

Clinical Outcomes of Global Derotation Single Rod Operation Technique for Adolescent Idiopathic Scoliosis at Haji Adam Malik Hospital Medan 2016-2020

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Abstract

Introduction

This study aims to evaluate the clinical outcome of the Single Rod Operation (SRD) surgical technique in AIS at Haji Adam Malik General Hospital Medan.

Methods

A retrospective cross-sectional study was conducted in 2016-2020 at Haji Adam Malik General Hospital Medan. The subjects in this study were Adolescent Idiopathic Scoliosis (AIS) patients who had undergone surgery with the SRD technique and had complete medical record data including demographic data, onset, kyphosis angle before and after surgery, and Cobb angle before and after surgery.

Results

This study involved 23 female AIS subjects with a mean age of 16.09 years. The most common Lenke-based diagnoses were AIS Lenke 1 (52.2%), followed by AIS Lenke 3 (26.1%), AIS Lenke 6 (13%), and AIS Lenke 4 and 5 (4.3%). In this study, there were no patients with AIS Lenke 2. The average change in the angle of kyphosis before and after surgery showed significant results (25.830 VS 15.910 $p < 0.001$) with a mean correction of 31.82%. There was a significant difference in the mean Cobb angle before and after SRD surgery (67.260 vs 34.870, $p < 0.001$). SRD is able to correct the Cobb angle with an average of 48.69%. The mean blood volume during SRD surgery was 393.48 ml with an average surgical duration for 249.13 minutes.

Conclusion

The SRD technique significantly improves the kyphosis and Cobb angles so that it can be a good surgical option for patients with AIS.

Keywords: Adolescent idiopathic scoliosis; Outcomes; Single rod derotation; Kyphotic angle; Cobb angle

1. INTRODUCTION

Scoliosis is a three-dimensional spinal deformity characterized by lateral curvature and axial rotation of the spine. Adolescent Idiopathic Scoliosis (AIS) is the most prevalent form, comprising approximately 80% of pediatric scoliosis and affecting approximately 3% of adolescents younger than 16 years old.¹ The ratio of females to males affected by AIS is between 1.5:1 and 3:1 while the prevalence of AIS ranges from 0.47% to 5.2% globally.²⁻⁵ In Indonesia, an AIS early detection study on 784 elementary and high school students in Surabaya in 2010 reported 23 students with AIS (prevalence rate 2.93%).⁶

Historically, the surgical treatment of AIS has evolved from compression-distraction rod placement to posterior pedicle screw instrumentation. The development of more potent instrumentation improves the

effectiveness of various correction maneuvers.⁷ Cotrel-Dubousset (CD) instrumentation and pedicle screw instrumentation are techniques that can provide three-dimensional correction with concave single rod derotation (SRD) while the global derotation (GD) maneuver corrects deformities in the coronal, sagittal, and axial profiles via single rod derotation from the concave side. In addition, it has been demonstrated that the use of single rod derotation provides additional benefits, such as shorter operation times, less blood loss, and lower infection rates.⁷⁻⁸

This study aims to examine the clinical outcomes of single rod derotation surgery techniques for AIS patients performed between 2016 and 2020 at Haji Adam Malik General Hospital in Medan.

2. MATERIAL AND METHODS

2.1. Material

This study is a retrospective analytic study with a cross sectional approach. The sample was selected from the medical records of AIS patients treated at Haji Adam Malik General Hospital between 2016 and 2020. The data collection process occurred between January and April of 2021. Patients with a diagnosis of adolescent idiopathic scoliosis who had undergone single rod derotation surgery at the Orthopedic Department of Haji Adam Malik General Hospital were eligible for this study. The inclusion criteria were as follows: (1) All patients with a diagnosis of adolescent idiopathic scoliosis who underwent single rod derotation surgery at Haji Adam Malik General Hospital; (2) Patients with complete medical record data including preoperative (patient demographic data, disease onset, preoperative vertebral angle), postoperative (blood loss, outcome), and follow-up X-ray examination results (Cobb angle); (3) Patients with at least six months of clinical and radiological follow-up data after surgery. This study excluded AIS who were also diagnosed with congenital bone disorders such as Pott's disease or other spinal disorders.

