Alternate Pedicle Screws Technique versus Hybrid Construct for the Correction of Adolescent Idiopathic Scoliosis: A Prospective Randomized Study

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Abstract

Background Data: The use of all pedicle screws technique, instead of hybrid constructs, for the treatment of AIS became more popular over the past several years. Studies to compare both techniques were usually retrospectively performed.

Purpose: To compare between an alternate all pedicle screws technique and hybrid constructs in correction of AIS in a prospective trial.

Study Design: Prospective, non-randomized.

Patients and Methods: The study included 50 patients with adolescent idiopathic scoliosis divided into 2 groups; 27 patients had surgical correction using alternate pedicle screws technique (Group 1) and 23 patients had surgical correction using hybrid constructs (Group 2). The age at surgery had an average of 15y ± 7m in Group 1 and 14y ± 8m in Group 2. The dorsal curves in Group 1 ranged from 40° to 62° with a mean of 46.5° and in group 2 ranged from 32° to 79° with a mean of 54.3°. The lumbar curves ranged from 14° to 73° with a mean of 41.7° in Group 1 and in Group 2 ranged from 31° to 77° with a mean of 46.8°. The deformity was measured by Cobb's method preoperatively, postoperatively and at final follow up with measurement of postoperative correction %. Operative time and blood loss were also measured and recorded. All patients had posterior correction, instrumentation and fusion using either an all pedicle screws technique, in an alternating manner, (Group 1); or a hybrid construct including pedicle screws, hooks and sublaminar wires (Group 2).

Results: The dorsal curves were corrected in group 1 and group 2 to a mean of 18.2° and 20.9° respectively. The lumbar curves were corrected in group 1 and group 2 to a mean of 14.6° and 17.7° respectively. Patients were followed up for a minimum of 2 years with an average loss of correction of 2.2° and 2.0° respectively. Overall, there was no major postoperative neurological deficit and no metal failure in either group.

Conclusion: Correctional power of alternating all screws technique for AIS in the coronal plane was slightly but insignificantly better than hybrid constructs. However, the correction of vertebral rotation was significantly better leading to a lesser need for thoracoplasty with its consequent hazards. (2012ESJ010)

Keywords: scoliosis, idiopathic, all screws, hybrid.

Introduction

Scoliosis is defined as coronal curve of 10° or more and approximately 80% of curves are ultimately diagnosed as idiopathic[8,9]. The use of all pedicle screws technique for the treatment of AIS became more popular over the past several years since it was introduced in scoliosis surgery by Luque in 1986[7].

A few studies concluded that all screws technique is safe, effective, having greater correction rates and shorter fusion levels in all planes over hook constructs[1,11,4,5]. The greater correction power of pedicle screws than hybrid constructs was referred to its capacity for three-column fixation of the vertebral body and true derotation of the spine in all 3 planes rather than posterior medialization of the spinal column that was offered by hybrid techniques[3]. Studies to compare both techniques were usually retrospectively performed and in these studies, the all pedicle screw technique included instrumenting every pedicle in all levels included.

The aim of this prospective study was to compare the correctional capacity of an alternating all screws technique and hybrid constructs in AIS patients.

Patients and Methods

The study included 50 patients with adolescent idiopathic scoliosis divided into 2 groups; 27 patients had surgical correction using alternate pedicle screws technique (Group 1) and 23 patients had surgical correction using hybrid constructs (Group 2). The age at surgery had an average of 15y ± 7m in group 1 and 14y ± 8m in group 2. The sex distribution in group 1 was 5 males and 22 females and in group 2 was 4 males and 19 females.

Preoperatively, all patients had plain X-rays (standing AP & Lat and supine side bending), MR imaging and photography. The deformity was measured by Cobb's method; in group 1 the dorsal curves ranged from 40° to 62° with a mean of 46.5° and the lumbar curves ranged from 14° to 73° with a mean of 41.7°, in group 2 the dorsal curves ranged from 32° to 79° with a mean of 54.3° and the lumbar curves ranged from 31° to 77° with a mean of 46.8°. According to Lenke classification more than 40% of all patients were type 1 (Table 1).

Table 1.
Curve distribution of both groups According to Lenke Classification.

Lenke type	Group I			Group II	
1	11	1 B	3	10	All type C
		1 C	8		
3	4			6	
5	6	5 B	1	3	
		5 C	5		
6	6			4	

Degree of vertebral rotation was determined in all patients pre and postoperatively according to the Nash and Moe method. All patients had no abnormal neurological findings on examination or any signs of spinal dysraphism in the MRI studies of the spinal canal.

Surgical technique:

Patients were positioned prone on a Relton-Hall-style frame; electrocautery dissection was carried to the tip of the transverse processes in the thoracic spine and to the midpart of the transverse processes in the lumbar spine.

