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ORIGINAL ARTICLE

Assessment of Outcomes of Operative Management of Scheuermann's Kyphosis

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ABSTRACT

Background: Surgical treatment of Scheuermann's kyphosis is tailored individually and may be considered in patients whose back pain cannot be relieved with conservative methods. Junctional kyphosis is a frequent complication that can arise either proximally or distally to the instrumentation. This study aimed to assess the clinical and radiological outcomes after restoration of the spinopelvic parameters of sagitally corrected patients with Scheuermann's kyphosis.**Methods:** We carried out this prospective cohort study on 12 caseswith Scheuermann's kyphosis at Zagazig University Hospitals and were treated with posterior approach, pedicular screw fixation, the required osteotomy according to type of the deformity. Follow up was done postoperatively at 3,6, 12 and 24 months by Oswestry Disability Index (ODI) score and by radiological evaluation in lateral standingposition.**Results**: There were direct significant correlations between pre and postoperative ODI, visual analogue score (VAS), lumbar lordosis (LL) angle, thoracolumbar kyphosis (TLK) angle, thoracic kyphosis (TK) angle, pelvic Incidence – lumbar lordosis mismatch (PI-LL) with P value <0.001 for each, also there was a direct significant correlation between pre and postoperative Sagittal Imbalance (P value = 0.001).**Conclusion:** Ponte technique was found to be useful in correction of Scheuermann's Kyphosis cases. The combination technique improved the maintenance of the kyphosis correction to a small but noticeable degree. Proximal junctional radiographic kyphosis was prevalent and appeared to be related to both large curve magnitudes before and after surgery and to pelvic incidence.

Keywords: Outcomes, Operative Management, Scheuermann's Kyphosis.

INTRODUCTION

Kyphosis and other sagittal plane abnormalities cause more than just aesthetic issues; they can also cause chronic back pain and neurological dysfunction. These abnormalities might be the result of development, trauma or medical intervention [1]. Scheuermann's kyphosis is a deformity of the spine that forms gradually during adolescence (at puberty). The vertebrae, which should be straight and parallel, get

curved and stuck together when the front of the spine doesn't expand as quickly as the back. This results in an abnormal curvature of the thoracic spine. Patients develop a hunched, forward posture [2].

Scheuermann's kyphosis typically manifests in young adults, about the time they hit puberty. Most frequently, parents report that their kid is experiencing weariness and minor pain in the thoracic region of the spine. In rare situations, patients may also experience chest pain or difficulty breathing due to diminished lung capacity in addition to pain, a hard curve of the spine that gets worse with forward bending and only partially improves with standing, co-existing scoliosis, etc. [2].Full-length lateral view x-rays of the spinal column are taken in both the standing and prone positions to assess curve flexibility and vertebral wedging, providing a conclusive diagnosis. Kyphosis curvature is quantified in degrees. If a patient has a kyphotic curve of 50 degrees or more, three or more neighboring vertebrae are jammed together by at least 5 degrees per segment and Schmorl's nodes are present, then the diagnosis is Scheuermann's kyphosis [2].

Scheuermann's kyphosis treatment is individualised based on the age of the patient, the degree of the curve and the presence or absence of neurological complications (very uncommon). Most doctors recommend watching for worsening kyphosis with annual checkups and x-rays unless the condition is quite severe. Activities that strengthen the spine's extension muscles and keep the curve as flexible as possible are generally recommended to patients during this time[2].

Patients whose back pain cannot be alleviated with conservative approaches and whose kyphosis grows progressively with cosmetic concerns may be candidates for individualised surgical treatment. The primary objectives of the treatment are the correction and maintenance of the repaired curvature. Kyphosis can be fixed using anterior, posterior or combination surgical techniques [3]. One or more osteotomies that stretch or shorten a specific spinal column (anterior or posterior) to correct a specified degree of imbalance in the sagittal plane are commonly used to treat spinal imbalance.The Smith-Petersen osteotomy, pedicle subtraction osteotomy, cervical extension osteotomy and vertebral column resection are all examples of osteotomies [4].