2.2. Methods

This study was conducted using the total sampling technique. The sampling was conducted retrospectively, using the medical records of patients admitted to the hospital during a specified time frame. The sample for the study was derived from primary patient data. Patients who satisfied the inclusion criteria had their age, gender, Cobb angle, and Risser grade recorded.

Age is determined using the date of birth from the medical record or identification card. Age range from 10 to 18 years old. Gender is recorded in the medical record and ID card. Male and female genders are distinguished. Cobb angle is the angle formed by two lines drawn from the most proximal and distal ends of the curved vertebra and is used to measure the degree of scoliosis curvature. Angle Cobb is measured in degrees.

3. RESULTS

Participating in this study were 23 patients. The youngest patient was 12 years old, and the oldest was 24 years old, with a mean age of 16.09 years. The majority of patients (52.2%) were diagnosed with AIS Lenke 1. Table 1 lists the characteristics of the patients.

Table 1. Patients' characteristic in this study

Characteristic	N (%)	Mean \pm SD	Median
Age, (years)	-	16,09 \pm 3,3	16
Gender			
Boy	0	-	-
Girl	23 (100.0)	-	-
Diagnosis			
AIS Lenke 1	12 (52,2)		
AIS Lenke 2	0 (0,0)		
AIS Lenke 3	6 (26,1)		
AIS Lenke 4	1 (4,3)		
AIS Lenke 5	1 (4,3)		
AIS Lenke 6	3 (13,0)		

Before SRD surgery, the Cobb angle of all patients ranged from 300 to 900, with a mean of 67,260 (\pm 14,570). After the SRD operation, the Cobb angle range was determined to be between 80 and 620 degrees, with a mean of 34,870 (\pm 12,400). It appears that the operation can correct the Cobb angle between 20.5% and 83.0%, with a mean of 48.69% (\pm 13.83%). Table 2 lists additional measurement outcomes from this study.

Table 2. Measurement result of this study

Characteristic	Mean \pm SD	Median
Age, (years)	16,09 \pm 3,3	16
Cobb Angle		
Pre op ($^{\circ}$)	67,26 \pm 14,57	70
Post op ($^{\circ}$)	34,87 \pm 12,75	36
Cobb Angle's Correction(%)	48,69 \pm 13,83	
Kyphotic angle		
Pre op ($^{\circ}$)	25,83 \pm 12,75	24
Post op ($^{\circ}$)	15,91 \pm 8,28	14
Kyphotic's Correction (%)	31,82 \pm 28,34	
Amount of Bleeding (ml)	393,48 \pm 231,75	300
Operation Duration (minutes)	249,13 \pm 46,43	240

Before surgery, the kyphotic angle measurement ranged from 60 to 500, with a mean of 25,830 (\pm 12,750), whereas after surgery, the range was 60 to 400, with a mean of 15,910 (\pm 8,280). After surgery, the mean kyphotic angle correction was 31.82% (\pm 28.34%). However, two patients (8.7%) did not experience correction of the kyphotic angle following surgery. The average amount of blood loss during SRD surgery was 393.48 ml (\pm 231.75 ml), and the average length of the procedure was 249.13 minutes (\pm 46.13 minutes).

Table 3. Pre-operative and Post-operative Cobb Angle with SRD Technique

Variable	Mean \pm SD	<i>p</i> value
Pre operative	67,26 \pm 14,57	< 0.001
Post operative	34,87 \pm 12,75	

Analyzing the dependent T test calculation, Table 3 demonstrates that there was a statistically significant difference between the preoperative angle and the postoperative angle using the SRD technique ($p < 0.001$). These findings indicate that there is a significant difference between the Cobb angle before and after SRD surgery in patients with AIS.

