

QUALITY OF LIFE ASSESSMENT IN ADOLESCENT AND YOUNG ADULTS WITH SCHEUERMANN'S KYPHOSIS

✉ Fatih Şentürk¹, ✉ Mehmet Ozan Aşık², ✉ Ebubekir Bektaş³, ✉ Turgut Akgül¹, ✉ İsmet Teoman Benli²,
✉ Doğaç Karagüven⁴

¹İstanbul University, İstanbul Faculty of Medicine, Department of Orthopaedics and Traumatology, İstanbul, Turkey

²Private Adatıp Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey

³University of Health Sciences Turkey, İstanbul Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, Clinic of Orthopaedics and Traumatology, İstanbul, Turkey

⁴Ufuk University Faculty of Medicine, Department of Orthopedics and Traumatology, Ankara, Turkey

ABSTRACT

Objective: In this study, Scheuermann's kyphosis patients with 80° or more kyphotic deformities were evaluated both for correcting the deformity and effects of changes in the life qualities.

Materials and Methods: Mean age was found to be 18.6±2.4 years and patients with minimum 2 years follow-up were evaluated. In 10 patients below 17 years of age (27%), segmental compression was applied through the apex and correction was obtained. In the remaining 27 patients (73%) correction was obtained with Ponte osteotomies performed at the apex of the kyphosis and the same fixation and maneuver as the first group. Patients thoracic kyphosis angles if concomitant scoliosis was present scoliosis angles were measured via the Cobb method preoperatively, postoperatively and during the last control visit. Patients were evaluated preoperatively with SRS-22 questionnaire. Mean values of the preoperative, postoperative and in the last control visit were compared statistically ($p=0.05$).

Results: Preoperative mean kyphotic angles were measured as 84.9°±5.0°. Postoperative mean kyphotic correction angles were measured as 40.7°±6.5° and in all patients' physiological kyphotic angles were obtained ($p=0.0001$). Preoperative SRS22 questionnaire mean score was 3.17±0.3 while postoperatively increased to 4.95±0.1 which was found to be statistically significant ($p=0.0001$). Almost all patients were satisfied with the pain improvement, look, function, mental status and satisfaction from the treatment was measured as 4.5 to 5 that is almost perfect. Kyphotic correction angles were found to be statistically similar between patients under and over 18 years of ages (>0.05).

Conclusion: As a result, SRS-22 scores which was used for the first time in Scheuermann's Kyphosis patients undergone surgery, a statistically meaningful result was obtained in quality of life scores and relief of mechanical pain.

Keywords: Scheuermann's kyphosis, surgical treatment, posterior instrumentation, Ponte osteotomy, SRS-22 questionnaire

INTRODUCTION

Scheuermann's kyphosis is the most common disease due to structural kyphosis in adolescents. Diagnosis is confirmed with the increase in kyphosis angles 5 degrees at each vertebral segment in minimum 3 consecutive vertebrae and, existence of Schmorl nodules radiological⁽¹⁾. Lack of sharp kyphosis angle, and existence of a moderate kyphosis (round back) causes a delay in diagnosis and treatment of the pathology⁽²⁾. Findings like back pain and an increase in kyphosis, presence of shoulders and the head in front of the torso which are not more common than the normal population clinically, attract attention of the families⁽³⁾. Orthotic treatment applied during preadolescent period is found to be effective but during adolescence, progression can be seen^(1,4,5). Minimal increase or

remission in kyphosis angles can be seen in adulthood. Surgery is indicated when kyphosis angle is greater than 80° in the thoracic spine or 50 degrees in the thoracolumbar spine⁽²⁾. Kyphosis of patients aged over 18 treated with minimum 2 maximum 3 segments of Ponte osteotomy with posterior spinal instrumentation and patients aged between 14 and 17 years of age treated with posterior spinal instrumentation and cantilever maneuver. A total of 37 patients were included in the study and SRS 22 questionnaire was used for the outcomes of the surgery in life qualities of the patients⁽⁵⁾.

