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LONG-SEGMENT POSTERIOR INSTRUMENTATION FOLLOWING POSTERIOR CLOSING WEDGE OSTEOTOMY FOR THE TREATMENT OF KYPHOTIC DEFORMITY IN THE PATIENTS WITH ANKYLOSING SPONDYLITIS

ANKİLOZAN SPONDİLİTLİ HASTALARDAKİ KİFOTİK DEFORMİTENİN TEDAVİSİ İÇİN POSTERİOR KAPALI KAMA OSTEOTOMİSİNİ TAKİBEN UZUN SEGMENT POSTERİOR ENSTRÜMANTASYON UYGULAMASI

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SUMMARY:

The resulting spinal kyphosis due to the progressive flexion deformity in ankylosing spondylitis is a challenging issue where thoracolumbar osteotomies are to be of consideration in the correction of the global sagittal and gaze alignment as treatment modalities. The purpose of this retrospective clinical study was to evaluate the clinical and radiological results of posterior closing wedge osteotomy that we performed in the treatment of kyphotic deformities in the patients with ankylosing spondylitis. Eleven patients having kyphotic thoracolumbar deformities due to ankylosing spondylitis were included in the study and they were treated with posterior transpedicular closing wedge osteotomy followed by long-segment posterior instrumentation. After a mean follow-up period of 43.5 ± 18.7 months patients were evaluated in terms of Cobb angle measurements and clinical results. Additionaly, 7 of 11 patients were assessed in terms of SRS-22 questionnaire for pain, self image and satisfaction of treatment. The mean preoperative thoracic kyphosis which was 87.3° ± 4.3° improved to 54.0° ± 9.5° postoperatively ($p<0.05$). At the final follow-up it was 58.2° ± 9.1° with an average correction loss of 4.2° ± 2.5°. The mean preoperative lumbar lordosis was 19.6° ± 6.3°. Than it improved to 39.6° ± 5.7° ($p<0.05$) postoperatively and were 37.0° ± 5.5° at the final follow-up with an average correction loss of 2.6° ± 2.3°. Preoperative,

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postoperative and final mean sagittal balance values were 6.6 ± 2.3 cm, 3.1 ± 1.5 cm (p<0.05) and 3.4 ± 1.6 cm, respectively. Loss of correction in sagittal balance was 0.23 ± 0.26 cm in the last control visit. In the all patients whom were applied SRS-22 questionnaire; the levels of pain, appearance, mental status, function and satisfaction of treatment revealed results of minimum 4 points. There was no death, neurological compromise, implant failure, pseudoarthrosis or infection, but one pulmonary embolism and one postoperative thoracic kyphosis proximally to the osteotomy level. We concluded that; posterior transpedicular closing wedge osteotomy followed by long-segment posterior instrumentation in the management of kyphotic deformities due to ankylosing spondylitis seems to be an effective procedure in terms of satisfactory sagittal balance and implant survival.

Key Words: *Ankylosing spondylitis, closing wedge osteotomy, and treatment.*

Level of Evidence: *Level III, retrospective clinical study*

ÖZET:

