-1,2).



**Figure-1.** Lateral standing x-ray of a 17 years old adolescent with Scheuermann's Kyphosis.



**Figure-2.** Preoperative photograph of the same patient.

All of the operations were performed under general anesthesia in a prone patient position using posterior midline incision on a radiolucent operating table. Pedicle screws were used bilaterally at all levels of instrumentation. Proximal end point was set to be the vertebra where thoracic kyphosis changed in to cervical lordosis. The distal end of the instrumentation was generally stopped above the first lordotic disc to avoid sagittal decompensation. All pedicle screws were inserted by free-hand technique and they were confirmed by intra-operative fluoroscopy. Inferior facetectomies were performed at the levels two above and two below the apical segment. Rods were cantilevered from

proximal screw engagement to distal fixation point for reduction. Gentle segmental compression maneuvers were performed for each level in order to correct the spinal deformity posteriorly (Figure-3). Local bone autograft and allograft spongious chips were used after decortication for posterior spine arthrodesis. After surgery, none of the patients was immobilized in a brace. After one night in the intensive care-unit they were initially engaged in a supervised rehabilitation program in the department and were let to stand-walk on the next postoperative 2-3 days (Figure-4). The apical vertebrae of kyphosis and the instrumented levels are given in Table-1.



**Figure-3.** Follow-up lateral view of the same patient with some degree of proximal junctional kyphosis.



**Figure-4.** Follow-up photograph of the same patient

The retrospective data of radiographical parameters were analyzed using SPSS for Windows 11.5.0 software package (6 Sep. 2002, LEAD Technologies Inc.). For the comparison of; preoperative-postoperative-follow-up thoracic kyphosis and lumbar lordosis Pillai's Trace test was used via general linear models in repeated measures method. p values smaller than 0.05 were accepted as being statistically significant.

### RESULTS:

The mean follow-up period was 47.5 months (range 17-70 months). The average loss of blood was 1700 cc (range 800-3600 cc) respectively. The mean SRS-30 questionnaire value was 3.74 (range 3.1-4.4) SRS-30 assessment of the patients are given in Table-2.

The mean preoperative thoracic kyphosis was 80.4° (range 66°-90°). In the postoperative period the mean thoracic kyphosis was corrected to 42.4° (range 26°-56°) as statistically significant ( $p<0.01$ ). Then in the final follow-up period it was reduced to 45.7° (range 31°-56°) which was still significant when compared with the preoperative kyphosis ( $p<0.01$ ). The final kyphosis correction rate was 43.3 % respectively (Table-3).

The mean preoperative lumbar lordosis was 52.2° (range 38°-72°). In the postoperative period the mean lumbar lordosis was spontaneously reduced to 36.7° (range 24°-50°) as statistically significant ( $p<0.01$ ). Then in the final follow-up period it was measured as 38.4° (range 24°-50°) which was still significant when compared with the preoperative lordosis ( $p<0.01$ ), but the

**Table - 2.** SRS-30 assesment.

| Patient | Functional Activity | Pain | Self image | Mental health | Satisfaction with management | Mean Score |
|---------|---------------------|------|------------|---------------|------------------------------|------------|
| G.İ.    | 4                   | 4,3  | 3,5        | 4             | 3,3                          | 3,9        |
| M.A.    | 2,6                 | 3,7  | 3,4        | 3,6           | 3,3                          | 3,3        |
| B.İ.    | 3,1                 | 2,8  | 2,9        | 3             | 4,3                          | 3,1        |
| M.K.    | 2                   | 3,6  | 3,9        | 2,8           | 3,3                          | 3,2        |
| F.K.    | 3,4                 | 2,3  | 3,7        | 2,8           | 4,7                          | 3,3        |
| M.Z.    | 4,4                 | 4,3  | 3,7        | 4,6           | 4,7                          | 4,2        |
| C.Z.    | 3,6                 | 3,3  | 3,7        | 3,8           | 4,3                          | 3,7        |
| Ş.G.    | 3,4                 | 2,3  | 3,7        | 2,8           | 4,7                          | 3,3        |
| D.K.    | 2,6                 | 3,7  | 3,4        | 3,6           | 3,3                          | 3,3        |
| B.Ş.    | 3,9                 | 4,5  | 4,2        | 4,5           | 4,8                          | 4,3        |
| P.G.    | 4,8                 | 4,2  | 3,8        | 3,7           | 4,5                          | 4,2        |
| M.E.    | 4,2                 | 4,8  | 4,1        | 4,7           | 4,3                          | 4,4        |
| E.G.    | 3,8                 | 4,1  | 4          | 3,8           | 4,2                          | 4          |
| S.B.    | 3,6                 | 3,8  | 3,9        | 4,1           | 4,2                          | 3,9        |
| E.Ö.    | 4,1                 | 3,9  | 4          | 3,7           | 4,1                          | 3,9        |
| A.K.    | 3,4                 | 3,6  | 3,9        | 4             | 3,9                          | 3,8        |

