Comparative analysis of pedicle screw versus hybrid instrumentation in adolescent idiopathic scoliosis surgery

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ABSTRACT

Introduction: Adolescent idiopathic scoliosis is the most common type of scoliosis. A Cobb angle of 50° will progress beyond the age of spinal maturity. Surgery over bracing is advised at a Cobb angle above or equal to 50°. The aim of surgery is to bring the Cobb angle down below 50° to prevent reprogression as well as improve the quality of life. The objective of the study is to analyze the efficacy and significance in lifestyle improvement of pedicle screw-only fixation system versus the more common hybrid instrumentation system used for the surgical treatment of adolescent idiopathic scoliosis. **Materials and Methods:** A prospective cohort study was conducted involving two groups of patients were included in the study. One group was operated with pedicle screw-only method while the other with hybrid instrumentation system. The pre- and post-operative Cobb's angles were taken across a follow-up of 4 years. An SRS-30 questionnaire was given in a yearly follow-up to assess the lifestyle improvement of the patient. **Results:** Pedicle screw-only method was significantly more effective in reducing Cobb's angle ($P = 0.0487$). It was showed less loss of correction ($P = 0.009$) pedicle screw-only surgery was also better at reducing thoracic curves ($P = 0.001$). There seemed a better recovery time with pedicle screw surgery ($P = 0.003$). **Conclusion:** Pedicle screws are more effective and durable than hybrid systems at when treating adolescent idiopathic scoliosis.

Key words: Adolescent idiopathic scoliosis, hybrid instrumentation system, pedicle screws

Introduction

Scoliosis is often arbitrarily described as a lateral deviation of the spine larger than 10°; however, the problem is much better described as a complicated three-dimensional deformity of the spine resulting in a lateral displacement from the normal spinal angle. Idiopathic scoliosis is described as scoliosis occurring without any describable pathophysiological cause.^[1-4] The study aims to establish any long-term benefit in using pedicle screw-only surgery regarding efficacy as well as any development

of long-term complications and if there is any difference between long-term functionality and satisfaction between patients treated with the two methods.

Materials and Methods

The research was designed to be a prospective cohort study. Patients who were operated between 2006 and 2010 and managed to follow-up for 4 years were included in the study. In total, there were eighty patients in the pedicle screw-only group and 75 in the hybrid instrumentation system group. The number of males nearly equaled the number of females in both groups. The overall Cobb's angle ranged from 52° to 117° with a mean of 84.7°. Patients included in the study ranged between 11 years and 17 years.

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Inclusion criteria were patients with adolescent idiopathic scoliosis, aged between 11 and 17, who underwent the same standardized procedures and were similar in terms of operative time, bleeding, and surgical trauma. Patients were excluded from the study if there was any underlying body disorder running in the family and if they were loss to follow-up. Patients with deformity involving the lumbar spine only were also excluded from the study.

The technique used in the hybrid instrumentation group was standardized as usage of pedicle screws in the thoracolumbar area while the claw, hook, and wire instruments were utilized in the rest of the spine. In surgery involving pedicle screws only, the screws were applied using a free hand technique on the concave areas of all segments and the convex side of the cranial and caudal ends. Postoperative bracing was not used to prevent the occurrence of bias.

Correction of Cobb's angle, percentage correction, correction loss during follow-up were physical variables measured in assessing the effectiveness of both systems while the SRS-30 questionnaire was used for measuring improvement of the quality of life and satisfaction postsurgery. Development of surgical complications was also included and analyzed in both groups.

Statistical analyses were performed using SPSS statistics software version 20.0 [IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.]. A paired *t*-test was utilized to evaluate the difference between each physical variable pre- and post-test while the SRS-30 questionnaire scores were tallied and compared. *P* value for the analyses was set as $P < 0.05$.

Results

The mean percentage correction of thoracolumbar Cobb's angle in hybrid instrumentation method was found to be 59.56 ± 5.81 . The mean percentage correction of the pedicle screw system was found to be 63.78 ± 6.56 . The paired *t*-test applied to reveal significance calculated a value of $P = 0.0487$, which was statistically significant.

