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EFFICACY OF MULTIPL SMITH PETERSEN OSTEOTOMY IN ADULTS WITH THORACIC HYPERKYPHOSIS

TORASİK HİPERKİFOZU OLAN ERİŞKİNLERDE ÇOKLU SMİTH PETERSEN OSTEOTOMİSİNİN ETKİNLİĞİ

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SUMMARY:

Introduction: This is clinical study of adult patients with rigid hyperkyphosis, curve magnitude bigger than 70˚ who underwent with multipl Smith Petersen osteotomy and segmental pedicle screw. The aim of the study to show efficacy and safety of this surgical procedure for adult's hyperkyphosis

Material and Method: Between 2011 and 2012, fifteen patients were operated for thoracic hyperkyphosis. Radiologic parameters were evaluated on standing long cassette anteroposterior (AP) and lateral columna vertebralis. We measured the thoracic and lumbar sagittal curve, pelvic incidence angle (PI), pelvic tilt (PT), sacral slope (SS), thoracic inlet alignment (TIA), T1 slope, relationship of the central sacral line (CSVL) preoperatively and at final follow-up

Result: The mean 7 (6-8) level SPO was performed in patients and 5,9˚ correction was obtained with each level osteotomy. Intraoperative mean bleeding was 980 ± 429 SD ml mean operative time was 342 ± 429 SD minutes. Patients were followed up for an average of 18,5 ± 5 SD months. The mean preoperative thoracic kyphosis was 79º ± 8,2 SD (70º-90º) and improved to 38º ± 8,3 SD (28º-42º) postoperatively and correction rate was 52% (range 39% to 62 %). Lumbar lordosis was 65º ± 3,3 SD (61º-69º) preoperatively and improved to 40º ± 2,4 SD (37º-43º) postoperatively. There were not significant differences between preoperative and postoperative spinopelvic values. T1 vertebra tilt was improved from 38º ± 2,9 SD to 29º ± 3,8 SD and TIA was improved from 80º ± 5,2 SD to 66º ± 3,1 SD. One dural tear was occurred and treated with suture and fibrin clothe.

Conclusion: In this small series, using segmental pedicle screw and multipl SPO more than six level, overall correction of the thoracic kyphosis was 52 % and correction was 5,9˚ per one level osteotomy. SPO is effective and safe treatment method for adults with rigid deformity thoracic hyperkyphosis.

Key words: Deformity, adult hyperkyphosis, Smith Petersen osteotomy

Level of evidence: Retrospective clinical study, Level III

ÖZET:

Giriş: Bu çalışmada erişkinlerde görülen 70˚ den büyük rijit torakal hiperkifoz tedavisinde çoklu Smith petersen osteotomisi ve segmental pedikül vida ile tespitin etkinliği gösterilmesi amaçlanmıştır.

Hastalar ve Yöntem: 2011 ve 2012 yılları arasında torakal hiperkifoz tanısı ile opere edilen 15 hasta bu çalışmaya alınmıştır. Radyolojik olarak ayakta çekilen AP ve LATERAL ortoröntgenogramlarda sagital torakolomber eğrilikler, pelvik insidans (PI),torasik inlet alignment (TIA),T1 slope, santral sakral düşey çizgi (CSVL) ameliyat öncesi ve kontrolleri karşılaştırıldı.

Sonuçlar: Ortalama olarak 7 seviye (6-8) SPO yapıldı. Her seviye için ortalama 5,9 ˚lik düzeltme sağlandı. Peroperative ortalama kanama miktarı 980 ± 429 ml ve ortalama ameliyat süresi 342± 41 dakika olarak tespit edildi. Ortalama takip süresi 18,5 ± 5 aydı. Ortalama torakal hiperkifoz 79˚ ± 8,2˚ den (70˚ -90˚) 38˚ ± 8,3˚ ye (28˚-42˚) geriledi. Lumbar lordoz 65˚ ± 3,3˚ den (61˚ -69˚) 40 ˚ ± 2,4˚ye (37˚ -43˚) düştü. T1 vertebra tilt 38 ˚ ± 2,9˚ SD den 29 ˚ ± 3,8˚ye ;TIA 80˚ ± 5,2 SD den 66˚ ± 3,1˚ ye geriledi. Bir hastada durameter yaralanması meydana geldi sütür ve fibrin yapıştırıcı ile tedavi edildi.