4. DISCUSSIONS

This study included 23 female patients from Haji Adam Malik General Hospital. According to a study by Janani et al., 58 students diagnosed with AIS ranged in age from 11 to 15 years, with a male-to-female ratio of 1:2.⁹ During the period of rapid growth in children, AIS curve development also increases. During the phase of vertebral maturation, the development of the majority of curves slows considerably, whereas some curves continue to increase by $>60^\circ$ in adulthood. In line with our findings, Nery et al. stated that scoliosis can affect adolescents between the ages of 8 and 14 years old.¹⁰

The prevalence of AIS in Padang, Indonesia in 2020 was found to be 10-20 years old with a mean age of 15.13 years (SD \pm 2.3), of the 31 AIS patients who were the research subjects, most of the patients were female (93.5%) with a comparison of 14. :5:1.¹¹ The prevalence rate of AIS in Surabaya is 2.93% in school-aged children between 9-16 years, where the Adam's forward bend test in this study was found to be positive in 50 students (6.37%), of which 19 female students had a Cobb angle of 10° . Among them found 3 female students with severe scoliosis with the age of 14 years. This prevalence is higher with studies of other Asian countries (1.09% in Nepal; 2.22% in Singapore), and also when compared with other Asian countries.¹² The mean Cobb angle of all subjects before SRD surgery was performed in this study was 67.260 (\pm 14.570), while post-surgery was found 34.870 (\pm 12.750). It appears that the operation is able to correct the Cobb angle with an average correction magnitude of 48.69% (\pm 13.83%). The statistical test in this study found that there was a significant difference between the Cobb angle before and after surgery with the SRD technique in AIS patients. Our study was also consistent with a study conducted by Panya-amornwat et al. in Thailand, who retrospectively studied 29 AIS patients who had undergone surgical correction using either SRD or simple derotation. In both groups, postoperative overall vertebral repair parameters improved significantly, but there was no significant difference in apical vertebral rotation or thoracic kyphosis in the SRD group.¹³

Cotrel-Dubousset's research on the SRD maneuver found that derotation can induce a three-dimensional correction, but the correction is generally only satisfactory in two planes, namely the coronal and sagittal. In our study, correction of the kyphosis angle using the SRD surgical technique was found to be 21.1%. Kaya et al. found that rotation of the screw system may increase the incidence of lordosis of thoracic kyphosis in AIS patients.⁷ Due to the translation of the overgrown vertebral body from a lateral to an anterior position, derotation may have a lordogenic effect, according to the study. Similar to Watanabe's 3D simulation study, complete correction of the coronal and rotational deformities reduced kyphosis.¹⁴

SRD and double rod techniques have been used to assist in the reduction of thoracolumbar vertebral deformity.¹⁵ In the surgical treatment of AIS, the objective of posterior vertebral instrumentation is to correct the spinal deformity and stabilize the spine in its newly corrected position. A study by Hassanzadeh et al revealed that with the SRD technique, it was possible to achieve an average thoracic curve correction of 84%, an average lumbar curve correction of 75%, and an average sagittal plane reduction of 1.5 cm. The study also

examined the outcomes of double rod derotation correction, wherein the average thoracic curve correction was 58% and the average lumbar curve correction was 55%, with the conclusion that the reduction achieved using the SRD technique was superior in all vertebral planes.¹⁶ This result was consistent with our research, which determined that the Cobb angle correction was 64.2% and was statistically significant ($p < 0.001$).

The rod derotation technique relies on a combination of forces to correct the spinal deformity in three dimensions while simultaneously stabilizing the corrected position. Hassanzadeh et al. discovered that the SRD technique corrected the thoracic curve by 26% and the lumbar curve by 20% more than the double rod technique. These results demonstrate that the SRD technique is superior to the double rod technique for coronal and sagittal correction. Using the double rod technique concurrently can result in a mismatch between the two rods, which hinders the reduction of the scoliotic curve.¹⁶ Ito et al. stated that despite the widespread use of the single rod technique, their research indicates that the simultaneous double rod derotation technique may be superior because it demonstrates a greater reduction in the sagittal plane than the SRD technique.¹⁷