Historically, a single osteotomy was used to perform the Smith-Petersen osteotomy (SPO), which was primarily used to treat ankylosing spondylitis.SPO was originally developed for the treatment of kyphosis caused by scoliosis, but its indications have since been broadened to include the correction of kyphosis caused by iatrogenic fixed sagittal imbalance (flat-back syndromes), congenital spine deformities like Scheuermann's kyphosis, and kyphosis caused by trauma. For coronal imbalance correction, Smith-Petersen osteotomies have also seen increased application in a polysegmental context and in conjunction with asymmetric osteotomy procedures [5].

The working hypothesis is that surgical management of Scheuermann’s Kyphosis could restore spinopelvic parameters with less pain and improve the quality of life of these patients.This research was conducted to assess the clinical and radiological outcomes after restoration the spinopelvic parameters of sagitally corrected patients with Scheu-ermann’s kyphosis.

METHODS

We conducted this prospective study on twelve patients, who presented with

Scheuermann's kyphosisand were treated with posterior approach, pedicular screw fixation and required osteotomy according to type of the deformity at Zagazig University Hospitals during the period from June 2022 to June 2023. Written informed consent was obtained from all participants and the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University, Institutional Research Board (IRB) number (#10449/13-2-2023).The Declaration of Helsinki, issued by the World Medical Association to ensure the protection of people participating in medical research, was strictly followed during this study.

Inclusion Criteria were: adolescents and adults cases who had scheuermann's kyphosis from both genders, while cases were excluded if hadactive infection, medically unfit for surgery or refused to participate.All subjects underwent the following: clinical evaluation: full history including patient complaint, present, past and family history.Clinical examination including presence of back pain, radicular pain ,sciatica, neurogenic claudication , deformity (rib hump, gibus) , the form of the gait was examined, muscle power, reflexes and tone in the lower limbs as well as sensations were examined.

Radiologically: Plain x-ray was done for sagittal balance assessmentshowing the anatomy of the lesion with its grades and in detecting associated deformity, including kyphosis and scoliosis.A plumb line was drawn from the midpoint of the C7 vertebral body to the pelvis. Sagittal vertical axis is roughly in this direction. The offset of the sagittal vertical axis is the distance between this line and the posterosuperior aspect of the vertebral body of S1.The average deviation from the sagittal vertical axis is between 2.5 and 5 centimeters. Sagittal imbalance is negative when the plumline is located posterior to the posterosuperior angle of the S1 vertebral body.When the plumb line is perpendicular to the posterosuperior aspect of the S1 vertebral body, sagittal equilibrium is achieved. Plumb line is located anterior to the posterosuperior aspect of the S1 vertebral body, indicating a positive sagittal imbalance. The patient was placed in a safe standing position for lateral radiographs of the spine and pelvis. The patient was instructed to lay his or her hands on the support and stand in an upright, relaxed position. Spinal parameters that were involved in this analysis were: Lumbar lordosis, The pelvic incidence (PI), The pelvic tilt (PT), The sacral slope (SS), and Global Tilt angel (GT).

Clinical and Functional assessment : Patients were divided into preoperative and postoperative group according to improvement of sagittal balance , oswerty disability index score (ODI) , VAS score and developing or not PJK. Radiologic factors and clinical outcomes were compared ODI score.

Surgical Technique :All patients subjected to general and laboratory examination for surgery under general anaethesia and treated by posterior approach, pedicular screw fixation, the required osteotomy according to type of the deformity ranging from facetectomy to release the stiffness of the spine and posterior vertebral column resection extra-pedicular approach. To achieve balanced spine and the rod curvature and bending according to patient specific measurements. Follow up was done postoperatively at 3 ,6 ,12 and 24 months byfunctional evaluation by ODI score and radiological evaluation is done by lateral x-ray in standing position.

Statistical analysis:The statistical work was

performed in SPSS 28. (IBM Co., Armonk, NY, USA). Categorical data were analysed using the Chi-square test or the Fisher exact test, and the results were presented as frequencies and percentages. The normality of the continuous data was examined using the Shapiro-Wilk test. When comparing two dependent groups with non-normally distributed data, the Wilcoxon signed ranks test was utilized. Spearman's rank correlation coefficient was used to determine the degree of association between the variables in the study.