Ankilozan spondilit hastalığına bağlı omurgada görülen ilerleyici fleksiyon deformitesi sonucu gelişen kifozun tedavisi oldukça güçtür ve sagittal denge ve karşıya düz bakışın sağlanabilmesi için torakolomber osteotomiler göz önüne alınması gereken tedavi seçeneklerindendir. Bu geriye dönük çalışmadaki amaç, ankilozan spondilite bağlı olarak gelişmiş omurga kifozu tedavisi için uygulanan posterior kapalı kama osteotomisinin radyolojik ve klinik sonuçlarını değerlendirmektir. Bu çalışmaya 11 hasta dâhil edilmiştir. Ortalama 43.5 ± 18.7 aylık takip sonrası hastaların Cobb açısı ölçümleri ve klinik sonuçları değerlendirilmiştir. Ayrıca çalışmaya dahil edilen 11 hastadan 7'sinde SRS-22 anketiyle ağrı, klinik görünüm ve tedaviden tatmin düzeyleri de değerlendirilmiştir. Ameliyattan önce ortalama 87.3° ± 4.3° olan torakal kifozun, ameliyat sonrası 54.0° ± 9.5°'ye indirildiği (p<0.05) ve son takipte 4.2° ± 2.5° düzeltme kaybıyla 58.2° ± 9.1° olarak ölçüldüğü saptanmıştır. Ameliyattan önce ortalama 19.6° ± 6.3° olan lomber lordozun, ameliyat sonrası 39.6° ± 5.7°'ye yükseldiği ve son takipte ortalama 2.6° ± 2.3° kayıpla beraber 37.0° ± 5.5° olarak ölçüldüğü belirlenmiştir. Preoperatif, postoperatif ve final sagittal denge değerleri sırasıyla 6.6 ± 2.3 cm, 3.1 ± 1.5 cm ve 3.4 ± 1.6 cm olup, elde edilen düzelmenin istatistiki olarak anlamlı olduğu belirlenmiştir (p<0.05). Sagittal dengedeki düzelme kaybı, son kontrolde 0.23 ± 0.26 cm gibi oldukça düşük düzeyde olduğu anlaşılmıştır. Hiçbir hastada ölüm, nörolojik defisit, implant yetmezliği, enfeksiyon veya psödoartroz görülmedi, fakat bir hastada pulmoner emboli ve bir hastada kavşak kifozu tespit edildi. SRS-22 anketi uygulanan hastaların tamamında ağrı, görünüm, mental durum, fonksiyon ve tedaviden tatmin düzeylerinin 4 ve üzeri olduğu belirlenmiştir. Sonuç olarak ankilozan spondilite bağlı omurga kifozunun tedavisinde uygulanan kapalı kama osteotomisi ile birlikte uzun segment enstrümantasyon tatmin edici sagittal denge ve implant sağ kalımı açısından etkin bir yöntem olduğu fikri elde edilmiştir.

Anahtar Kelimeler: *Ankilozan Spondilit, kapalı kama osteotomisi, tedavi.*

Kanıt Düzeyi: *Düzey III, retrospektif klinik çalışma*

INTRODUCTION:

Ankylosing spondylitis (AS) is a chronic inflammatory disease that affects the axial skeleton [3,9]. The inflammation leads to a profound tendency for ossification of involved ligaments and joints with fusion of the spine, sometimes with a fixed kyphosis causing sagittal imbalance [10]. The kyphotic deformity may restrict activities of daily living and the major complaint is an inability to look straight ahead [6]. Thoracolumbar osteotomies can be performed to correct sagittal imbalance and gaze alignment [9]. Presently there are 3 commonly used methods of osteotomy, namely opening wedge, multilevel and closing wedge osteotomy. Vascular complications and high rate of loss of correction associated with opening wedge osteotomy make the closing wedge superior among the others in terms of radiological and clinical outcomes [8].

The purpose of this retrospective clinical study was to evaluate the clinical and radiological results of posterior closing wedge osteotomy that we performed with long-segment posterior instrumentation in the treatment of kyphotic deformities due to AS. SRS-22 questionnaire was performed in 7 patients via telephone calls in order to define the final clinical status and satisfaction of treatment during the last control visits.

MATERIALS-METHODS

Between 2003 and 2008, 11 patients having kyphotic spinal deformities due to AS were treated with posterior closing wedge osteotomy followed by long-segment posterior instrumentation in two different clinics and they were included in the study. Patients were evaluated in terms of radiological and clinical outcomes retrospectively.