Çıkarım: Çoklu SPO, rijit torakal hiperkifozun tedavisinde etkin ve güvenli tedavi metodu olarak kullanılabilir.

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INTRODUCTION:

The surgical treatment of thoracic kyphosis is indicated in patient with pain and disgusting their cosmetic appearance. Curve magnitude bigger than 75° is an objective criteria for surgery[6,13]. Anterior release and posterior instrumentation is basic treatment protocol for hyperkyphosis. Recently, posterior instrumentation with segmental pedicle screw has been popularized and its results were comparable with combined approach[8,12]. In rigid deformity, to restore sagittal kyphosis couldn't be possible only posterior approach without osteotomy of bony structure[4,6].

Posterior shortening osteotomy such as Smith Petersen osteotomy (SPO) was described in deformity correction in Scheuermann disease[6,8,14]. Generally SPO is localized at apex of kyphosis and adjacent segment that is more rigidity[6,14]. In adult patient, correction of deformity with osteotomy just localized apex side is inadequate to restore thoracic kyphosis. That situation can be resolved with combined posterior instrumentation and anterior release or only posterior instrumentation with multipl SPO. In literature, several studies up to seven SPO in adolescent patients have been reported[7,9].

The aim of this study to show efficacy and safety of multipl Smith Peterson osteotomy and segmental pedicle screw via only posterior approach in adults with rigid thoracic hyperkyphosis.

MATERIAL AND METHOD:

Between 2011 and 2012, fifteen patients were operated for thoracic kyphosis with multiple Ponte osteotomy and segmental pedicle screw, cobalt chrome rod combination by one senior author. Main indications for operation were pain that significantly reduce functional capacity and cosmetic expectations. The patients were analyzed prospectively with minimum two years followed-up after operation.

Radiologic parameters were evaluated on standing long cassette anteroposterior (AP) and lateral vertebral column (Figure-1a,b). We measured the thoracic and lumbar sagittal curve, pelvic incidence angle (PI), pelvic tilt (PT), sacral slope (SS), thoracic inlet alignment (TIA), T1slope, relationship of the central sacral line (CSVL) preoperatively and at final follow-up[10-11].

Patient were placed prone position and posterior midline incision was performed. Segmental pedicle screw was inserted at every level after wide facetectomy. Upper instrumentation level was T2 at all patients and distal fusion level was determined using distal sagittal vertebra that cross-linked with posterior sacral line. Spinous processes and interspinous ligament were excised with rongeurs. High speed burr and Kerrison rongeurs were used for posterior bony structure excision rectangular (Figure-1.c). Bilateral cobalt chrome 6,0 mm rod were placed beginning at proximal side and tightened. Reduction was performed with two rods simultaneously using cantilever technique and segmental compression was added. 60 cc spongious allograft and spinous process autograft was used for grafting. Cell saver was used in all surgery to reduce allogenic erythrocyte replacement.

Patients were allowed to sit at the bed side and walk on the first postoperative day. Routine follow-up examinations were performed on the 6th week and 3rd, z6th and 12th months and yearly after this. Standard standing long cassette anteroposterior and lateral radiographs were obtained at each visit (Figure-1.d,e).

Statistical analyses were performed using SPSS version 20.0. Comparisons of all preoperative and postoperative measurements were done using a matched-pair t-test and ANOVA. A p value of less than 0.05 was considered to be significant.

RESULTS:

Fifteen patients were operated on at a mean age of 27 (range 22 to 35) years with hyperkyphosis. Eleven patient was excluded from study because lack of follow-up. Two patients were female (50%) and two patients were (50%) male.

The apex of kyphosis was T-8 in three patients and T-9 in one patient. The mean 7 (6-8) level SPO was performed in patients and 5,9° correction was obtained with each level osteotomy. Intraoperative mean bleeding was 980 ± 429 SD ml and mean salvage cell account was 455 ± 216 SD ml .The mean operative time was 342± 429 SD second. Patients were followed up for an average of 18,5 ± 5 SD (range, 12 to 24) months (Table-1).