RESULTS

Table 1 show that the mean of preoperative ODI of the studied patient , it was 27 and the mean of post operative ODI of the patients was 19, the mean of preoperative VAS of the studied patient was 5.667 and the mean of post operative VAS of the patients was 3, in comparison between the pre and postoperative assessment there is direct significant correlation between pre and postoperative ODI, and VAS (P value <0.001) .

Table 2 show that the mean of preoperative PI of the studied patient is 49 and the mean of post operative PI of the patients is 49, the mean of preoperative SS of the studied patient is 32.5 and the mean of post operative SS of the patients is 32.167, in comparison between the pre and postoperative assessment no changes occurs in the value of PI (P=1.00)as there is insignificant correlation between pre and postoperative SS (P value =0.767) .

Table 3 show that the mean of preoperative PT of the studied patient is 16.5 and the mean of post operative PT of the patients is 16.833, the mean of preoperative LL of the studied patient is 69.0 and the mean of post operative LL of the patients is 49.167, in comparison between the pre and postoperative assessment there is insignificant correlation between pre and postoperative PT (P value =0.767) while in comparison between the pre and postoperative assessment there is direct significant correlation between pre and postoperative LL (P value <0.001).

Table 4 show that he mean of preoperative TLK of the studied patient is 18.667 and the mean of post operative TLK of the patients is 6.833, the mean of preoperative TK of the studied patient is 84.33 and the mean of post operative TK of the patients is 54.667, in comparison between the pre and postoperative assessment threre is direct significant correlation between pre and postoperative TLK, and TK (P value =0.003 and <0.001 respectively) .

Table 5 show that the mean of preoperative PI-LL of the studied patient is 20.0 and the mean of post operative PI-LL of the patients is 6.5, the mean of preoperative Sagittal Imbalance of the studied patient is 1.667 and the mean of post operative Sagittal Imbalance of the patients is 1.00, in comparison between the pre and postoperative assessment there is direct significant correlation between pre and postoperative PI-LL and Sagittal Imbalance (P value <0.001, =0.001 respectively).

Table 1: comparison pre operative and post operative assessment of among the studied patients regarding Oswerity Disability Index (ODI), and Visual analogue system (VAS)

ODI	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	18	-	34	18	-	20	8.000	5.657	4.899	<0.001*
Mean ±SD	27.000	±	6.120	19.000	±	1.044				
VAS	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	4	-	7	2	-	4	2.667	0.985	9.381	<0.001*
Mean ±SD	5.667	±	0.985	3.000	±	0.603				

Table 2 :comparison pre operative and post operative assessmentof among the studied patients regarding pelvicincidence (PI)and sacral slope (SS).

PI	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	35	-	59	35	-	59	0.000	0.000	0.000	1.000
Mean ±SD	49.000	±	8.571	49.000	±	8.571				
SS	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	26	-	39	28	-	40	0.333	3.798	0.304	0.767
Mean ±SD	32.500	±	4.777	32.167	±	3.973				

Table 3: comparison pre operative and post operative assessment of among the studied patients regarding pelvic tilt (PT) and lumbar lordosis angle (LL).

PT	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	9	-	23	4	-	28	-0.333	3.798	-0.304	0.767
Mean ±SD	16.500	±	6.599	16.833	±	10.026				
LL	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	50	-	80	44	-	55	19.833	11.159	6.157	<0.001*
Mean ±SD	69.000	±	13.017	49.167	±	3.433				

Table 4: comparison pre operative and post operative assessment of among the studied patients regarding Thoracolumbar kyphosis angle (TLK) and Thoracic kyphosis angle (TK) .