Clinical, radiological and laboratory studies were performed in order to confirm the diagnosis AS. AS was diagnosed with preoperative laboratory and radiological analysis consisting of; elevated erythrocyte sedimentation rate, periarticular osteoporosis, loss of intervertebral disc spaces, anterior longitudinal ligament fibrosis due to subchondral sclerosis and paravertebral ossification [3]. HLA-B27 antigen was positive in 5 cases. A total global kyphosis covering both thoracal and lumbar region with a deteriorated horizontal gaze accompanying no response to medical therapy for back pain were determined. Deterioration in all respiratory function tests with decreased head-wall and chest circumference measurements was also noted.

All of the patients were men and the mean age at the operation time was 43.9 ± 7.3 (range 32-55). The average hospitalization period was 8.0 ± 1.6 days (range 6-19 days) (Table-1).

Table - 1. Demographics and operational datas of the patients (n: number of the patient).

n	Age	Gender	Operation time (hour)	Hospitalization (days)	Blood loss (cc)	Osteotomy level	Follow-up (Months)
1	47	Male	3	10	2250	L-2	12
2	35	Male	3	7	2250	L-2	30
3	32	Male	3	9	1350	T-12	52
4	40	Male	3	9	1350	L-1	36
5	39	Male	2,2	10	1950	T-10	72
6	49	Male	2,4	7	1900	T-11	62
7	44	Male	3,5	10	1470	T-12	60
8	54	Male	3	7	1550	T-12	54
9	41	Male	2,5	6	1200	L-1	48
10	55	Male	3,1	6	1100	T-10	28
11	47	Male	2,1	7	1100	T-12	24
TOTAL	**43,9 ± 7,3**	**-**	**2,8 ± 0,4**	**8,0 ± 1,6**	**1588,2 ± 431,3**	**-**	**43,5 ± 18,7**

A detailed physical examination of columna vertebralis and peripheral joints in terms of range of motion was performed. Radiological assessment of the patients consisted of good-quality standing anteroposterior-lateral orthoroentgenograms, computerized tomography and magnetic resonance imaging studies (Figure-1).

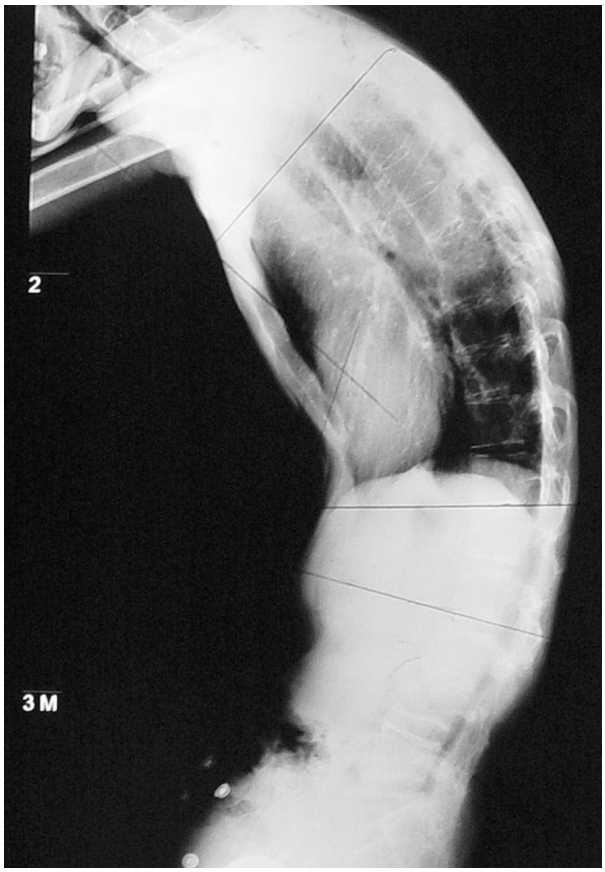

Figure-1. Lateral view of a 40 years old male with anklosing spondylitis (Case-4).