MATERIALS AND METHODS

In our study, 37 patients who had kyphosis angle increase in consecutive 3 thoracic vertebrae and who had been shown to present Schmorl nodules radiological and diagnosed as

Address for Correspondence: İsmet Teoman Benli, Private Adatıp Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey

Phone: +90 533 024 49 16 **E-mail:** i.teoman.benli@gmail.com **Received:** 27.04.2022 **Accepted:** 06.07.2022

ORCID ID: orcid.org/0000-0002-1878-0653



Scheuermann's Kyphosis and whose mean age was found to be 18.6 ± 2.4 years with minimum 2 years follow-up were evaluated (mean follow-up: 61.5 ± 29.0). Eleven patients were female and female to male ratio was 11/26 (Table 1).

Patients were evaluated preoperatively; thoracic MRI and preoperative radiographs were obtained to exclude congenital and other causes of kyphosis. Patients' thoracic kyphosis angles if concomitant scoliosis was present scoliosis angles were measured via Cobb method preoperatively, postoperatively and in the last control visit. Patients were evaluated preoperatively with SRS-22 questionnaire.

Five domains including pain mental status, function, appearance, and satisfaction from previous treatments were evaluated and mean SRS-22 values were obtained. Questionnaire which was validated with Alanay et al.⁽⁶⁾ were used.

Patients were positioned prone under general anesthesia and a long midline incision was performed and paravertebral muscles were stripped and vertebrae were visualized. All patients were monitored with Neuromonitoring combined electromyography (EMG), somatosensory evoked potential (SEP) and motor evoked potential (MEP) were measured during the surgery.

In 10 patients below 17 years of age (27%) instrumentation was done at each vertebral segment and multidirectional corrective

transpedicular screws were introduced and pre-bend hard rods bent in 30 to 50 degrees of thoracic physiological kyphosis angle were introduced starting from the distal screws and with cantilever maneuver segmental compression was applied through the apex and correction was obtained.

Remaining 27 patients (73%) correction was obtained with Ponte osteotomies performed at the apex of the kyphosis and pre-bend hard rods with transpedicular fixation and cantilever maneuver with segmental compression through the apex was applied.

Proximally screws were introduced into the T-2 vertebrae in 32 patients (86.5%), and T-3 in 5 patients (13.5%). Each vertebral segment was instrumented starting from the most proximal screw distally in 27 (72.9%) patients at L-1 level and 9 (24.3%) patients at the level of L-2 (27%) and 1 (2.8%) patients with Scheuermann's Kyphosis placed apical vertebra in the thoracolumbar at the level of L-3 (Figure 1).

Local autographs mixed with cancellous allografts were introduced at the fusion area and Neuromonitoring was used at each segmental fixation and corrective manipulation phase. No neurological deficit was seen in any patients preoperatively or postoperatively.

Table 1. Demographic data's [Mean age of the patients was 18.6 ± 2.4 (14-24) years-old]

	TOTAL	<18 years (n=10)		≥ 18 years (n=27)	
	Mean \pm SD	Mean \pm SD	Median (Min.-Max.)	Mean \pm SD	Median (Min.-Max.)
Age	18.6 ± 2.4	15.5 ± 1.2	16 (14-17)	19.7 ± 1.5	19 (18-24)
Follow-up	61.5 ± 29.0	103.5 ± 13.0	106 (82-120)	45.9 ± 13.2	44 (24-72)
Sex (F/M)	11/26	4/6		7/20	
Complication n (%)	4 (10.8)	1 (10.0)		3 (11.1)	