Since the hallmark difference between the two systems is the use of pedicle screws in the thoracic spine, the percentage correction between the thoracic spines of the two groups was analyzed. The hybrid system revealed a thoracic correction percentage of 54.47 ± 6.92 . The pedicle screw showed a thoracic correction of 61.57 ± 4.33 . Paired

Table 1: A comparison with *P* values between the hybrid system and pedicle screw groups

	Hybrid system (n=75)		Pedicle screw (n=80)		<i>P</i>
	Mean	SD	Mean	SD	
Total correction % (n=155)	59.56	5.81	63.78	6.56	0.0487
Thoracic correction % (n=96)	54.47	6.92	61.57	4.33	0.009
Thoracolumbar correction % (n=51)	65.19	4.72	68.85	6.23	0.776
Double major correction % (n=8)	66.75	5.25	69.25	5.75	0.645
Total correction % loss (n=155)	9	3.16	3.95	1.43	0.0001

SD: Standard deviation

t-test revealed a $P = 0.009$, which was statistically very significant [Table 1].

Percentage of correction loss at the end of follow-up was calculated which revealed that the hybrid system had a mean loss of $9\% \pm 3.16\%$ while the pedicle system had a mean loss of $3.95\% \pm 1.4\%$. The paired *t*-test revealed that $P = 0.0001$ which was again very significant.

The SRS 30 questionnaires revealed a similar amount mental health, satisfaction of treatment and self-image scores across the follow-ups of both groups. In general, the higher the score is, the better the quality of life. Although functionality was not significantly different across follow-ups between both groups ($P = 0.32$ at 6 months and 0.202 at 4 years), the patients showed a definite increase in functionality after 4 years. The hybrid system scored a 2.45 ± 1.23 average on the pain scale at 6 months follow-up. The pedicle system group scored an average of 2.79 ± 1.03 ; the calculated *t*-test showed a $P = 0.003$ which was significantly different. Both groups scored similarly for pain relief at the 4th year of follow-up. There was no development of any significant morbidity postsurgery till the end of the 4 year follow-up [Table 2].

Discussion

Adolescent idiopathic scoliosis has the highest incidence among idiopathic scoliosis as well as scoliosis overall.^[1,4,5] It is understood that a deviation of a Cobb's angle of 50° will progress beyond the age of spinal maturity.^[2,3,6] Deviations above a Cobb's angle between 60° and 100° will result in a loss of 32% total lung volume as well as a vital capacity of 45% of normal.^[3,4,7] Curves $>110^\circ$ are associated with respiratory failure, repeated pulmonary infections, and a lower life expectancy. Due to this, the indication of scoliosis surgery over bracing is often described as a Cobb's angle $\geq 50^\circ$.^[3,8] The aim of surgery is to bring the Cobb angle down below 50° to prevent reprogression as well as improve the quality of life.

Table 2: The comparison with *P* values between hybrid system and pedicle screw groups regarding pain during the 6 months follow-up and restriction in function between the 4 years of follow-up

	Hybrid system		Pedicle screw		<i>P</i>
	Mean	SD	Mean	SD	
Pain 6 months	2.45	1.23	2.79	1.03	0.0034
Pain 4 years	4.05	0.69	4	0.75	0.303
Function 6 months	2.1	0.72	2.53	0.61	0.326
Function 4 years	3.8	0.89	4.16	0.96	0.202

SD: Standard deviation

Scoliosis surgery has made major leaps in development since its birth in the 1800's. Many techniques, ranging from osteotomies and discectomies to nonsegmental rod systems and multiple hooks and wire constructs. The Cotrel–Dubousset hook and wire construct was once considered gold standard for the surgical treatment of idiopathic scoliosis surgery.^[1,8,9] Today, most modern instrumentation systems rely heavily on the Cortel–Dubousset method which introduced a hook and claw system attached and tightened with a system of wires interlocking between them.^[4,5] One such method is the hybrid instrumentation system which utilizes segmental hooks and wires along with a newer generation instrument called pedicle screws. In 1995, a newer system emerged and has gained popularity in idiopathic scoliosis surgery. It involved the use of pedicle screws only over the hybrid system norm. The surge in this type of surgery was preceded by reports of better stabilization and improvement of angle curvature.^[9] There is, however, the concern of the increase in physical demand on the spine because of the small contact area of the pedicle screw, and the risk of spinal trauma due to its location of placement in the concavity of the spine.^[10] Mixed reports of success of the pedicle screw-only method and the limited literature on long-term follow-up cause there to obscure in the advantage of pedicle screws over hybrid systems.