On the lateral standing x-rays; preoperative, postoperative and final follow-up global thoracic kyphosis and lumbar lordosis values were noted using Cobb method. The deviation in the sagittal plane was defined as the sagittal distance of the center of C-7 to the center of the body of S-1. The cervical plumb line remained anterior to the S-1 body defined as a positive sagittal axis deviation in all of the patients preoperatively. One patient having Type I kyphosis with normal thoracic kyphosis and localized kyphotic deformity in lumbar region according to the description of Hammerberg was excluded from the study [3]. Eleven patients having Type II kyphosis which was spreading from the thoracic region to the lumbar area with reduced lumbar lordosis were included in the study. The indications for surgical intervention consisted of obvious horizontal gaze restriction and serious back-pain which was regardless of medical therapy. It was decided to perform long-segment posterior instrumentation following posterior closing wedge osteotomy which was supposed to be performed in the apical points of global kyphotic deformities consisting of; lower thoracic (T-10: 2 patients, T-11: 1 patient), thoracolumbar (T-12: 4 patients, L-1: 2 patients) and lumbar region (L-2: 2 patients) (Table-1).

All of the operations were performed by the senior authors in two different institutions using the same surgical technique. Osteotomies involved removal of the posterior elements (facet joints, pedicles, transverse processes and laminae) of one vertebra and removal of a posterior wedge of the vertebral body by a decancelization procedure. Angle curettes were used in both creating a cavity and thinning of the lateral and posterior cortex of the vertebral body. Both pedicles were enucleated using a small osteotome and posterior cortex was pushed down in to the body. Than posterior transpedicular segmental instrumentation with contoured dual rods after the closure of the osteotomy with a gentle extension maneuver was performed (Figure-2, 3, 4). The reason of

long-segment instrumentation was to avoid junctional kyphosis proximally to the implantation and to restore the sagittal imbalance in an effort to maintain the entire correction. Two transverse connectors were adapted to the rods to complete the frame and the resected posterior elements were used as autografts for fusion both in the osteotomy site and the decorticated instrumented levels. No braces were applied to any of the patients in the postoperative period. Cell-saver was used in 7 patients for autologous blood transfusion. The average amount of blood loss was 1588.2 ± 431.3 cc (range 1350-2250 cc). Main operation time was 2.8 ± 0.4 hours.

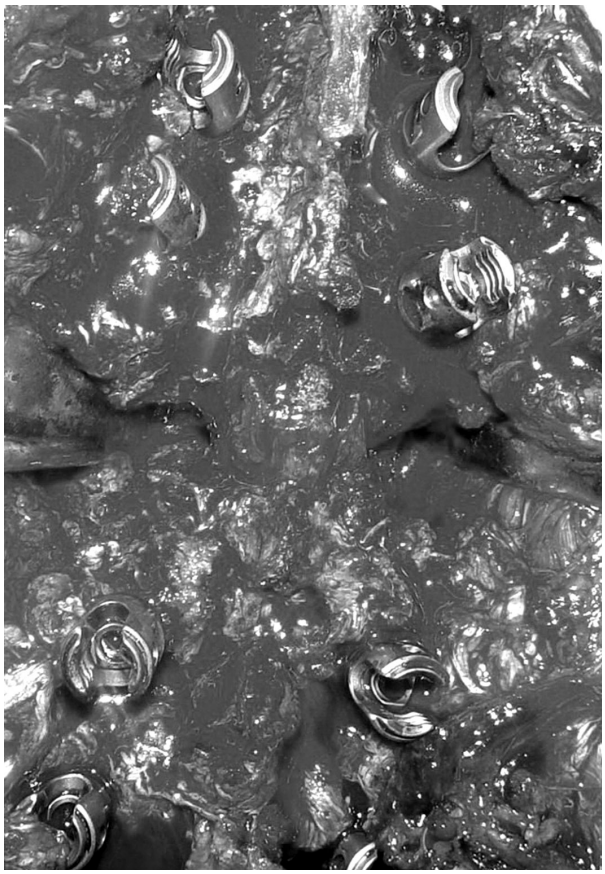

Figure-2. ntraoperative view of the osteotomy site at L-2 level.