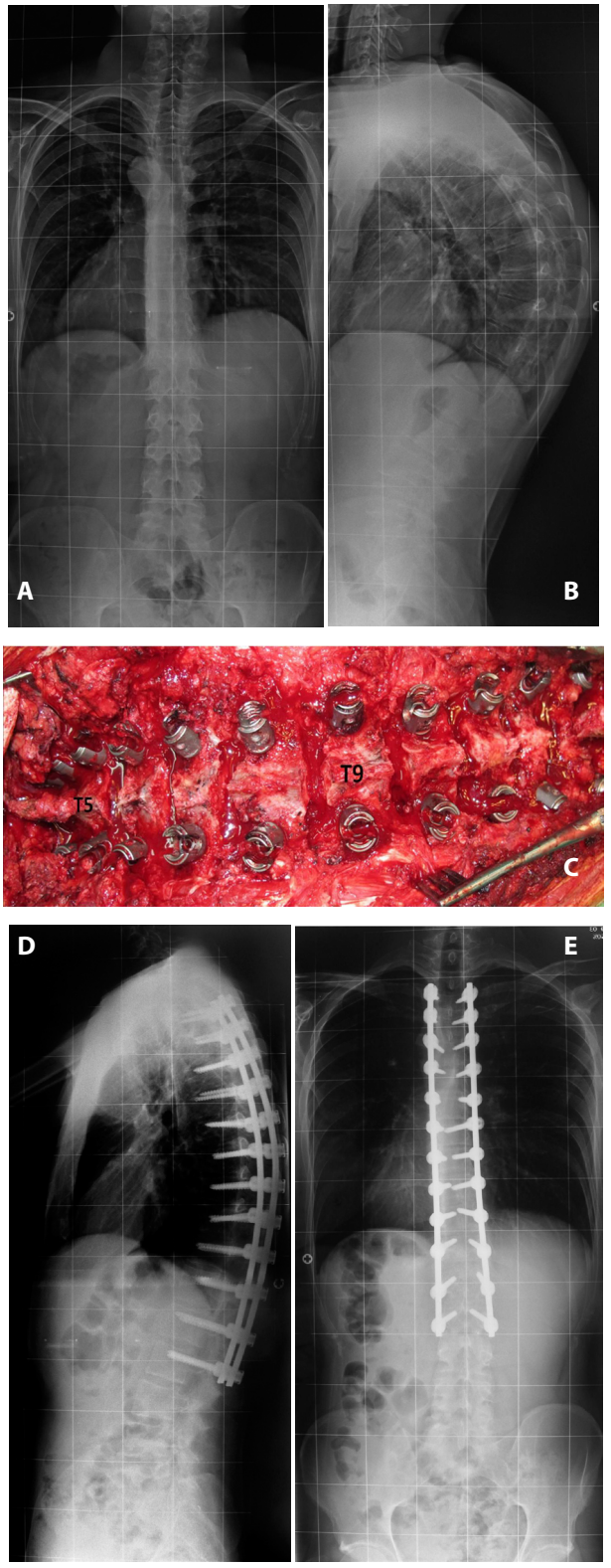

Figure-1. Patient number 2 was 27 years old male diagnosed hyperkyphosis complaint with cosmoses. Preoperative standing long cassette AP (**A**) and Lateral (**B**) radiograph was obtained. His thoracic kyphosis was79˚ and lumbar lordosis was 61˚. Peroperative picture show SPO level and pedicle screw placement clinically (**C**). Control X-rays shows thoracic kyphosis was improved 79˚ to 42˚ after eight level SPO and pedicle screw placement only posterior approach (**D,E**).

Table-1. Patients Data F: female, M: male, T: thoracic, ml: milliliter

Patient	Sex	Age	Follow-up (months)	Fusion Level proximal	Fusion Level distal	Osteotomy Level	Number osteotomy	Operation time (minutes)	Intraoperative bleeding (ml)	Intraoperative cell saver (ml)
B.K.	F	26	20	T2	L3	T5-T12	7	290	620	260
E.K.	M	27	18	T3	L2	T5-L1	8	380	900	440
Ö.G	M	22	12	T2	L3	T5-T12	7	390	1600	760
S.T.	F	35	24	T2	L2	T6-T12	6	310	800	360

The mean preoperative thoracic kyphosis was 79º ± 8,2º SD (70º-90º) and improved to 38º ± 8,3º SD (28º-42º) postoperatively. There was a significant difference in the mean thoracic kyphosis values between the last follow-up and preoperative measurements (p=0,0002). The mean kyphosis correction rate was 52% (range 39% to 62%). Lumbar lordosis was 65º ± 3,3º SD (61º-69º) preoperatively and improved to 40º ± 2,4 SD (37º-43º) postoperatively and there was significant difference (p=0,0001). T12 and L2 sagittal alignment was improved from 9º (5º -20º) to 3,5º (3º -4º) (Table-2) (Figure-2).