SD: Standard deviation, F: Female, M: Male, Min.: Minimum, Max.: Maximum

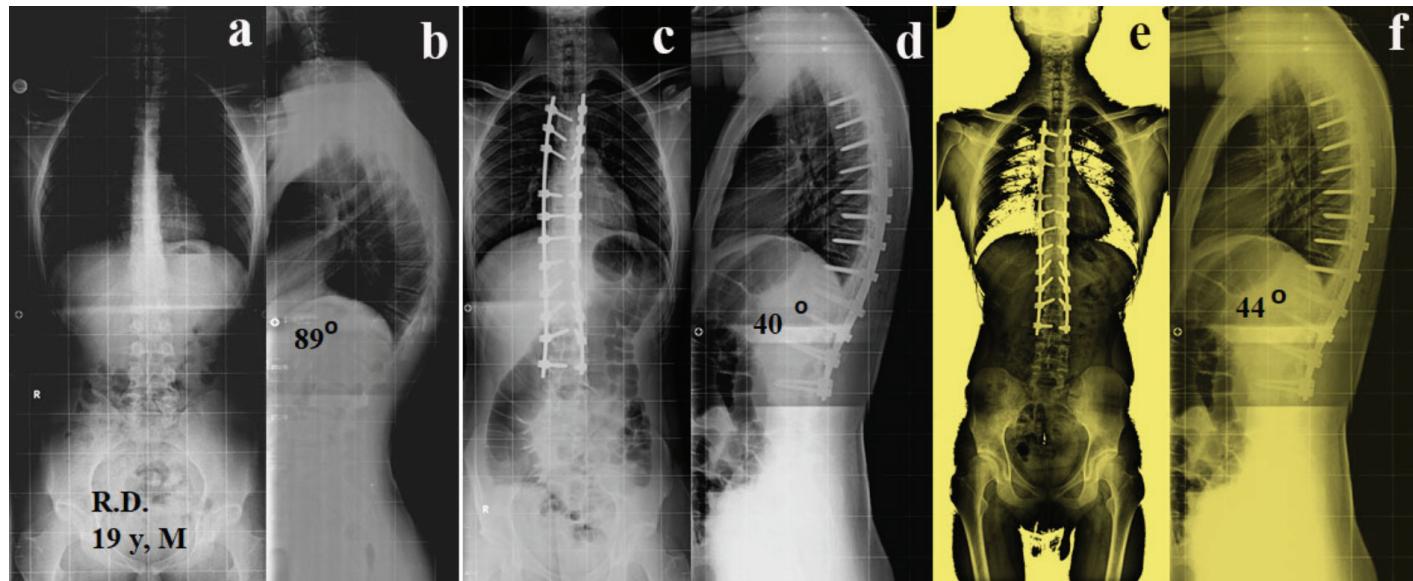


Figure 1. (a-b) Preoperative, (c-d) postoperative and (e-f) last control AP and lateral X-rays of the patient who is 19 years-old male with the thoracolumbar Scheuermann's Kyphosis

AP: Anteroposterior

Postoperative thoracic kyphosis and scoliosis angles, early SRS22 evaluations were noted. Last follow-up of the patients were done in January 2022. In the last polyclinic visit SRS22 evaluations, thoracic kyphosis and scoliosis angles were calculated and complications were noted, also while evaluating life quality patients' marital status, and continuation of the education were noted and evaluated proportionally.

Our study was approved by İstanbul University, İstanbul Faculty of Medicine Ethic Committee in 19th April, 2022 (approval no.: 850601). Informed consent forms of all patients in this study were taken.

Statistical Analysis

Statistical analysis was made with SPSS 21.0 program. Mean values for preoperative postoperative and last control data were tested for importance in similar groups (Wilcoxon signed-rank test). In all patient's correction with posterior segmental instrumentation only patients in 14-17 years' age group, patients over 18 years of age in whom Ponte osteotomy with posterior segmental instrumentation and correction were made, comparison of sagittal kyphosis and coronal scoliosis and SRS 22 values were done. Probability value of p was selected as 0.05.