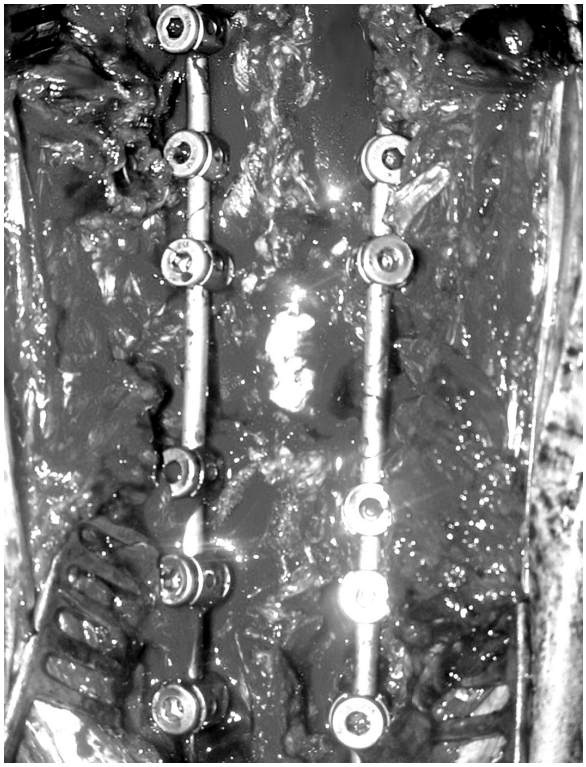

Figure-3. Intraoperative view of the osteotomy site after posterior instrumentation.

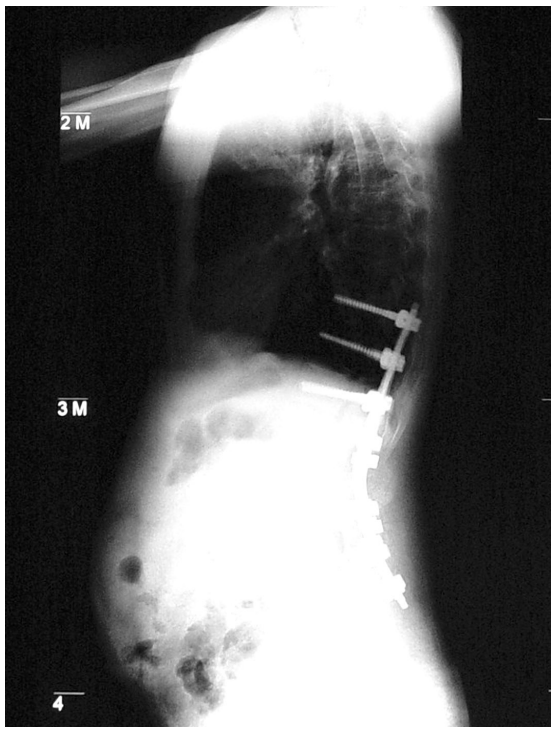

Figure-4. Postoperative lateral standing x-ray of the Case-1.

All of the controls were made in the outpatient clinics of the two different institutions and patients were evaluated in terms of loss of correction, implant failure, clinical complaints and fusion under the light of the data obtained from the physical examinations and Cobb measurements on the lateral standing x-rays. Preoperative, postoperative and final follow-up radiographic findings and complications were noted. SRS-22 questionnaire was performed in 7 patients via telephone calls in order to define the levels of pain, function, mental status, self image (cosmetic) and satisfaction of treatment. They were evaluated upon 5 questions and patients scoring ≥4 were graded 'good' where ≥4.5 were graded as 'perfect' respectively.

Student t-test in SPSS 9.0 for Windows was used for statistical analysis and 0.05 was defined as the significant value.

