Year 3 SSC Coversheet –

MOHAMMAD ZABIT RISHAD

Title of your project	Comparison of derotation achieved using two different surgical methods for the treatment of Lenke 1A Adolescent Idiopathic Scoliosis
Student Number	C23005433
Project Description and Aims:	- Undertake a literature review to collect and analyse different published literature exploring the pathophysiology of AIS and the different metrics involved to measure and assess severity and derotation. - Using radiographic images, develop a novel volumetric analysis to assess derotation achieved in relation to the apical vertebral body and the spine after correction from either of the two surgical techniques. - Develop competence in using software such as Synapse 5 PACS to view radiological images and use the software's tools to undertake mathematical measurements (e.g volumetric ratios) and classify certain metrics (e.g Nash-Moe Grading) - Incorporate established metrics such as Cobb Angles, Nash-Moe grading, and Rib Flare Distance (RFD) to quantify spinal correction and derotation. - Determine if there are any significant differences between the two rod construct groups in each parameter.
Educational Objectives:	- Develop a detailed understanding of the pathophysiology, classification, and clinical implications of vertebral body rotation and deformity in Adolescent Idiopathic Scoliosis - Acquire an in-depth understanding of the mechanisms, advantages and limitations of using the two surgical correction techniques - Gain experience in measuring and interpreting radiographic parameters e.g Cobb Angles, Nash-Moe classification, Rib Flare Distance to objectively assess surgical outcomes

	- Enhance ability to organize and critically appraise complex data - Develop understanding of the statistical analysis required to convert raw data into meaningful results
SSC Logistics:	- Reviewing comprehensive records of all AIS surgeries which have taken place in Cardiff & Vale UHB. Then applied inclusion criteria to select patients with AIS Lenke 1A Scoliosis with the specific implants. - Undertook literature review to collect papers on AIS, pathophysiology, corrective surgery and different measurement metrics used in quantifying AIS and subsequent correction. - Developed a novel volumetric analysis to quantify spinal correction by using the changes in projected area of the apical vertebral body on perpendicular PA/Lateral X-Rays both pre- and post-operatively. - Used tools of Synapse 5 PACS Software to calculate other metrics like Rib Flare Distance and use literature to support other classification systems like Risser Grades when interpreting patient radiographs. - Data analysis using IBM SPSS Version 29 software to work out statistical significances and translate data into meaningful research and analysis. - Also attended a corrective scoliosis surgery in theatre in Noah's Ark Children's Hospital for Wales.
Was Ethics Approval required?	NO
Word Count (for abstract and poster)	**Abstract**: 522 Words **Poster**: 717 words
AI Declaration	I declare that this work is entirely my own and no part of it has been produced by Generative AI tools.

Comparison of derotation achieved using two different surgical method for the treatment of Lenke 1A Adolescent Idiopathic Scoliosis

Mohammad ZABIT Rishad, Professor Michael J H McCarthy, Mr. Mohammad Abdallah

Introduction

Adolescent Idiopathic Scoliosis (AIS) is a three dimensional spinal deformity characterised by lateral deviation of the spine and vertebral rotation with unknown aetiology. Worsening scoliotic curves levy cardiopulmonary complications and distort spinal balance. Surgical intervention aims to correct sagittal and coronal alignment along with achieving derotation.

Current surgical instrumentation vary from pre-contoured constructs with apical monoaxial screw based en masse correction techniques to manually contoured rod systems with polyaxial screws using dual-innie derotation methods, but their relative effectiveness in spinal correction and derotation remains insufficiently quantified on standard radiographs.

This study introduces a novel volumetric analysis of the apical vertebral body to compare its correction between the two implants. It also uses established metrics like Rib Flare Distance (RFD), Nash-Moe and Cobb angles to assess derotation outcomes and determine if there are any significant differences.

Methodology

A retrospective cohort of 60 female patients, aged 11-18 years, with Lenke 1A deformity were selected, split equally between manually contoured implants with dual-innie system and pre-contoured implants with apical monoaxial screws. Patients with neuromuscular or syndromic scoliosis were excluded. Erect PA and Lateral radiographs taken pre- and post-operatively were then analysed via Synapse 5 Software.

A novel two-plane volumetric analysis was conducted by measuring the projected apical vertebral body area from both PA and lateral radiographs. This allowed for a pre- and postoperative vertebral area ratio and the change in those ratios quantified derotation and indicated whether the spinal alignment had become more symmetrical. Secondary metrics were also calculated, including Nash-Moe, Cobb angles and RFD, while Risser grades accounted for potential differences in skeletal maturity. Data collected were then analysed using independent samples t-tests with corresponding effect sizes (Cohen's d) via IBM SPSS Version 29.

Results

Patients receiving pre-contoured implants with apical monoaxial screws had a significantly greater reduction in Cobb Angle (41.5° vs 33.9°, p=0.007) despite having an insignificant pre-operative Cobb angle between the two groups (67.6° vs 67.4°, p=0.951). The novel derotation ratio demonstrated a non-significant trend favouring pre-contoured implants (–0.24 ± 0.13 vs –0.20 ± 0.12, p=0.18) however Nash-Moe grading significantly improvement in this group (0.90 ± 0.61 vs 0.70 ± 0.46, p=0.034), demonstrating significant apical vertebral body derotation.