TLK	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	8	-	34	3	-	10	11.833	10.994	3.728	0.003*
Mean ±SD	18.667	±	10.334	6.833	±	2.657				
TK	Time						Differences		Paired Test	
	Pre			Post			Mean	SD	t	P-value
Range	73	-	94	47	-	60	29.667	6.315	16.274	<0.001*
Mean ±SD	84.333	±	7.050	54.667	±	5.710				

Table 5: comparison pre operative and post operative assessment of among the studied patients regarding Pelvic Incidence – Lumbar Lordosis Mismatch (PI-LL) and Sagittal Imbalance

PI- LL	Time	Differences	Paired Test						
	Pre	Post	Mean	SD	t	P-value			
Range	6	-	28	2	-	10	13.500	8.480	5.515	<0.001*
Mean ±SD	20.000	±	7.556	6.500	±	3.119				
Sagittal imbalance	**Time**	**Differences**	**Paired Test**						
	Pre	**Post**	**Mean**	**SD**	**t**	**P-value**			
Range	1	-	2	1	-	1	0.667	0.492	4.690	0.001*
Mean ±SD	1.667	±	0.492	1.000	±	0.000				

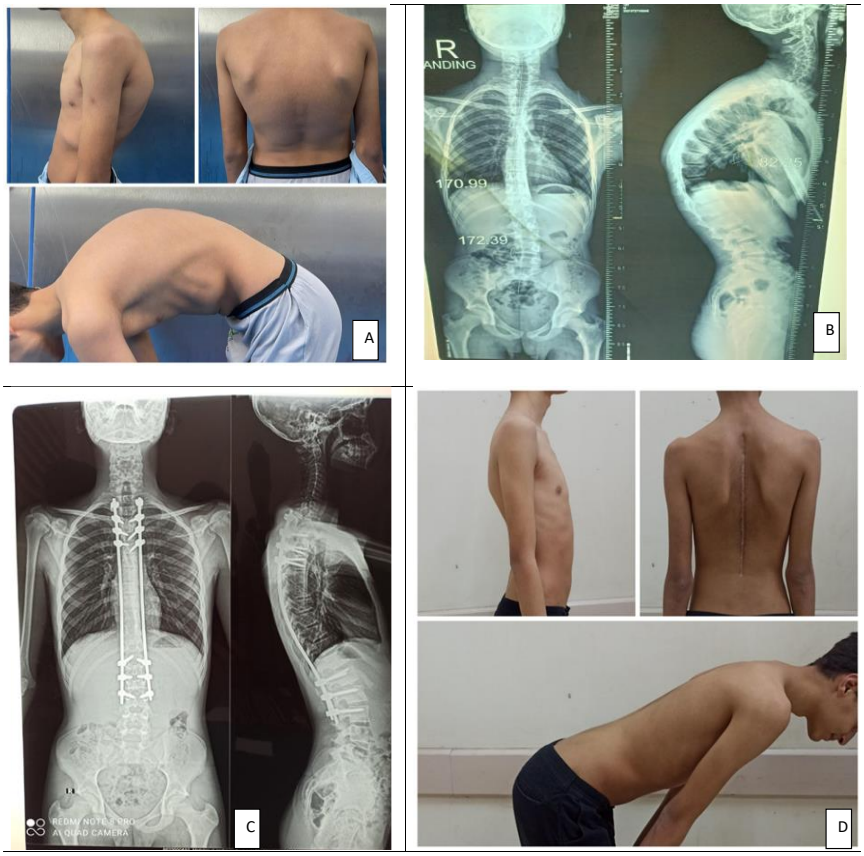

Figure 1: Male, 18 years old presented with low back pain and lump on the back, diagnosed to have Scheurmann's kyphosis of thoraco-lumbar type, operated by posterior approach for surgical correction, (A): Clinical photo of the patient with increase the deformity by adam's bending test, (B): Preoperative Full spine radiograph of the patient with thoraco-lumbar Scheurmann's kyphosis: PI : 35,PT: 9, SS: 26**.** LL: 53, TLK :30, TK: 84, Mismatch PI-LL=18 (C): postoperative full spine x-ray at 2 years: PI : 35, PT :4 ,SS :31,LL :44,TLK : 10, TK :48, Mismatch PI-LL :9, (D): Post operative clinical photos of the patient at 2 years