RESULTS

Preoperative, postoperative and final thoracal and lumbar Cobb measurements with sagittal balance values are given in Table-2. The mean preoperative thoracic kyphosis which was 87.3° ± 14.3° (range 70° -115°) improved to 54.0° ± 9.1° (range 45°-71°) postoperatively with statistically significant (t: 14.7, $p<0.05$). At the final follow-up it was 58.2° ± 9.1° with an average correction loss of 4.2° ± 2.5° (Table-3). There was significance between the mean final thoracic kyphosis and preoperative kyphosis ($p<0.05$), but there was no significance when compared with postoperative kyphosis ($p>0.05$). The mean preoperative lumbar lordosis was 19.6° ± 6.3° (range 10°-30°). Than it improved to 39.6° ± 5.7° (range 30°-50°) postoperatively with statistically significant (t: -9.1, $p<0.05$) and was 37.0° ± 5.5° (range 24°-44°) at the final follow-up with an average correction loss of 2.6° ± 2.3° (Table-3). There was a significance between final lumbar lordosis and preoperative lordosis ($p<0.05$), but there was no significance when compared with postoperative lordosis in lumbar region ($p>0.05$).

Table - 2. Preoperative, postoperative and final thoracic annd lumbar sagittal contours and sagittal balance values of the patient.

	THORACIC			LUMBAR			SAGITTAL		BALANCE
No.	PREOP.	POSTOP.	FINAL	PREOP.	POSTOP.	FINAL	PREOP.	POSTOP.	FINAL
1	110°	71°	75°	20°	40°	40°	5	2,5	2,5
2	83°	60°	61°	10°	40°	39°	6	1,5	1,5
3	74°	48°	50°	15°	30°	24°	9	4	4
4	70°	45°	47°	12°	40°	36°	3	1	1
5	95°	50°	60°	30°	40°	38°	8	4	4,5
6	90°	55°	60°	25°	45°	40°	8	4	4,5
7	80°	50°	55°	20°	50°	44°	6	3,5	4
8	78°	45°	50°	25°	40°	38°	5	2	2,5
9	80°	45°	50°	15°	40°	40°	5	2	2
10	85°	55°	60°	18°	30°	30°	6	4	4
11	115°	70°	72°	25°	40°	38°	11	6	6,5
TOTAL	**87,3° ± 14,3°**	**54,0° ± 9,5°**	**58,2° ± 9,1°**	**19,6° ± 6,3°**	**39,6° ± 5,7°**	**37,0° ± 5,5°**	**6,6 ± 2,3**	**3,1 ± 1,5**	**3,4 ± 1,6**

Table - 3. Average values of thoracic and lumbar sagittal contours and balance of the patients.

	PREOP.	POSTOP.	t	p	FINAL	t	p	LC
THORACIC	87,3° ± 4,3°	54,0° ± 9,5°	14,7	< 0,05	58,2° ± 9,1°	15,0	< 0,05	4,2° ± 2,5°
LUMBAR	19,6° ± 6,3°	39,6° ± 5,7°	-9,1	< 0,05	37,0° ± 5,5°	-8,0	< 0,05	2,6° ± 2,3°
SAGITTAL BALANCE (cm)	6,6 ± 2,3	3,1 ± 1,5	9,9	< 0,05	3,4 ± 1,6	9,6	< 0,05	0,23 ± 0,26

PREOP.: Preoperative, POSTOP.: Postoperative, LC: Loss of correction

Any of the patients had a physiological thoracic kyphosis or lumbar lordosis preoperatively. In the postoperative period, we were able to restore the physiological sagittal contours of 9 patients (81.8%) in both thoracal and lumbar regions. The preoperative thoracal kyphosis of 2 patients which were 110° and 115° were reduced to 70° and 71° in the postoperative period and the restriction in horizontal gaze was totally eliminated respectively.