The mean preoperative PI was 50º ± 6,3º SD and it was measured as 42º ± 5,5º SD at postoperatively. PT was measured preoperatively as 14º ± 4,8º SD and postoperatively as 9,5º ± 3 SD, SS was measured preoperatively as 32º ± 4,3 SD and postoperatively as 36º ± 5,2 SD. There was not significant difference between preoperative and postoperative spinopelvic parameters (Table-3).

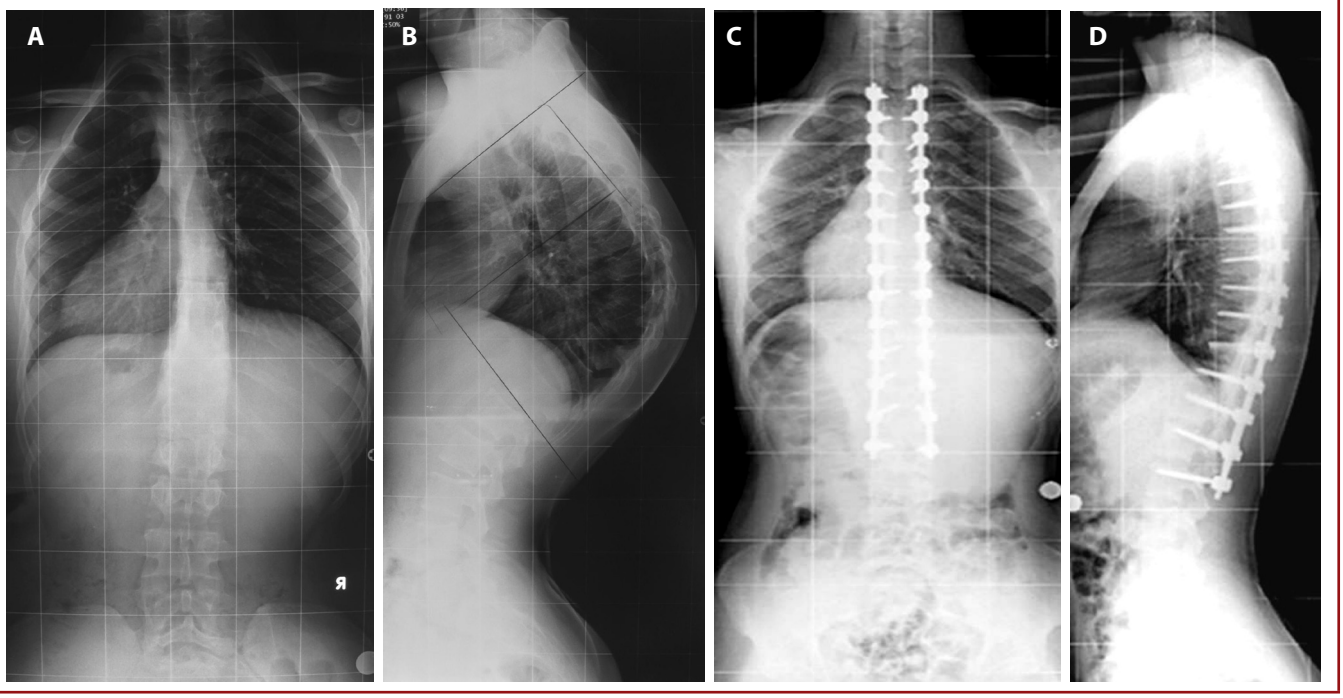

Figure-2. Patient number 3 was 22 years old male diagnosed hyperkyphosis complaint with pain. Preoperative standing long cassette AP (**A**) and Lateral (**B**) radiograph was obtained. His thoracic kyphosis was 90˚ and lumbar lordosis was 69˚. Control X-rays shows thoracic kyphosis was improved 90˚ to 37˚ after seven level SPO and pedicle screw placement only posterior approach (**C,D**).

Table-2. Sagittal Plane measurement. Preop.: Preoperative, Postop.: Postoperative, TIA: thoracic inlet alignment, T1: Thoracic 1 vertebra.* statistical comparison of preoperative and postoperative value.