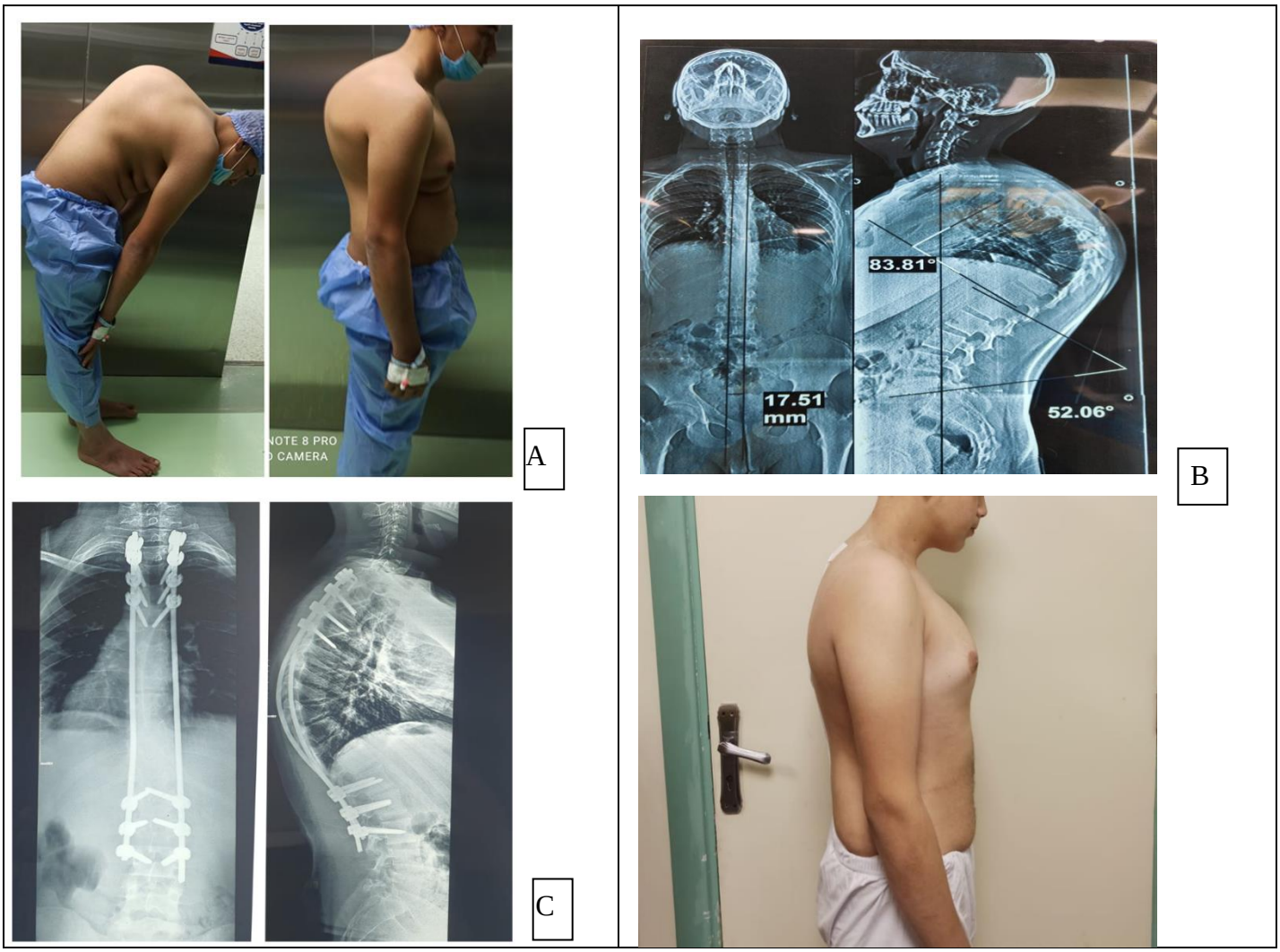

Figure 2: Male, male, 22 years old, presented with low back pain and lump on the back, operated by posterior approach for surgical correction, (A): Clinical photo of the patient with increase the deformity by adam's bending test, (B): Full spine radiograph of the patient with thoraco-lumbar Scheurmann's kyphosisPI : 50, PT: 22,SS: 28, LL: 76, TLK :9, TK: 94, Mismatch PI-LL=16, (C): postoperative full spine x-ray at 2 years:PI : 50, PT :20,SS :30, LL :55,TLK : 5, TK :61, Mismatch PI-LL :5, (D): Post operative clinical photos of the patient at 2 years.