The cervical plumb line remained anterior to the S-1 body defined as a positive sagittal axis deviation in all of the patients preoperatively and the mean deviation in the sagittal plane was 6.6 ± 2.3 cm (range 3-11 cm). Postoperative sagittal balance value which was 3.1 ± 1.5 cm regarded as a significant improvement (t: 9,9, $p<0.05$). There was a significance between the final sagittal balance value which was 3.4 ± 1.6 cm and preoperative balance (t: 9.6, $p<0.05$), but no significance was noted between the final and postoperative sagittal balance values respectively ($p>0.05$). The mean loss of correction in sagittal balance during the last controls revealed 0.23 ± 0.26 cm which may be defined as a little difference. (Table-3) Solid fusion was achieved without recurrence or progression of the deformity in all of the patients in the study.

According to the evaluation performed in the last follow up, the levels of pain, function, mental status, self image (cosmetic) and satisfaction of treatment were listed in order as following; 4 .2 ± 0.4, 4.1 ± 0.2, 4.6 ± 0.4, 4.2 ± 0.2 and 4.6 ± 0.6 points respectively.

There was no death, neurological compromise, pseudoarthrosis or infection, but one pulmonary embolism and one postoperative thoracic kyphosis proximally to the osteotomy level. The patient with pulmonary embolism was treated with anti-embolic medication for 5 months. The patient having junctional kyphosis rejected the proposed reoperation and did well at the end of the 17th month. There were no cases of failure of instrumentation in terms of breakage, bending or loosening of the pedicle screws or the rods. There was no implant removal in any of cases. At the final follow-up, a subjective leveled horizontal gaze and improvement in daily living activities were achieved in all of the patients.

DISCUSSION

In the current retrospective study, the clinical and radiological results of long-segment posterior instrumentation following posterior closing wedge osteotomy which was performed in 11 patients with Type II global kyphosis due to AS were evaluated.

Deteriorated horizontal gaze and back-pain having no response to medical therapy were the common features. The mean preoperative thoracic kyphosis was 87.3° ± 14.3° and the mean lumbar lordosis was 19.6° ± 6.3°. The reason of long-segment instrumentation was to avoid junctional kyphosis proximally to the implantation and to restore the sagittal imbalance in an effort to maintain the entire correction. The mean postoperative thoracic kyphosis improved to 54.0° ± 9.5° and lumbar lordosis was measured as 39.6° ± 5.7° respectively. Any of the patients had a physiological thoracic kyphosis or lumbar lordosis preoperatively. In the postoperative period, we were able to restore the physiological sagittal contours of 9 patients (81.8%) in both thoracic and lumbar regions. The restriction in horizontal gaze was totally eliminated postoperatively. A solid union mass was achieved in all of the patients. Postoperative sagittal balance value which was 3.1 ± 1.5 cm regarded as a significant improvement ($p<0.05$). The mean loss of correction in sagittal balance during the last controls revealed 0.23 ± 0.26 cm which may be defined as a little difference. Correction rates achieved in sagittal contouring and balancing correlated with the results in the literature [1-10]. Under the light of the data obtained from the current study, this technique is thought to be a safe and effective procedure in terms of sagittal balance and horizontal gaze restoration in AS patients.