Patient	Thoracic Kyphosis		Lumbar Lordosis		T12-l2 Sagittal		TIA		T1 tilt	
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop	Preop.	Postop	Preop	Postop
B.K.	78	41	66	43	6	3	80	63	36	31
E.K.	79	42	61	40	5	4	72	64	42	33
Ö.G	90	37	69	40	20	4	83	70	36	24
S.T.	70	28	65	37	5	3	83	65	39	29
P value*	0,0002		0,0001		0,186		0,036		0,009	

Table-3. Pelvic parameter Preop.: Preoperative, Postop.: Postoperative, PI: Pelvic incidence angle , PT: Pelvic tilt , SS: Sacral slope, CSVL: Central sacral line. .* statistical comparison of preoperative and postoperative value

Patient	SS		CSVL		PT		PI	
	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
B.K.	34	27	-26	-17	10	7	44	34
E.K.	34	34	+32	-12	21	13	55	47
Ö.G	43	37	-30	-11	12	7	55	44
S.T.	31	30	+27	+12	13	11	44	41
P value*	0,34		0,67		0,16		0,10	

T1 vertebra tilt was improved from 38º ± 2,9º SD to 29º ± 3,8º SD and TIA was improved from 80º ± 5,2º SD to 66º ± 3,1º SD. The difference in the mean T1 slope and TIA values between the preoperative and postoperative measurements was significant (p=0.009 and p=0,036) (Table-2).

One dural tear was occurred and treated with primary suture and fibrin cloth as called intraoperative complications. This patient was mobilized lately and healed spontaneously at follow-up.

DISCUSSION:

Posterior arc osteotomy (SPO) was first described by Smith Peterson as one or two level for ankylosing spondylitis in 1954[16]. Lately multipl chevron posterior arc osteotomy was introduced by Ponte for Scheuermann's kyphosis[14]. Those osteotomies based on posterior bony structures shortening and compression with mobile anterior disc space that opens anteriorly acting as hinge. This type osteotomies have lower risk for vascular and neurologic complication when compared with anterior lengthening osteotomies[1,17].

The classical indication is rounded that classified type 1 kyphosis for SPO. The mean correction degree was 9,3°-10° per each level[5-7,14]. In our cases the mean correction was 5,9°per each level. This correction value is lower than reported case series. Geck et al reported their correction value mean 9,3° (5,9°-15°) in Scheuermann disease. They noted that SPO is useful for adolescent patient who have flexible curve. In this series the mean age was 16,4 years and one patient over twenty years was reported[6]. Also Koptan et al. report 52.2% correction rate in adolescent patient with mean age 15 years old and the mean 5 level SPO[8]. Maida et al reported one case was 45 years with Scheuermann kyphosis. He was treated with seven level Ponte osteotomy and pedicle screw-rod combination. The correction degree per level was 6,1° which was similar as we presented[9]. The lost of the correction degree per level can be explained with older age that kyphosis become stiffer. Our correction ratio was 52 % and this was similar with other

studies were reported in literature[6,8,12,13]. Also this correction rate was similar with combined surgery[7].

Coronal decompenzation seems to be the major disadvantage of the technique in reported paper[2,5]. In our series, there was no decompenzation on coronal balance. That was related with segmental pedicle screw instrumentation.

In thoracic region, SPO can effect T1 vertebra tilt and thoracic inlet alignment positively (p=0,009 and p=0,03). This results influence further cervical malaligment because sagittal balance of the cervical spine could influence by the T1 position[11]. Contrary our study showed that The effect of thoracic SPO on the spino-pelvic alignment was statistically not significant also on CSVL (SS p=0,34, PI p=0,10, PT p=0,16, CSVL p=0,67). Our finding was supported by Bridwell suggest that SPO not useful for major sagittal imbalance have just indication on minor imbalance[4].

Reported neurological complication rate was 0-3,3 % although overall complication rate was 29-47 % (2,4,6,14). We have one complication as dural tear was occurred during laminectomy. That was treated with primary suture and fibrin cloth. Although this complication was seen, SPO is safer than other osteotomies[2,3,4,5].

In this small series, using segmental pedicle screw and multipl SPO more than six level, overall correction of the thoracic kyphosis was 52% and correction was 5,9° per one level osteotomy. SPO is effective and safe treatment method for thoracic hyperkyphosis although adult age with rigid deformity.

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