DISCUSSION

Scheuermann's kyphosis is characterized by at least 5 degrees of anterior wedging between three contiguous vertebrae in the thoracic and/or thoracolumbar spine (Sorensen criteria). About 2.8% of the population is thought to have it and it most often affects young people who are otherwise healthy [6].The degree of the deformity, the presence of pain or neurological symptoms and the age of the patient all play a role in determining the best course of treatment. Nonoperative treatments, including as stretching and bracing are typically used to treat individuals with less severe deformities.Back pain is a common symptom of Scheuermann's, typically felt near the deformity's peak and exacerbated by extended sitting or exercise. Pain usually decreases as bones mature and mild curvature (less than 70 degrees) should cause few long-term issues. Progressive deformity, chronic pain, and even neurologic consequences have been reported in people with severe kyphosis [7].

Reports on the outcomes of surgical care of Scheuermann's kyphosis with modern

procedures and implant systems are scarce. Small sample sizes and limited radiographic analysis have been problems in these investigations. Interventions have been recommended both anteriorly and posteriorly, or only posteriorly [8].

The objectives of this study were to report the health-related quality of life outcomes in sagittal imbalance correction surgery, assess the radiological outcomes of surgically corrected sagittal imbalance of the vertebral column and assess the restoration of pelvic parameters after surgically correction of kyphotic sagittal balance.The current study revealed that the mean of preoperative ODI of the studied patient is 27 and the mean of post operative ODI of the patients is 19. There was direct significant correlation between pre and postoperative Oswerity Disability Index (ODI). The mean of preoperative VAS of the studied patient is 5.667 and the mean of post operative VAS of the patients is 3, there was a direct significant correlation between pre and postoperative Visual Analogue System (VAS).Our current findings clearly revealed that the mean of preoperative PI of the studied patient is 49 and the mean of post operative PI of the patients is 49 with no statistically significant difference between the pre and postoperative assessment regarding pelvic incidence (PI).In agreement with our findings, Zhu et al. [9]reported that before surgery, a higher significant PI in the group of Scheuermann thoracic kyphosis (STK)(8.3±1.0, 22.7±22.0° and 39.3±6.7°, respectively) than those in the group of Scheuermann thoracolumbar kyphosis (STLK) (13.6±3.7, 59.4±17.2°, and 30.7±9.9°, respectively). Quality of life evaluations before surgery showed no significant differences between Groups STK and STLK. There was no statistically significant difference in pelvic incidence between the groups at the 2-year follow-up. A stronger association was observed between lordosis and pelvic incidence than between lordosis and kyphosis by Legaye et al [10].The PI (35.1) was considerably lower in 49 patients with either congenital kyphosis or angular kyphosis due to persistent TB, as reported by Li et al. The authors hypothesised that developmental angular kyphosis could result in abnormal pelvic morphology.Also, the PI in the SK group was found to be considerably lower than in the normal control group (32 vs. 45). Consistent evidence suggests that the reduced PI in paediatric SK patients may play a role in the development and progression of the condition. However, hormonal variables such elevated growth hormone have been linked to a role in SK etiology.

In the current study we found that the mean of preoperative SS of the studied patient is 32.5 and the mean of post operative SS of the patients is 32.167. There was insignificant correlation between pre and postoperative sacral slope (SS).These results were compatible withZhu et al [9]who reported that before corrective surgery, patients in the STK and STLK groups had comparable SS.Both groups exhibited visible improvements in their hyper kyphosis abnormalities and those improvements persisted throughout the follow-up period. Both STK and STLK were successfully corrected to the same amount, with postoperative SS measurements remaining stable both immediately following surgery and at the conclusion of the follow-up period.Quality of life evaluations before surgery showed no significant differences between Groups STK and STLK. There was no statistically significant difference in SS between the groups at the 2-year follow-up.

Also, Scheuermann's thoracic kyphosis was associated with a greater SS than controls, as reported by Jiang et al. [12].In the present study we found that the mean of preoperative PT of the studied patient is 16.5 and the mean of post operative PT of the patients is 16.833. There was insignificant correlation between pre and postoperative pelvic tilt (PT).This was in accordance with Zhu et al [9]who found that PT values to be comparable before surgery between STK and STLK groups. Both groups showed visible improvements in their hyper kyphosis abnormalities and those improvements persisted throughout the follow-up period. STK and STLK were repaired to the same extent, with equivalent PT both immediately after surgery and at the end follow-up, despite having differing distal fusion techniques. Quality of life evaluations before surgery showed no significant differences between Groups STK and STLK. At the 2-year follow-up, no group had a discernible advantage in PT.