All patients had posterior surgery; release of all posterior elements (supraspinous ligaments, interspinous ligaments, ligamentum flavum, facet joints); 4-6 Ponte osteotomies were performed at the apex of the deformity.

In group 1, the most proximal and distal anchors consisted of 2–4 pedicle screws; in between both anchors, alternating pedicle screws were placed at each level. All screws were placed by a free hand technique. The rods were cut and contoured; the concave rod was placed first then the convex rod and curve correction was carried out by a combination of cantilever, rod rotation and compression/distraction maneuvers (Figure 1).

Figure 1. Intraoperative photograph showing the all screws technique in an alternating manner.

In group 2, the distal anchor consisted of 2–4 pedicle screws; the proximal anchor consisted of hooks placed in a claw formation at either side; in between, sublaminar wires were placed mainly on the concave side. Appropriately sized rods were contoured; the concave rod was placed first followed by the convex rod. Curve correction was carried out by rod rotation, sequential tightening of the wires and slight distraction on the concave side and compression on the convex side.

In both groups, when needed, thoracoplasty (costectomy) was done for the rib hump; in group 1, only 4/27 patients needed thoracoplasty, on the other hand, thoracoplasty was performed in 21/23 patients in group 2. Fusion was enhanced by decortication of the posterior elements and autologous bone graft from the removed local bone graft and ribs.

Postoperatively; suction drains were removed by the second postoperative day, all patients had plain X-rays AP & Lat and the Cobb's angles were re-measured. Patients were followed up both clinically and radiologically at 1, 3, 6, 12, 18 and 24 months and at yearly intervals thereafter (Figure 2).

Figure 2. A 15 year old female with 56° and 45° curves corrected to 2° and 1° respectively.

Patients were instructed for rest with permission to return to school at 1 month, at 3 months light activities were allowed; swimming and bicycle riding were permitted. At 6 months, most activities were permitted, including team sports (non-contact), running, and other low-impact activities. At 1 year, any activity or sport was permitted.

Results

Hospital Notes:

The mean operative time was 3:25 h (range 3:05-4:00) in group 1 and was 3:15 h (range 2:55-3:40) in group 2. The mean blood loss was 225 cc (range 175-300) in group 1 and was 200 cc (range 155-300) in group 2.

Curve Correction:

At 2 year follow up; the mean dorsal curve was corrected in group 1 from 46.5° to 18.2° (P<0.001) and in group 2 from 54.3° to 20.9° (P<0.001) (Table 2) (Figure 3). The mean postoperative correction % of group 1 and 2 were 46.1 and 53.9 respectively (P=0.35) (Table 3) (Figure 4). The mean lumbar curve was corrected in group 1 from 41.7° to 14.6° (P<0.001) and in group 2 from 46.8° to 17.7° (P<0.001) (Table 2) (Figure3). The mean postoperative correction % were 41.3 and 46.4 in group 1 and 2 respectively (P=0.19) (Table 3) (Figure 4). The mean loss of correction at 2 years follow up in group 1 and 2 were 2.0° and 2.2° respectively (P=0.26). The mean dorsal kyphosis angle was corrected in group 1 from 29.6° to 31.7° (P=0.45) and in group 2 from 27.2° to 32° (P=0.036) (Table 2).

Vertebral Rotation:

Using Nash & Moe method; the mean vertebral rotation in group 1 was corrected from 1.74 (range 1-3) to 0.65 (range 0-2) (P<0.001) and in group 2 from 1.84 (range 1-3) to 0.83 (range 1-2) (P<0.001) (Table 4). The mean degree of correction of vertebral rotation (pre - post) were 1.11 and 0.92 in group 1 and 2 respectively (P=0.02) (Table 5).

Complications:

Overall, there was no postoperative neurological deficit and no metal failure.

Table 2. Comparison of Curve Correction.

Cobb angle	Group I N = 27		P	Group II N = 23		P
	Pre operative	Post operative		Pre operative	Post operative	
Dorsal curves Range (Min-Max): Mean ± SD:	(40-62) 46.5± 5.4	(2-40) 18.2±9.6	**<0.001***	(32-79) 54.3±12.3	(6-36) 20.9±8.4	**<0.001***
Lumbar curves Range (Min-Max): Mean ± SD:	(14-73) 41.7± 15.2	(2-43) 14.6±9.1	**<0.001***	(31-77) 46.8±11.3	(6-35) 17.7±7.7	**<0.001***
curves Sagittal Range (Min-Max): Mean ± SD:	(4-63) 29.6±17	(15-42) 31.7±7.4	0.45	(8-47) 27.2±11.5	(16-48) 32±7.9	0.036
Wilcoxon Signed Rank Test						

Table 3. Comparison of Postoperative Correction %.