RESULTS

Thoracic Kyphosis and Concomitant Scoliosis

Thirty-seven patients with 18.6 ± 2.4 years of mean age were followed up for 61.5 ± 29.0 (24-120) months. Preoperative mean kyphosis angles were measured as $84.9^\circ \pm 5.0^\circ$ and statistically significant correction of $40.7^\circ \pm 6.7^\circ$ was accomplished and postoperatively was measured as $40.7^\circ \pm 6.5^\circ$ ($p=0.0001$). Postoperative kyphosis angles were measured in physiological limits (40° - 50°) in all patients⁽⁷⁾. Last follow-up measures yielded a slight increase in thoracic kyphosis average values

were measured as $41.3^\circ \pm 6.5^\circ$, but no statistical difference could be measured according to the postoperative values ($p>0.05$) (Table 2).

Coronal plane scoliosis deformities were measured as 8.2° (0° - 24°) preoperatively and were corrected fully postoperatively. Last follow-up Cobb angles yielded a slight difference but was not found to be statistically significant ($p>0.05$) (Table 3).

SRS-22 Scores

Mean values for SRS-22 values were 3.17 ± 0.3 preoperatively while postoperative values were measured as 4.95 ± 0.1 which was found to be statistically significant ($p=0.0001$). Almost all patients were satisfied with the results, taking into account with pain, function, mental status and appearance, almost obtaining a perfect score around 4.5 to 5 and a mean 66.7% (21.9-78.6%) increase in SRS-22 score was measured. Last follow-up scores yielded a slight decrease of 0.0-0.3 which was not found to be significant ($p=1.0$) (Tables 2, 3).

Assessment According to Age Groups

In this study two groups according to age was separated and evaluated. Ten patients under 18 years of age and 27 patients over 18 years of age were compared. Corrective instrumentation only was applied to patients under 18 years of age and as it is suggested in the literature⁽⁸⁾. Ponte osteotomies (2-3 segments) were added to posterior instrumentation in patients over 18 years of age.

Statistically two age groups were similar in case of follow-up period, preoperative and postoperative and last control values and mean age values ($p>0.05$). Both groups revealed statistically improved results in postoperative kyphosis angles Cobb angles and SRS-22 values ($p<0.05$) (Table 3), and no significant difference could be measured between postoperative and last follow-up values ($p>0.05$).

6 patients (16%) who were actively working before the surgery continued work life after 28 patients who were students at the

Table 2. Preoperative, postoperative and last control kyphosis angles in the sagittal plane, Cobb angles of the scoliosis in the coronal plane and SRS-22 scores, loss of correction of <18 and >18 years-old patients

	Total	<18 years-old (n=10)	≥18 years-old (n=27)	p-value
Preoperative Kyphosis	84.9 ± 5.0	84.6 ± 4.4	85.1 ± 4.9	0.389
Postoperative Kyphosis	40.7 ± 6.7	44.2 ± 4.6	40.4 ± 7.9	0.057
Values of the correction	40.7 ± 6.5	39.2 ± 4.2	42.4 ± 6.4	0.005
Kyphosis in the last control	41.3 ± 6.5	45.4 ± 4.9	41.3 ± 6.7	0.078
Preoperative Cobb angles	8.2 (0-24)	8 (0-17)	10 (0-24)	0.960
Postoperative Cobb angles	0 (0-8)	0 (0-0)	0 (0-8)	0.408
Loss of correction degree	0 (0-8)	0 (0-0)	0 (0-8)	0.408
Preoperative SRS-22	3.17 ± 0.3	3.18 ± 0.3	3.17 ± 0.3	0.853
Postoperative SRS-22	4.95 ± 0.1	4.90 ± 0.2	4.97 ± 0.1	0.371
% Correction	66.7 (21.9-78.6)	54.8 (25.0-66.7)	66.7 (21.9-78.6)	0.105
Loss of correction degree	0 (0.0-0.3)	0 (0.0-0.2)	0 (0.0-0.3)	1.00

n: Number of patient

time of surgery continued their schools, remaining 3 girls who were single were married before the last follow-up and 1 was engaged. No changes were noted in marital status of working and patients going to school at the time of last follow-up yet.