Children with Scheuermann's disease have an abnormal growth pattern, as shown by the findings of Fotiadis et al [13], who showed that these children were heavier, taller and had higher body mass indexes. Therefore, we hypothesize that the tiny PI in young SK patients is due to the aberrant growth pattern affecting not only the development of the spine but also the pelvic morphology.Negative PT were far more common among SK patients than among healthy controls and the rate of negative PTs was statistically lower than among healthy controls. The correlation between PI, PT and SS suggests that low PI may be to blame for the reduced PT.

Our current findings clearly revealed that the mean of preoperative LL of the studied patient is 69.0 and the mean of post operative LL of the patients is 49.167. There was a direct significant correlation between pre and postoperative lumbar lordosis angle (LL).

Zhu et al [9]stated that LL parameters were comparable between STK and STLK groups. Both groups showed visible improvements in their hyper kyphosis abnormalities and those improvements persisted throughout the follow-up period. Both STK and STLK had similar levels of correction, both immediately following surgery and during the end follow-up, despite utilizing distinct distal fusion techniques. Quality of life evaluations before surgery showed no significant differences between Groups STK and STLK. There was no statistically significant difference in LL rates between the two groups at the 2-year follow-up.

In the current study we found that the mean of preoperative TLK of the studied patient is 18.667 and the mean of post operative TLK of the patients is 6.833. There was direct significant correlation between pre and postoperative Thoracolumbar kyphosis angle (TLK). The mean of preoperative TK of the studied patient is 84.33 and the mean of post operative TK of the patients is 54.667. There was direct significant correlation between pre and postoperative Thoracic kyphosis angle (TK).

High rates of junctional kyphosis were observed by Lonner et al [14]. Twenty-five patients (32.1%) were diagnosed with proximal junctional kyphosis (PJK), while four patients(5%) experienced DJK. Despite the high proportion of radiographic abnormalities, only four individuals needed additional surgery or experienced clinical difficulties. Very few authors have provided in-depth guides to avoiding this issue.Koller et al [15]reported that preoperative JK was 7.7 ± 7.3 (ranging from -4 to 28),

postoperatively 11.5 ± 8.5 (ranging from-2 to 40) and follow-up 14.7 ± 8 (ranging from -3 to 38). There were significant variations from pre- to post-, and post-, operative to follow-up.Denis et al [16]examined 67 patients who underwent SK surgery. DJK occurred in 8 patients (12 %) and 7 of them had fusion short of the FLV. They suggested to incorporate the FLV into the fusion.In individuals with SK, Loder et al [17] showed that primary thoracic hyperkyphosis was linked to greater lumbar lordosis but preserved sagittal balance.

The study's limitations including a lack of long-term follow-up, a small sample size and stringent inclusion criteria. Another limitation is the study design, which lacked a control group to compare the procedure to the standard one.

Advantages of Ponte osteotomy in our study includes: A high destabilizing power for thoracic deformities, providing flexibility in flexion, extension and rotation to maximize coronal, sagittal and rotational corrections and a biomechanical advantage for posterior corrective forces in kyphosis and kyphoscoliosis.Kyphosis and kyphoscoliosis had benefit from the considerable biomechanical advantage consisting in a lengthened moment arm for posterior corrective forces.

Recommendations: Correction of spine deformity is very challenging; carful and adequate surgical planning is a must with 3D program ND printed model to clarify the deformed anatomy very well. Further studies on greater sample size personnel of homogenous patients, and in log-term follow up (over 2 years)may give more valuable information.

CONCLUSION

Ponte technique was found to be useful in correction of Scheuermann's Kyphosis cases. The combination technique improved the maintenance of the kyphosis correction to a small but noticeable degree. Proximal junctional radiographic kyphosis was prevalent and appeared to be related to both large curve magnitudes before and after surgery and to pelvic incidence.