Postoperative correction %	Patients group		P
	Group I	Group II	
Dorsal curves correction Range (Min-Max): Mean ± SD:	(39.6-61.3) 46.1±5.4	(31.8-78.7) 53.9±12.3	0.35
Lumbar curves correction Range (Min-Max): Mean ± SD:	(12.7-72.6) 41.3± 15.3	(30.4-76.8) 46.4±11.3	0.19
Wilcoxon - Mann/Whitney Test			

Table 4. Vertebral Rotation in both Groups.

Vertebral rotation (Nash & Moe method)	Group I N = 27		P	Group II N = 23		P
	Pre	Post		Pre	Post	
Range (Min-Max): **Mean ± SD:**	(1-3) 1.74±0.6	(0-2) 0.65±0.5	**<0.001***	(1-3) 1.84±0.7	(1-2) 0.83±0.6	**<0.001***
Wilcoxon - Mann/Whitney Test						

Table 5. Comparison of Correction of Vertebral Rotation.

Degree of correction of vertebral rotation (pre/post)	Patients group		P
	Group I	Group II	
Mean ± SD	1.11±0.4	0.92±0.5	0.02
Wilcoxon - Mann/Whitney Test			

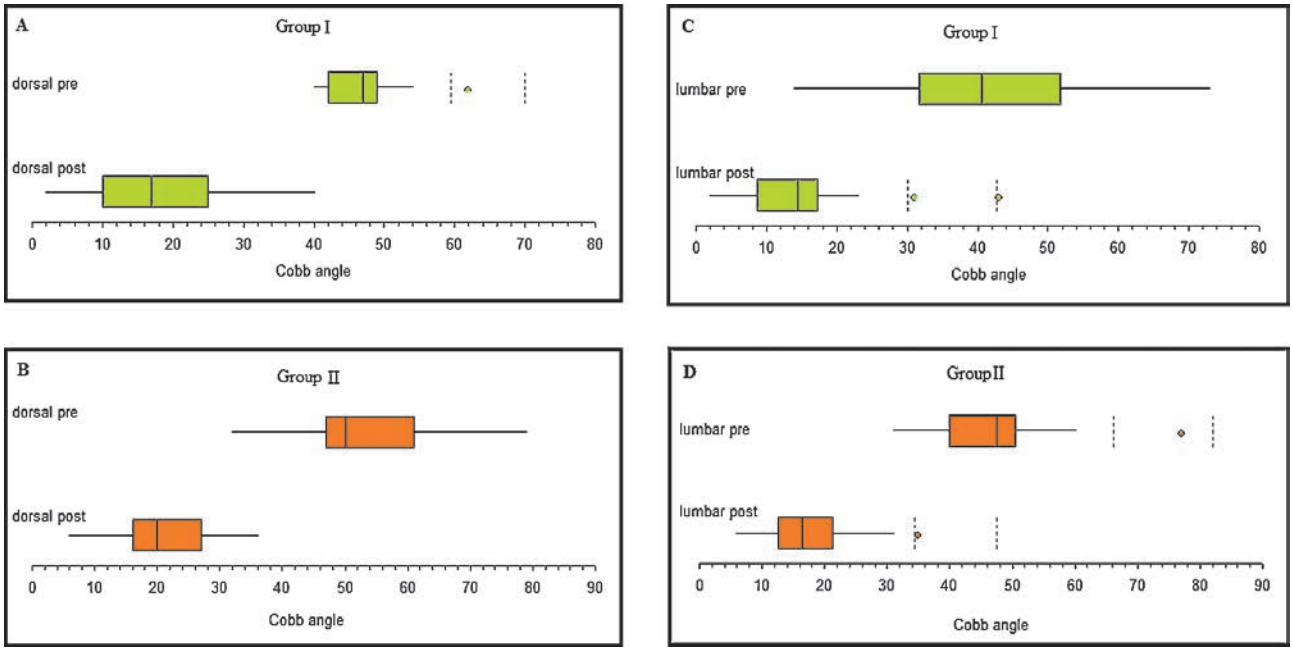
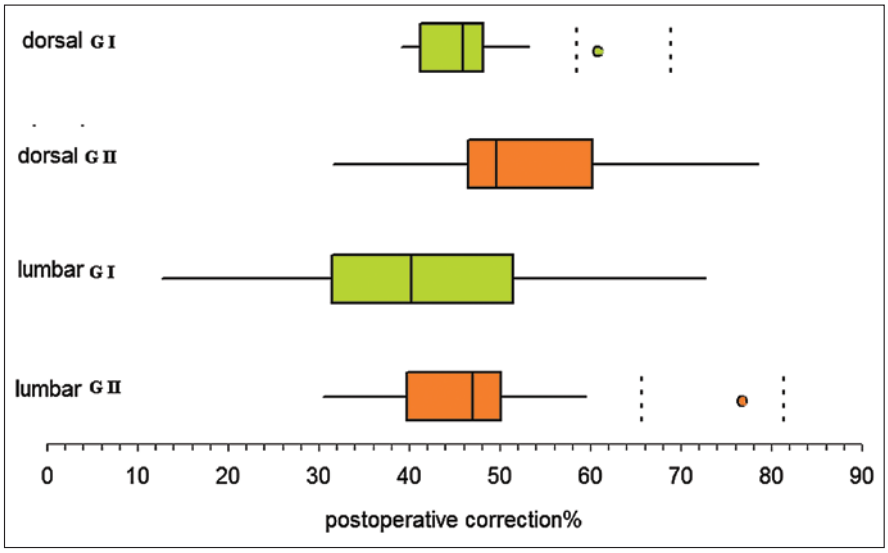