Giacomini et al. conducted a study comparing the rod technique in 62 patients with AIS (Lenke type 1 or 2). The average final correction for apical vertebral rotation with SRD was 55.8% and with double rod it was 50.1%; this difference was statistically significant ($p < 0.05$), and the final correction was greater than the MT curve (61.1% and 59.1% respectively). Before surgery, the T5-T12 kyphosis angles were identical (SRD 17.5° and Double-R 17.2°) and were then corrected to 12.5° and 13.5°. In order to avoid the hypokyphotic effect of the derotation procedure, Giacomini advises against derotation prior to rod insertion.¹⁸ Our research is also consistent with that of Kadoury et al, who discovered that the derotation technique provided 64% correction of the apical vertebrae in the axial plane, which he deemed to be a significant improvement over the wired CD system (33% correction).¹⁹

Patients with AIS who were instrumented for posterior correction were observed 6 weeks, 2 years, and 10 years postoperatively in a study conducted by Min et al. The mean correction was determined to be 63% at the 6-week follow-up ($p < 0.05$), 60% at the 2-year follow-up ($p < 0.05$), and 55% at the 10-year follow-up ($p < 0.05$). Correction decreased by 5% on average from 6 weeks to 10 years postoperatively ($p < 0.05$).²⁰ Thus, a longer follow-up period is required to demonstrate our findings.

The limited number of subjects in our study made it difficult to generalize about the population, particularly the population of children with AIS in Indonesia. Our study was also limited to a single operative technique, making it difficult to compare and evaluate the efficacy of this SRD technique in relation to other techniques. The patient's short follow-up period was also limited to observing the angle changes that occurred post-operatively.

5. CONCLUSION

The SRD technique is an option that can be considered for the operative technique. Further studies with a larger sample size and longer follow-up period are required to determine the efficacy of SRD in patients with AIS.

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Declaration of competing interest

None.

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References

1. Tajdari M, Pawar A, Li H, Tajdari F, Maqsood A, Cleary E, et al. Image-based modelling for Adolescent Idiopathic Scoliosis: Mechanistic machine learning analysis and prediction. *Comput Methods Appl Mech Eng.* 2021;374:113590.
2. Wong H-K, Hui JHP, Rajan U, Chia H-P. Idiopathic Scoliosis in Singapore Schoolchildren. *Spine (Phila Pa 1976).* 2005 May;30(10):1188–96.
3. Cilli K. School screening for scoliosis in Sivas, Turkey. *Acta Orthop Traumatol Turc.* 2009;43(5):426–30.
4. Soucacos PN, Soucacos PK, Zacharis KC, Beris AE, Xenakis TA. School-Screening for Scoliosis. A Prospective Epidemiological Study in Northwestern and Central Greece. *J Bone Jt Surg.* 1997 Oct;79(10):1498–503.
5. Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. *J Child Orthop.* 2013 Feb;7(1):3–9.
6. Komang-Agung I, Dwi-Purnomo S, Susilowati A. Prevalence Rate of Adolescent Idiopathic Scoliosis: Results of School-based Screening in Surabaya, Indonesia. *Malaysian Orthop J.* 2017 Nov;11(3):17–22.
7. Kaya O, Akgul T, Ozkunt O, Dikici F, Yazicioglu O, Domanic U. Treatment of adolescent idiopathic scoliosis with global (rod) derotation maneuver using pedicle screws. 2018;(1):13–8.
8. Tsirikos AI, Loughenbury PR. Single rod instrumentation in patients with scoliosis and comorbidities: Indications and outcomes. *World J Orthop.* 2018 Sep;9(9):138–48.
9. R J, Ramachandran A, S D. ANALYSIS OF PREVALENCE AND FACTORS INFLUENCING ADOLESCENT IDIOPATHIC SCOLIOSIS AMONG SCHOOL STUDENTS IN THIRUVALLUR DISTRICT. *Int J Physiother* [Internet]. 2019 Jun 1;6(3). Available from: <https://www.ijphy.org/index.php/journal/article/view/423>
10. Nery L, Halpern R, Nery P, Nehme K, Stein A. Prevalence of scoliosis among school students in a town in southern Brazil. *Sao Paulo Med J* [Internet]. 2010;128(2):69–73. Available from: <https://www.scielo.br/j/spmj/a/XVCgzKgYc5xpHCzrBJynWCn/?lang=en&format=pdf>
11. Syifaurrehmah. KARAKTERISTIK PASIEN ADOLESCENT IDIOPATHIC SCOLIOSIS DI POLIKLINIK ORTHOPEDI RSUP DR. M. DJAMIL PADANG TAHUN 2013-2019 [Internet]. Universitas Andalas; 2020. Available from: <http://scholar.unand.ac.id/56118/>