We observed a significantly better improvement in Cobb's angle and percentage in the pedicle screw-only group. We believe that this is due to the screw's ability to grip the spine more firmly and deeply, resulting in the surgeon being able to offer a more significant correction. We also noted that postoperative loss of correction was significantly higher in hybrid systems. This may be because hooks have limited mobilization capability which results in less effective arthrodesis distribution and maturation postcorrection. We encountered a significantly higher degree of thoracic correction postsurgery which corresponds with current literature which suggests that pedicle screws may just allow for

the greatest degree of improvement in thoracic scoliosis than any other type of instrumentation.^[1,8,11]

In the article published by Suk *et al.*, it was reported that pedicle screw-only surgery produced a 79.6% of thoracic curves and an 80.5% correction of lumbar curves and a study by Min *et al.* revealed a mean correction in Cobb angle to be 68% when using pedicle screws only.^[12] Meanwhile, hybrid systems used in a study by Liu *et al.* reveal a 47% correction ratio.^[13]

Combination studies performed by Kim *et al.* in 2004 compared the results of pedicle screws with hybrid systems where they also reported an advantage for pedicle screws. In their study pedicle screws were found to have better correction ratios and fewer fusion levels, which ultimately meant fewer complications and lower correction loss.^[9]

There are also some studies which show a result differing from ours. A study done by Arlet *et al.* reported similar correction angles in both pedicle screws and hybrid instrumentation and the results proved to be statistically insignificant.^[10] However, their study comprised solely of Lenke Type 1 and 2 adolescent idiopathic scoliosis. It may well be that the advantage of pedicle screws lies in advanced spinal deviations with high Cobb angles and axial vertebral rotations.

The dangers suggested by literature for pedicle screw usage usually range from spinal ischemia due to over correction to tracheoesophageal erosions, vocal cord paresis, pneumonias, and ileus.^[2,11] However, these complications have been found to be more associated with the malpositioning or loosening of screws postsurgery rather than their presence itself. In fact, minimal malpositioning of the screw has found to be of little risk if the screw has an appropriate length and the stabilization of the spine is not affected due to the multisegmental nature of the arthrodesis.^[10] All in all, although complications such as pedicle violations are possible, their occurrence has not been widely recorded.

The end goal of scoliosis surgery can simply be said to improve patient's quality of life. The score of which has been divided into three parts by the Scoliosis Research Society, they are patient cosmesis, functionality, and complications. Since the most common symptom in spinal complications is pain, the SRS-30 questionnaire addresses complications through scoring it. In our study, it was seen that postoperative pain on the 6th month of follow-up was significantly less in the pedicle screw group despite there being no significant difference in functionality. Perhaps this is because of the greater

and more equal pressure distribution of the traction applied on the vertebra owing to the greater number of vertebra involved in the pedicle system. The fact that there may be fewer fusion levels in our pedicle screw procedures may also result in this observation. However, we did not record such data as part of our study, so it is difficult to say if this really is the case. Cosmesis can be measured along the terms of satisfaction with treatment and improvement in self-image and mental health. In our study, despite the statistical difference in spinal correction, there was no significant difference in measures of cosmesis.

Kim *et al.*^[14] concluded in a study that Apical vertebra translation (AVT) were better with Pedicle screw (PS) than Hybrid system (HS). However, global coronal and sagittal balance were similar in both groups. Karatoprak *et al.*^[1] found similar results regarding global coronal and sagittal balance, however, axial vertebral derotation was better with screw while AVT was better corrected with HS. In addition, there was no significant difference between postoperative thoracic kyphosis and lumbar lordosis in the two groups.

Recently, it was reported by Negrini *et al.*^[15] and Lusini *et al.*^[16] in two independent studies that conservative management in AIS using brace may be efficacious in Cobb's angle >50°. These studies utilized spinal braces for over 4 years in patients unwilling for surgical intervention. Considerable reduction in Cobb's angle was observed in 71% and 62% of the patients, respectively. These results although based on small sample population may challenge the indication of surgical intervention suggested by SRS.

Conclusion

With the limited data about spinal surgeries present in Pakistan, it is important to analyze the benefits of traumatic surgeries like scoliosis surgeries to fully appreciate if their reported benefits are indeed reproduced in setups available here. We saw that the new pedicle screw-only surgical method was superior both in terms of total spinal correction as well as loss of correction over time. It also proved to be more beneficial than other systems when correcting thoracic curves. Our study seems to suggest that pedicle screw surgery may also shorten the period of postoperative pain and enhance rehabilitation and is also associated with much less degree of complication as was suggested in global literature. However to fully analyze this, more data will be needed. There is the matter of increased cost of pedicle screws over other methods of spinal correction such as hybrid systems. For this matter, it may be better

to save pedicle screw-only methods for a higher degree of scoliosis which may shorten the life of the patient to fully realize the benefit of such a procedure.