**Table - 3.** Radiographical parameters (pre-op: preoperative, post-op: postoperative)

| pre-op<br>kyphosis | post-op<br>kyphosis | follow-up<br>kyphosis | pre-op<br>lordosis | post-op<br>lordosis | follow-up<br>lordosis | balance<br>cm(pre/post) |
|--------------------|---------------------|-----------------------|--------------------|---------------------|-----------------------|-------------------------|
| 80°                | 40°                 | 49°                   | 50°                | 34°                 | 46°                   | (+)3/0                  |
| 70°                | 44°                 | 50°                   | 60°                | 43°                 | 45°                   | (-)3/0                  |
| 90°                | 50°                 | 53°                   | 70°                | 50°                 | 50°                   | (+)6/(+)1               |
| 79°                | 26°                 | 32°                   | 38°                | 28°                 | 33°                   | (-)1/0                  |
| 66°                | 40°                 | 45°                   | 50°                | 40°                 | 40°                   | (-)2/0                  |
| 70°                | 26°                 | 31°                   | 51°                | 34°                 | 37°                   | 0/(-)2                  |
| 90°                | 45°                 | 45°                   | 48°                | 30°                 | 30°                   | (+)3/0                  |
| 77°                | 40°                 | 40°                   | 50°                | 35°                 | 39°                   | (-)2/0                  |
| 70°                | 47°                 | 50°                   | 50°                | 43°                 | 41°                   | (-)3/0                  |
| 90°                | 44°                 | 52°                   | 72°                | 48°                 | 50°                   | (+)1/(-)1               |
| 80°                | 30°                 | 38°                   | 44°                | 30°                 | 30°                   | (+)1/0                  |
| 88°                | 48°                 | 48°                   | 44°                | 30°                 | 30°                   | (-)2/0                  |
| 80°                | 50°                 | 52°                   | 48°                | 40°                 | 41°                   | (-)1/0                  |
| 90°                | 40°                 | 42°                   | 55°                | 33°                 | 33°                   | (-)6/(+)3               |
| 87°                | 56°                 | 56°                   | 50°                | 45°                 | 46°                   | (+)2/(-)2               |
| 80°                | 46°                 | 48°                   | 55°                | 24°                 | 24°                   | (+)2/0                  |

difference between postoperative and follow-up lordosis was not significant ( $p:0.145$ ) The final lordosis correction rate was 26.5% respectively (Table-3).

According to the global sagittal balance assessment the mean preoperative value was -1.25 mm and at the final follow-up it was measured as -0.6 mm. Eleven of 16 patients were in a total sagittal balance at the final follow-up (Table-3).

There was one hemothorax case which was managed with tube drainage and one proximal junctional kyphosis which did not affect the clinical outcome. There was no failure of implantation such as screw pull-out, bending or rod breakage. No definitive pseudoarthrosis was experienced. All of the patients were neurologically intact at the final follow-up. No deaths, infection,

gastrointestinal obstruction was seen throughout the patients.

#### DISCUSSION:

In the current study, the clinical and radiographical results of posterior-only all screw spinal fusion in the surgical management of SK were reported at a mean follow-up period of 47,5 months. The final kyphosis correction rate was 43.3 % respectively. Eleven of 16 patients (69 %) were totally balanced sagittal at the end of the follow-up period.