Complications

No intraoperative, postoperative and last follow-up control complications regarding bleeding, neurological damage or systemic complications were noted. Average 103.5 ± 13.0 (24-120) months of follow-up was obtained. No patients were diagnosed as cervico-thoracic or thoracolumbar junctional kyphosis. Total complication rate was measured as 10.8% (4 patients). Under 18 years of age 1 patient and patient over 18 years of age 3 patients were assessed as complication and no

significant difference was measured in between complication rates regarding age groups (Table 1).

Screw malposition was seen in one in each groups counting to 2 patients totally. In patient under 18 years of age screw malposition was occurred during compression maneuver but no Neuromonitoring change was seen so no revision was done (Figure 2). Patient over 18 years of age was diagnosed a malposition of screw with the computed tomography obtained routinely postoperatively and pedicle screw disturbed the medullary canal medially but no neurological deficit or pain was noted so no revision was planned (Figure 3).

One patient had iatrogenic brachial plexus strain but monoparesis and mild hypoesthesia resolved spontaneously

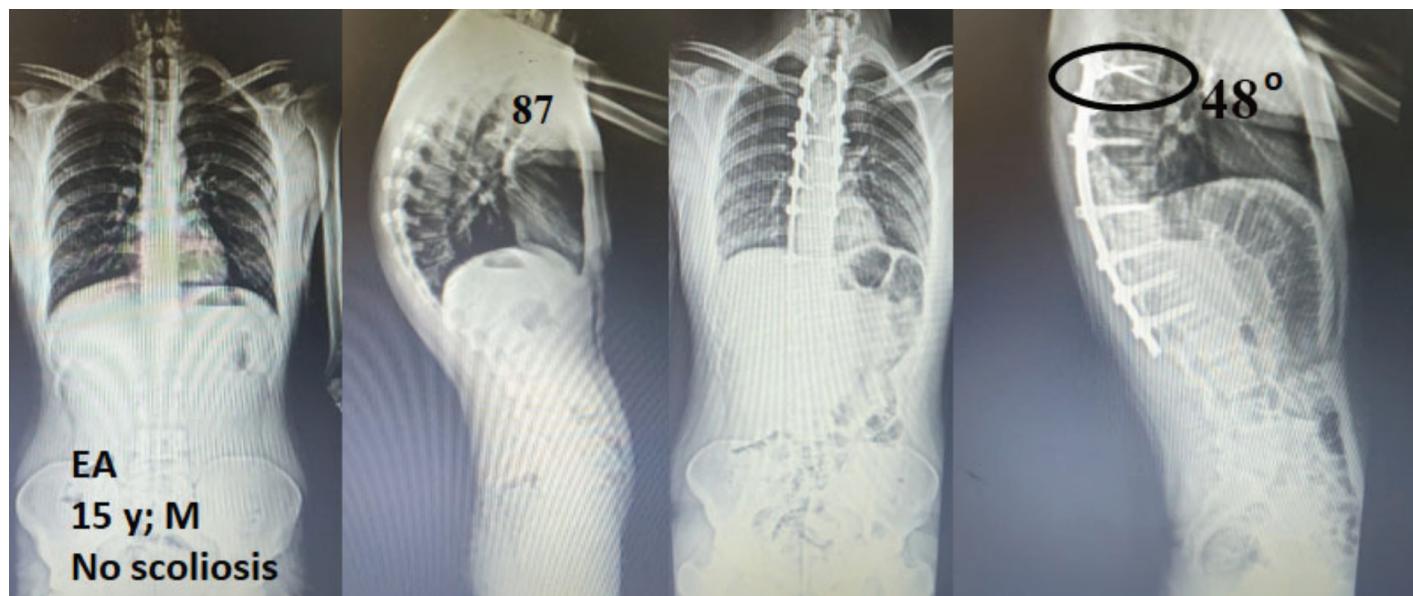


Figure 2. (a-b) Preoperative, (c-d) postoperative AP and lateral X-rays of the patient who is 15 years-old male. Preoperative Kyphosis was 87° and was corrected to 48°. There was malposition of the screws in the level of T-3