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Conflicts of interest

There are no conflicts of interest.

References

- Karatoprak O, Unay K, Tezer M, Ozturk C, Aydogan M, Mirzanli C. Comparative analysis of pedicle screw versus hybrid instrumentation in adolescent idiopathic scoliosis surgery. *Int Orthop* 2008;32:523-8.
- Hwang SW, Samdani AF, Marks M, Bastrom T, Garg H, Lonner B, *et al.* Five-year clinical and radiographic outcomes using pedicle screw only constructs in the treatment of adolescent idiopathic scoliosis. *Eur Spine J* 2013;22:1292-9.
- Helenius I, Mattila M, Jalanko T. Morbidity and radiographic outcomes of severe scoliosis of 90° or more: A comparison of hybrid with total pedicle screw instrumentation. *J Child Orthop* 2014;8:345-52.
- Crostelli M, Mazza O, Mariani M, Mascello D. Treatment of severe scoliosis with posterior-only approach arthrodesis and all-pedicle screw instrumentation. *Eur Spine J* 2013;22 Suppl 6:S808-14.
- Maruyama T, Takeshita K. Surgery for idiopathic scoliosis: Currently applied techniques. *Clin Med Pediatr* 2009;3:39-44.
- Abul-Kasim K, Ohlin A. Evaluation of implant loosening following segmental pedicle screw fixation in adolescent idiopathic scoliosis: A 2 year follow-up with low-dose CT. *Scoliosis* 2014;9:13.
- Mattila M, Jalanko T, Puisto V, Pajulo O, Helenius JJ. Hybrid versus total pedicle screw instrumentation in patients undergoing surgery for neuromuscular scoliosis: A comparative study with matched cohorts. *J Bone Joint Surg Br* 2012;94:1393-8.
- Suk SI, Kim WJ, Kim JH, Lee SM. Restoration of thoracic kyphosis in hypokyphotic spine a comparison between multiple hook and segmental pedicle screw fixation in adolescent idiopathic scoliosis. *J Spinal Disord* 1999;12:489-95.
- Kim YJ, Lenke LG, Cho SK, Bridwell KH, Sides B, Blanke K. Comparative analysis of pedicle screw versus hook instrumentation in posterior spinal fusion of adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)* 2004;29:2040-8.
- Arlet V, Ouellet JA, Shilt J, Shen FH, Wood K, Chan D, *et al.* Subjective evaluation of treatment outcomes of instrumentation with pedicle screws or hybrid constructs in lenke type 1 and 2 adolescent idiopathic scoliosis: What happens when judges are blinded to the instrumentation? *Eur Spine J* 2009;18:1927-35.
- Qian B, Jiang J, Zhu F, Zhu Z, Liu Z, Qiu Y. How is the trachea at risk of injury from pedicle screw insertion in proximal thoracic curve of adolescent idiopathic scoliosis patients? *Eur Spine J* 2013;22:338-44.
- Min K, Waelchli B, Hahn F. Primary thoracoplasty and pedicle screw instrumentation in thoracic idiopathic scoliosis. *Eur Spine J* 2005;14:777-82.
- Liu H, Zhou D, Wang H, Yi B, Wang B, Jin Z, *et al.* Posterior pedicle screw system and interbody fusion in the treatment of degenerative scoliosis. *Beijing Da Xue Xue Bao* 2003;35:163-5.
- Kim YJ, Lenke LG, Kim J, Bridwell KH, Cho SK, Cheh G, *et al.* Comparative analysis of pedicle screw versus hybrid instrumentation in posterior spinal fusion of adolescent idiopathic scoliosis. *Spine (Phila Pa 1976)* 2006;31:291-8.
- Negrini S, Negrini F, Fusco C, Zaina F. Idiopathic scoliosis patients with curves more than 45 cobb degrees refusing surgery can be effectively treated through bracing with curve improvements. *Spine J* 2011;11:369-80.
- Lusini M, Donzelli S, Minnella S, Zaina F, Negrini S. Brace treatment is effective in idiopathic scoliosis over 45°: An observational prospective cohort controlled study. *Spine J* 2014;14:1951-6.