Declaration of interest

The authors report no conflicts of interest.

REFFERENCES

1. Atici T, Aydinli U, Akesen B, Serifoğlu R. Results of surgical treatment for kyphotic deformity of the spine secondary to trauma or Scheuermann's disease. *Acta Orthop Belg*. 2004;70(4):344-8.
2. Palazzo C, Sailhan F, Revel M. Scheuermann's disease: an update. Joint Bone Spine. 2014;81(3):209-14.
3. Etemadifar M, Ebrahimzadeh A, Hadi A, Feizi M. Comparison of Scheuermann's kyphosis correction by combined anterior-posterior fusion versus posterior-only procedure. Eur Spine J. 2016;25(8):2580-6.
4. Gill JB, Levin A, Burd T, Longley M. Corrective osteotomies in spine surgery. *J Bone Joint Surg Am*. 2008;90(11):2509-20.
5. La Marca F, Brumblay H. Smith-Petersen osteotomy in thoracolumbar deformity surgery. *Neurosurgery*. 2008;63(3 Suppl):163-70.
6. Huq S, Ehresman J, Cottrill E, Ahmed AK, Pennington Z, Westbroek EM,et al. Treatment approaches for Scheuermann kyphosis: a systematic review of historic and current management. *J Neurosurg Spine*. 2019;32(2):235-47.
7. Sebaaly A, Farjallah S, Kharrat K, Kreichati G, Daher M. Scheuermann's kyphosis: update on pathophysiology and surgical treatment. *EFORT Open Rev*. 2022;7(11):78291.
8. Green C, Brown K, Caine H, Dieckmann RJ, Rathjen KE. Prospective Comparison of Patient-selected Operative Versus Nonoperative Treatment of Scheuermann Kyphosis. *J Pediatr Orthop*.

2020;40(8): 716-9.

9. Zhu W, Sun X, Pan W, Yan H, Liu Z, Qiu Y, et al. Curve patterns deserve attention when determining the optimal distal fusion level in correction surgery for Scheuermann kyphosis. *Spine J*. 2019;19(9):1529-39.
10. Legaye J, Duval-Beaupère G, Hecquet J, Marty C. Pelvic incidence: a fundamental pelvic parameter for three-dimensional regulation of spinal sagittal curves. *Eur Spine J*. 1998;7(2):99-103.
11. Li W, Sun Z, Guo Z, Qi Q, Kim SD, Zeng Y,et al. Analysis of spinopelvic sagittal alignment in patients with thoracic and thoracolumbar angular kyphosis. *Spine (Phila Pa 1976)*. 2013;38(13): 813-8.
12. Jiang L, Qiu Y, Xu L, Liu Z, Wang Z, Sha S,et al. Sagittal spinopelvic alignment in adolescents associated with Scheuermann's kyphosis: a comparison with normal population. *Eur Spine J*. 2014;23 (7) :1420-6.
13. Fotiadis E, Kenanidis E, Samoladas E, Christodoulou A, Akritopoulos P, Akritopoulou K. Scheuermann's disease: focus on weight and height role. *Eur Spine J*. 2008;17(5):673-8.
14. Lonner BS, Newton P, Betz R, Scharf C, O'Brien M, Sponseller P,et al. Operative management of Scheuermann's kyphosis in 78 patients: radiographic outcomes, complications, and technique. *Spine (Phila Pa 1976)*. 2007;32(24):2644-52.
15. Koller H, Juliane Z, Umstaetter M, Meier O, Schmidt R, Hitzl W. Surgical treatment of Scheuermann's kyphosis using a combined antero-posterior strategy and pedicle screw constructs: efficacy, radiographic and clinical outcomes in 111 cases. *Eur Spine J*. 2014;23(1):180-91.
16. Denis F, Sun EC, Winter RB. Incidence and risk factors for proximal and distal junctional kyphosis following surgical treatment for Scheuermann kyphosis: minimum five-year follow-up. *Spine (Phila Pa 1976)*. 2009;34(20): 729-34.
17. Loder RT. The sagittal profile of the cervical and lumbosacral spine in Scheuermann thoracic kyphosis. *J Spinal Disord*. 2001;14(3):226-31.

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