12. IS K-A, SB D-P, A S. Prevalence Rate of Adolescent Idiopathic Scoliosis: Results of School-based Screening in Surabaya, Indonesia. *Malaysian Orthop J* [Internet]. 2017 Nov 1;11(3):17–22. Available from: <http://www.morthoj.org/2017/v11n3/adolescent-idiopathic-scoliosis.pdf>
13. Panya-amornwat T, Methatien A, Pattarapongsanti A. Comparison of Surgical Results of Direct Vertebral Rotation with those of Simple Rod Derotation for Correction of Adolescent Idiopathic Scoliosis. *J Med Assoc Thai* [Internet]. 2017;100(2):116. Available from: <http://www.jmatonline.com/index.php/jmat/article/view/8138>
14. Watanabe K, Nakamura T, Iwanami A, Hosogane N, Tsuji T, Ishii K, et al. Vertebral derotation in adolescent idiopathic scoliosis causes hypokyphosis of the thoracic spine. *BMC Musculoskelet Disord* [Internet]. 2012 Dec 12;13(1):99. Available from: <http://bmcmusculoskeletdisord.biomedcentral.com/articles/10.1186/1471-2474-13-99>
15. Wattenbarger JM, Richards BS, Herring JA. A Comparison of Single-Rod Instrumentation With Double-Rod Instrumentation in Adolescent Idiopathic Scoliosis. *Spine (Phila Pa 1976)* [Internet]. 2000 Jul;25(13):1680–8. Available from: <http://journals.lww.com/00007632-200007010-00011>
16. Hassanzadeh H, Stein BE, Neubauer PR, Logan CA, Kebaish KM, Ain MC. Sawbones comparison of single-rod and double-rod derotation techniques for adolescent idiopathic scoliosis. *Curr Orthop Pract* [Internet]. 2014 May;25(3):257–60. Available from: <https://journals.lww.com/01337441-201405000-00014>
17. Ito M, Abumi K, Kotani Y, Takahata M, Sudo H, Hojo Y, et al. Simultaneous double-rod rotation technique in posterior instrumentation surgery for correction of adolescent idiopathic scoliosis. *J Neurosurg Spine* [Internet]. 2010 Mar;12(3):293–300. Available from: <https://thejns.org/view/journals/j-neurosurg-spine/12/3/article-p293.xml>
18. Giacomini S, Di Silvestre M, Lolli F, Vommaro F, Martikos K, Maredi E, et al. Is there a better derotation manoeuvre in posterior correction of thoracic adolescent idiopathic scoliosis? *Scoliosis* [Internet]. 2015 Dec 19;10(S1):O69. Available from: <https://scoliosisjournal.biomedcentral.com/articles/10.1186/1748-7161-10-S1-O69>
19. Araujo FF de, Marcon RM, Cristante AF, Barros Filho TEP de, Letaif OB. ROTATION ASSESSMENT IN ADOLESCENT IDIOPATHIC SCOLIOSIS WITH ROD DEROTATION. *Acta Ortopédica Bras* [Internet]. 2019 Feb;27(1):42–5. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-78522019000100042&tlng=en
20. Min K, Sdzuy C, Farshad M. Posterior correction of thoracic adolescent idiopathic scoliosis with pedicle screw instrumentation: results of 48 patients with minimal 10-year follow-up. *European Spine Journal*. 2013 Feb;22(2):345–54.