Based on above findings, the extend of posterior instrumentation in the surgical treatment of SK is a paramount issue for a satisfactory clinical outcome. In the study of Arlet et al. <sup>(1)</sup>, it was stated as the whole Cobb angle should be fused without hypercorrection

and stopped distally above the first lordotic disc to avoid sagittal decompensation. According to Cho et al. <sup>(4)</sup> inclusion of the distal end vertebra and the first lordotic disc beyond the transitional zone in distal fusion for thoracic hyperkyphosis did not always work due to the presence of a distal junctional breakdown. They also recommended that the distal end of a fusion for thoracic kyphosis should include the sagittal stable vertebra which is defined as the most proximal lumbar vertebral body touched by the vertical line from the posterosuperior corner of sacrum1. In the current study, the distal end-point of posterior instrumentation was set to be the proximal vertebral body above the first lordotic disc and no sagittal decompensation was achieved at the end, but there was one case having proximal junctional kyphosis even all Cobb angle was included in the fusion mass. In the study of Jansen et al. <sup>(9)</sup>, determinations of significant correlations between kyphosis and lordosis in SK was performed and they concluded that surgical correction of thoracic hyperkyphosis had given a predictable spontaneous decrease of lumbar lordosis mainly in the upper segment of lumbar region. Accordingly there was a spontaneous reduction in lumbar lordosis up to 26.5 % in the current study.

Smith-Peterson, Chevron, posterior subtraction or inferior facetectomies are recommended in the literature for the apical posterior release of kyphosis <sup>(13,17)</sup> and we used inferior facetectomies at two above and two below the apical vertebra of the kyphosis in order to maintain a good reduction of the deformity under segmental compression.

Since the novel article of Bradford et al. <sup>(3)</sup> 3-column fixation of the spine is possible now

via modern transpedicular multisegmental posterior instrumentation. In the literature there are several reports displaying superior results with the posterior-only treatment in the surgical treatment of SK. <sup>(1,3,5-7,13,17)</sup> In the study of Koptan et al. <sup>(11)</sup> single-staged all pedicle screws technique was compared with two-staged anterior release and posterior hybrid instrumentation in the surgical treatment of SK and it was concluded that the use of all pedicle screws technique allowed a rigid anchor for posterior correction of the deformity with less operating time, blood loss and hospital stay without the need for anterior release. In a study from Portugal <sup>(5)</sup>, posterior segmental instrumentation was performed in 38 patients with SK using a dynamic system without sublaminar fixation and the mean initial 68° of kyphosis was corrected to 43° at 5 year follow-up. Accordingly Geck et al. <sup>(6)</sup> reported excellent correction and minimal loss of reduction via thoracic pedicle screw posterior instrumentation.

On the other hand, there exist a number of studies from the literature favoring combined surgery for correction of hyperkyphosis due to SK. <sup>(2,8,10,14-16,18)</sup> In the study of Atici et al. <sup>(2)</sup>, they used combined surgery for the correction of kyphosis deformity due to trauma and SK and they reported no positive sagittal balance during follow-up. In the study of Herrera-Soto et al. <sup>(8)</sup> combined video-assisted thoracoscopic surgery release and posterior spinal fusion was advocated for the treatment of the more severe and rigid curves. Papagelopoulos et al. <sup>(17)</sup> also recommended combined anterior and posterior spine arthrodesis for rigid and more severe kyphosis deformities but other than SK. There was also a death case due to superior mesenteric artery syndrome in the same series. Poolman

et al. <sup>(18)</sup> evaluated the combined spondylodesis for SK in a prospective study and reported relatively fair outcome in the presence of a late deterioration of correction in the sagittal plane due to removal of posterior instrumentation. In the current study no implant removals were performed in any of the patients.

Blood loss during the procedures is another point of consideration in the operative treatment for SK. In the study of Herrera-Soto <sup>(8)</sup>, the average blood loss for the combined surgery was 1649 cc (range 400-3600 cc). In the study of Lee et al. <sup>(13)</sup> total blood loss in the combined fusion group averaged 1227 cc (range 800-3000 cc) versus 838 cc (range 40-2500 cc) in the posterior only fusion group. The estimated blood loss for posterior fusion group was 1350 cc (range 400-1800 cc) and 1800 cc (range 600-3030 cc) for the combined anterior/posterior fusions in the study of Lim et al. <sup>(14)</sup>. The average loss of blood in the current study was 1700 cc (range 800-3600 cc) for posterior-only all screw instrumented fusion respectively.

As a conclusion, despite the lack of a control group and relatively less number of patients involved in the study which may be pointed out as the weak points of the study, posterior-only all pedicle screw instrumentation provided a significant correction of thoracic kyphosis without the need for an anterior release and durable correction at the end of nearly 4 years with very low complication rates in patients with SK. Thus, posterior-only all pedicle screw instrumentation is a safe and effective modality of treatment in the surgical management of Scheuermann's Kyphosis.

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