In the study of Gülşen et al., it is reported that; as a result of the early failure of correction via one above-one below posterior transpedicular instrumentation in the beginning, they reversed in to two above-two below posterior approach in order to maintain the correction and the sagittal balance [2]. According to another data from the same study was that; the mean sagittal axis deviation was 28.5 mm preoperatively and it improved to 9.8 mm in the early postoperative period. At the final follow-up period 20.5 mm was the mean value of sagittal axis deviation [2]. In the study of Karel et al., it is reported that the average rate of implant failure via posterior closing wedge lumbar osteotomy followed by posterior transpedicular instrumentation performed in 62 patients was 10 cases (% 16) even though the average correction of lordosis between L-1 and S-1 was 27.3° respectively [9]. Brox et al. used the posterior closing lumbar wedge osteotomy for the treatment of 20 cases with kyphotic deformities due to AS and they instrumented 3 levels above and 3 levels below the osteotomy level by pedicle screws to ensure the stability and consolidation [1]. Two patients had a revision operation because of the early implant failure and extension of the instrumentation one level above and below was performed on one patient due to implant failure [1]. In the large series of Ing-Ho et al. consisting of 78 patients who were applied posterior transpedicular osteotomy followed by two above and two below approach for the spinal deformity due to AS, it is reported that only two patients had reoperations via anterior approach because of the screw pull-out in the early postoperative period and one patient was treated by extension of instrumentation for immediate loss of fixation due to implant failure. [3]. In our study, there were no cases of failure of instrumentation in terms of breakage, bending or loosening of the pedicle screws or the rods. There was no implant removal in any of cases.

The average amount of blood loss in the current study was 1800 cc (range 1350-2250 cc). Gülşen et al. reported 750 cc (range 400

cc - 1400 cc) as an average amount of blood loss through 20 AS patients treated by posterior closing wedge osteotomy [2]. In the series of Ing-Ho et al. consisting of 78 patients treated by the same technique the average loss of blood was 1150 cc (range 250 cc - 3200 cc) respectively [4]. In the other series of 7 patients who were applied spinal wedge osteotomy for severe kyphosis correction, the mean blood loss value was 1381 cc (range 850 cc - 2000 cc) [7]. Thus, a predictable high loss of blood is associated with the long-segment posterior instrumentation than the relatively short fusion techniques.

Opening wedge osteotomy (OWO) for the correction of kyphosis in the patients with AS is the other modality of treatment. Kao-Wha et al. used OWO in 127 patients with AS and the mean preoperative sagittal imbalance which was 144 mm declined to 37 mm postoperatively, it increased to 107 mm at the final follow-up respectively [5]. Additionally, a certain determination of sagittal translation at the osteotomy level (27 %) was pointed out in the study. Also 15 % of the patients with sagittal translation had neurological complications [5]. Neither sagittal translation nor neurological complication was associated with the current study.

In the postoperative period, the mortality rates are 8-10 % and the risk of neurological deficit is approximately 30 %. Other important complications after surgical treatment consist of; postoperative ileus, gastrointestinal system bleeding and urinary retention [3]. In our study, there was no death or neurological compromise as well as the other mentioned complications. We had one patient with pulmonary embolism who was treated with anti-embolic medication for 5 months.

The clinical results of this study were evaluated via SRS-22 questionnaire as a unique method in the literature. According to the evaluation performed in the last controls, the levels of pain, function, mental status, appearance (cosmetic) and satisfaction of treatment were listed in order as following; 4 .2 ± 0.4, 4.1 ± 0.2, 4.6 ± 0.4, 4.2 ± 0.2 and 4.6 ± 0.6 points respectively. All of the patients in the study had an improvement in terms of clinical results postoperatively. Pain scores were found more than 4, whereas cosmetic appearance and level of satisfaction from treatment we found than 4.5 in all patients. According these datas, the clinical results of the patients were noted as ‘good’ or ‘excellent’.

Kyphotic deformity due to AS is a rare condition. The number of surgical intervention as a treatment modality for this condition is limited in our country. For that reason, a retrospective clinical study was performed by the combination of patients who were treated with the same technique in two different institutions. The less number of patients and the inability to perform the SRS-22 questionnaire for the entire patient group may be considered as the weak points of the study. Limitations of this study are the less number of patients, measurements done by different doctors, and no applying the SRS-22 questionnaire in all patients.

As a conclusion, according to the results of our study we concluded that closing posterior wedge osteotomy and long-segment posterior instrumentation for the treatment of kyphotic deformities due to Ankylosing spondylitis was a safe and effective procedure in terms of sagittal balance and implant related complications.

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