AP: Anteroposterior

Table 3. Comparison of the mean preoperative, postoperative and last control kyphosis angles in the sagittal plane, Cobb angles of the scoliosis in the coronal plane and SRS-22 scores, loss of correction with age groups

	Preoperative	Postoperative	Last control	p-value
All of the cases				
Kyphosis	84.9 ± 5.0	40.7 ± 6.7	-	0.0001
Cobb	10 (0-24)	0 (0-8)	0 (0-8)	0.0001
SRS-22	3.17 ± 0.3	4.95 ± 0.1	-	0.0001
<18 years				
Kyphosis	84.6 ± 4.4	44.2 ± 4.6	-	0.006
Cobb	9 (0-17)	0 (0-0)	0 (0-0)	0.0001
SRS-22	3.18 ± 0.3	4.90 ± 0.2	-	0.005
≥18 years				
Kyphosis	85.1 ± 4.9	40.4 ± 4.0	-	0.0001
Cobb	10 (0-24)	0 (0-8)	0 (0-8)	0.0001
SRS-22	3.17 ± 0.3	4.97 ± 0.1	-	0.0001

Wilcoxon signed-ranks test, $p < 0.05$

in postoperative 3rd month. A smoking patient had wound complication and culture revealed *Staphylococcus aureus* which was eradicated with antibiotics and debridement with instrumentation retention. Postoperative 45th month follow-up yielded no persistent or new infection.

DISCUSSION

In patients with Scheuermann's Kyphosis, growth hormone or hormone transmitters responsible for growth and modulation of paravertebral musculature are thought to have role in etiology⁽⁹⁾. Currently, there is not a cause specific treatment as the etiopathogenesis could not be defined thoroughly. Generally conservative measures are accepted in Scheuermann's Kyphosis treatment^(5,10).

There are some publications in which orthotic corset treatment and some exercise programs are found to be successful in preadolescent and adolescent ages regardless of the kyphosis angles^(14,11,12). Corset treatment's acceptance by the patient and family and treatment time for several years decreases the adherence to treatment⁽⁵⁾. Reports have been made about aggressiveness and irritable personality changes and psychological inconsistencies in the patients⁽²⁾. In some publications in adherence to corset treatment causing an increase in kyphosis deformity was also reported^(2,13).

According to Lowe surgical treatment in adolescents and young adults should be considered if there is documented progression, refractory pain, loss of sagittal balance, or neurologic deficit⁽⁵⁾. However, Bettany-Saltikov et al.⁽⁷⁾ reported that no significant progression was observed in patients who had 55 to 80 degrees of kyphosis angles treated with conservative measures. Beside several complications were observed in patients who had undergone surgery⁽⁷⁾.

A study regarding general attitude in kyphosis deformity treatment around 80 degrees, almost 90% of the patients were treated surgically between 2003 and 2012. This high level of evidence study also revealed an increase in postoperative and follow-ups complication rates⁽⁸⁾.

Main goal in surgical treatment in kyphosis is to obtain a postoperative kyphosis angle between 40-50 degrees. Junctional kyphosis is inevitable in patients whose kyphosis angle was reduced under 30 degrees^(13,14). Lowe and Line⁽²⁾ recommends kyphosis angles to be at least 80 degrees before. Lin et al.⁽¹⁵⁾ suggested pedicle subtraction osteotomies to be successful in very rigid deformities. Cho et al.⁽¹⁶⁾ reported that according to sagittal stable vertebrae concept, instrumentation should be started at T2 or T3 at most proximal level and should be ended in the L1 or L2 most distally.

In our study all patients had undergone an instrumentation starting from T2 or T3 distally ending at L1 or L2. Compression was applied to T2-T3 and T12-L1 levels for decreasing probability of junctional kyphosis formation. Thus no junctional kyphosis was seen in our series.