Figure 3. Box and whisker plot comparing between pre and post dorsal angle of Group 1 (A), pre and post dorsal angle of Group 2 (B), pre and post lumbar angle of Group 1 (C), pre and post lumbar angle of Group 2 (D).

Figure 4.
Box and whisker plot comparing postoperative Correction (POC) (%) of dorsal and lumbar curves in both groups.
POC = Preoperative Erect Cobb angle - Postoperative Erect Cobb angle X 100 Preoperative Erect Cobb Angle.



Discussion

The most recent instrumentation introduced for the treatment of AIS was pedicle screws placed in the lumbar spine by Luque in 1986[7]. Suk et al[12] was the first to evaluate and compare the magnitude of curve correction between all-hook and all-screw constructs; they found significantly better coronal correction for all-screw constructs.

Pedicle screw instrumentation in AIS surgery has its popularity because of higher immediate rigidity and better correction. A few authors compared all-screw constructs with hybrid constructs. Kim et al[2,10] reported significantly better major curve correction in the all-screw group over the hybrid group.

On the contrary, a tricenter retrospective study comparing pedicle screws only technique and two hybrid techniques for correction of Lenke 1 AIS concluded that the pedicle screw only construct did not give an enhanced correction of Lenke 1 AIS with no significant advantage in using a relatively expensive pedicle screw construct in the correction of Lenke 1 AIS[13].

Lowenstein et al[6] concluded that hybrid constructs were comparable to all-screw constructs in the correction of coronal plane deformity and sagittal balance with no statistically significant difference. This correlates well with the results of the current study where the postoperative correction % was better but with no statistically significant difference.

The concept of "direct vertebral rotation" was introduced by Lee et al[3] as using direct rotation of the thoracic pedicle screws in conjunction with rod derotation and found a significant correction improvement with direct vertebral rotation technique over rod derotation alone. Lowenstein et al[6] used rod derotation alone for reduction in both the hybrid group and the all-screw groups and had similar results in terms of coronal and sagittal curve correction and balance.

This correlates well with our results as we used rod derotation for correction in both groups, and the all screw group had a better correction of vertebral rotation and lower degree of postoperative correction loss than the hybrid group.

Conclusion

Correctional power of alternating all screws technique for AIS in the coronal plane was slightly but insignificantly better than hybrid constructs. However, the correction of vertebral rotation was significantly better leading to a lesser need for thoracoplasty with its consequent hazards.

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الملخص العربي

تقنية مسامير العنيق البديلة مقابل البناء الهجين لتصحيح الجنف مجهول السبب في المراهقين: دراسة استطلاعية عشوائية

تستخدم مسامير عنق الفقرات الآن في علاج اعوجاج العمود الفقري لدى المراهقين على نطاق أوسع من استخدام النظام الهجين. وقد تم علاج خمسين مريضا باعوجاج العمود الفقري ومتابعتهم على مدى عامين على الأقل وتم تقسيمهم إلى مجموعتين:

المجموعة الأولى : ٢٧ مريضا عولجوا باستخدام نظام المسامير فقط بطريقة تبادلية.

المجموعة الثانية : ٢٣ مريضا عولجوا باستخدام النظام الهجين (مسامير- خطاطيف-أسلاك).

وقد أظهرت الدراسة تحسن جميع المرضى تحسنا ذا أهمية إحصائية عالية لكل مجموعة على حدة مع تفوق المجموعة الأولى في نسبة إصلاح الاعوجاج إلا أن هذا التفوق لم يحظ بفروق إحصائية ذات شأن. كما تبين تفوق المجموعة الأولى على الثانية تفوقا ذو أهمية إحصائية عالية في تقليل معدل الاحتياج إلي تجميل القفص الصدري.