Canikli et al.⁽¹⁷⁾ compared different posterior instrumentation types in their study and best results were obtained in patients with pedicular fixation at all levels when Ponte osteotomy added. With other instrumentation systems while a 75° kyphosis angle was reduced to 45 degrees postoperatively, at last follow-up progression was seen and kyphosis angles were measured as 57.4 degrees. Besides, in patients in whom all level pedicular fixation with Ponte osteotomy were done, preoperative mean 80 degrees of kyphosis angles were reduced to 41.7 degrees and last follow-up control yielded a minimal correction loss⁽¹⁷⁾. In our study as suggested by Lowe and Line⁽²⁾, patients with kyphosis deformities of 80 degrees or more were instrumented at each level and a cantilever maneuver was applied and correction was obtained and local auto-grafts and allografts were introduced to gain fusion. While patients between 15 and 17 years of age were instrumented only, patients over 18 years of age with rigid deformities, Ponte osteotomies were added⁽²⁾. Preoperative mean kyphosis angles measured as $84.9 \pm 5.0^\circ$ were reduced postoperatively to $40.7 \pm 6.5^\circ$ and normal physiological thoracic kyphosis were obtained. Last control and early postoperative mean kyphosis angles did not yield a significant difference and minimal correction loss was seen while posterior fusion was gained in all patients. Preoperative

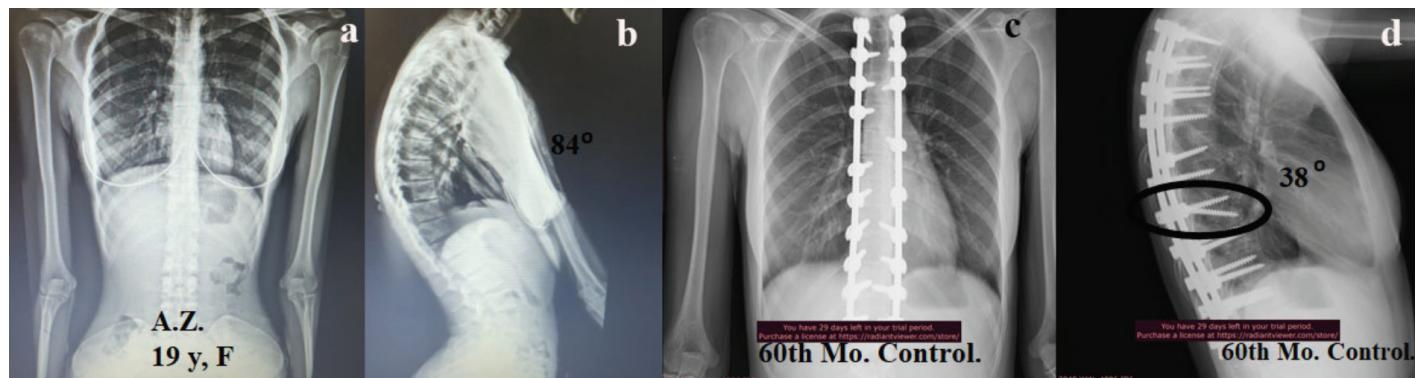


Figure 3. (a, b) Preoperative, (c, d) 60th months AP and lateral X-rays of the patient who is 19 years-old female. Preoperative Kyphosis was 84° and was corrected to 32°. There was malposition of the screws in the level of T-3. In the last control visit, thoracic kyphosis was 36°. She has no pain and neurologic deficit

AP: Anteroposterior

scoliosis angles were measured as 8.2° average was reduced to 0 degrees postoperatively. Obtained results were in concordance with the literature⁽²⁾.

Bradford et al.⁽¹⁸⁾ claimed that there was no difference in results of patients who were treated with anterior and posterior approaches. Etemadifar et al.⁽¹⁹⁾ suggested concomitant anterior and posterior fusion surgery was better than posterior only surgery in patients in whom growth was not completed in adolescent period to minimize correction loss.

Our general practice under 18 years of age is corrective only instrumentation and as suggested in the literature corrective instrumentation with 2-3 levels of Ponte osteotomies added in patients over 18 years of age. Ten patients in adolescent age group had preoperative mean kyphosis angles of 84.6°±5.0° and postoperative mean values of 44.2°±4.6° was obtained which was statistically significant ($p=0.007$). Twenty-seven patients over 18 years of age had preoperative mean kyphotic angles of 85.1°±4.9° while a mean postoperative mean kyphosis angle of 40.4°±4.6° was obtained which is also statistically significant ($p=0.0001$).

There was no difference regarding preoperative, postoperative and last control kyphosis and scoliosis angles and SRS-22 values in between these two groups ($p>0.05$). Ponte osteotomy added to corrective posterior instrumentation is thought to have a role in this situation. Correction losses observed in last control while no significant statistical results were obtained were seen more in adolescent age group. Solid posterior fusion was obtained in allograft groups.

The major postoperative complication after surgical treatment is junctional kyphosis proximally or distally, which is usually related to not including all levels of the kyphosis or overcorrection of the deformity (>50%)⁽⁵⁾. In our study proximal and distal end vertebrae were selected as T2 or T3 and L1 and L2 as suggested in the literature. Compression was applied at last two segments to prevent junctional kyphosis and by avoiding overcorrection; we did not observe any cervico-thoracic or thoracolumbar junctional kyphosis.

Neurological deficit was reported in 2% of patients in surgical treatment of Scheuermann's Kyphosis⁽¹⁴⁾. In our study we did not observe any neurological deficit after surgical correction. We do think that combined usage of SEP, MEP and EMG Neuromonitoring plays an important role. One patient had transient upper extremity brachial plexus sprain due to prone positioning which resolved in 3 months so after this complication to avoid traction injury we positioned the patients prone with arms positioned besides the torso.

Postoperative infection rates were reported as 3% while in our study we had one patient (2.7%) with deep infection treated with debridement and antibiotic therapy^(2,14). In our study group we had two patients with screw malposition's by chance which did not cause any neurological deficit. Follow-up of patients did not yield any pain no revision surgery was planned.

SRS-22 questionnaire used in our study is a life quality assessment tool in the literature. Pain, appearance, mental

status, function and satisfaction from the treatment is evaluated and by having an average of these domains score is calculated over 5 points. SRS-22 Turkish questionnaire which was described and validated by Alanay et al.⁽⁶⁾ were used in our study. Regarding all patients preoperative mean values of 3.17±0.3 was raised to 4.95±0.1 postoperatively and was found to be statistically significant ($p=0.0001$). Patients had no limitations in returning to school or work.

Study Limitations

The most important limitation of this study is a few numbers of patients involved in the study. Second limitation of the study is the follow-up periods of adolescent group was 103.5±13.0 months while follow-up period was 45.9±13.2 months in young adult group. This is because we do not perform any Scheuermann Kyphosis surgery regardless of kyphosis angles in 5 years recently.

CONCLUSION

As a result, in patients with kyphotic angles over 80 degrees, modern instrumentation in which correction obtained via each level segmental instrumentation with pedicle screws and pre-bend hard rods and cantilever maneuver to gain physiological kyphosis and concomitant scoliosis deformity correction is reported to be successful.

Scheuermann's Kyphosis patients treated surgically were assessed with SRS-22 questionnaire, regarding quality of life and pain reduction depicted a statistically significant result in which this questionnaire was firstly used.

Ethics

Ethics Committee Approval: Our study was approved by İstanbul University, İstanbul Faculty of Medicine Ethic Committee in 19th April, 2022 (approval no.: 850601).

Informed Consent: Informed consent forms of all patients in this study were taken.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Concept: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Design: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Data Collection or Processing: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Analysis or Interpretation: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Literature Search: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K., Writing: F.Ş., M.O.A., E.B., T.A., İ.T.B., D.K.

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