Pre-operative rib asymmetry were insignificant between the two groups (60.5 vs 60.7 mm, p=0.95) however pre-contoured implants resulted in a significantly greater correction in rib symmetry (6.28 ± 8.18 vs 1.10 ± 5.88 mm, p=0.007) with a moderate-to-large effect size (d = 0.724), indicating a clinically meaningful advantage in thoracic correction. Screw density was significantly higher in the pre-contoured implant cohort (71.9% vs 64.1%, p=0.003) whereas Risser grade had shown no significant difference (p=0.297) though patients in the pre-contoured implant cohort were non-significantly less skeletally mature.

Conclusion

Pre-contoured rod constructs with apical monoaxial screws offer superior coronal and rotational correction compared to manually contoured dual-innie systems. While they require higher screw density, established metrics support better correction with pre-contoured systems. The study emphasises the value of advanced radiographic metrics for implant design and choice in guiding future surgical planning for optimal deformity correction. This research paves the way for further studies on implant performance with other scoliotic curvatures to enhance best practice for correcting AIS.

Comparison of derotation achieved using two different surgical methods for the treatment of Lenke 1A Adolescent Idiopathic Scoliosis

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Special Thanks to **Professor McCarthy** and **Mr Abdallah** for their guidance throughout this project and to the **School of Medicine Year 3 SSC Team** for providing this opportunity.

INTRODUCTION

Adolescent Idiopathic Scoliosis (AIS) is a three-dimensional deformity characterised by lateral deviation of the spine, vertebral rotation and a reduced thoracic kyphosis with unknown aetiology (1). AIS predominantly affects females and is one of the most common presentations of spinal deformity in paediatric clinics (1). Progressive scoliotic curves can worsen respiratory function and in severe cases lead to significant cardiopulmonary complications (2). Thus, surgical intervention aims to correct sagittal and coronal alignment, achieve derotation and minimise pain and morbidity (3).

Current surgical instrumentation vary from pre-contoured constructs with apical monoaxial screw based en masse correction techniques to manually contoured rod systems with polyaxial screws using dual-innie derotation methods. However, their relative effectiveness in spinal correction and derotation remains insufficiently quantified on standard radiographs. This study introduces a novel volumetric analysis of the apical vertebral body, alongside established metrics, to assess derotation outcomes and determine any significant differences between the two implant systems.

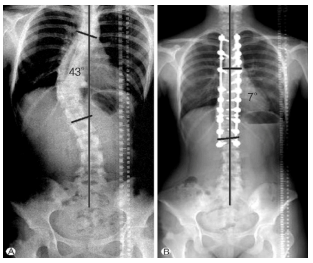

Figure 1 depicts AIS Lenke 1A Scoliotic curve with Cobb Angle of 43 degrees and subsequent correction with rod constructs (4)

METHODOLOGY

- Retrospecitve cohort of 60 female patients, aged 11-18years, with AIS Lenke 1A Scoliosis were selected. 30 patients had manually contoured implants with dual-innie system and 30 patients had pre-contoured implants with apical monoaxial screws.
- Pre- and post-operative erect PA and Lateral radiographs were analysed using Synapse 5 PACS Software
- Apical vertebral body were identified and a novel volumetric analysis was applied by measuring the projected vertebral body area on both PA and Lateral radiographs. Pre- and post-operative vertebral area ratios were calculated and the change in ratio quantified derotation and spinal correction.
- Secondary established metrics were also calculated and analysed.
- Data collected were analysed using independent samples t-test with corresponding effect sizes using IBM SPSS Version 29.

OBJECTIVES

- Using radiographic images, develop a novel volumetric analysis to assess derotation achieved in relation to the apical vertebrae and the spine.
- Incorporate established metrics such as Cobb Angles, Nash-Moe grading, and Rib Flare Distance (RFD) to quantify spinal correction and derotation.
- Determine if there are any significant differences between the two rod construct groups in each parameter.

RESULTS

Cobb Angles remain as the standard for quantifying scoliosis given its high reproducibility (5). Figure 2 demonstrates that patients receiving pre-contoured implants with apical monoaxial screws had significantly greater reduction in Cobb Angles (41.5° vs 33.9°, p=0.007) despite there being an insignificant pre-operative Cobb Angle between the two groups (67.6° vs 67.4°, p=0.951).

A negative change in the novel volumetric ratio indicates vertebral derotation as surgical correction reduces the PA/Lateral projected area. This metric demonstrated a non-significant trend favouring pre-contoured constructs (−0.24 ± 0.13 vs −0.20 ± 0.12, p=0.18) however Nash-Moe grading significantly improved in this group (0.90 ± 0.61 vs 0.70 ± 0.46, p=0.034), demonstrating a significant apical vertebral body derotation.

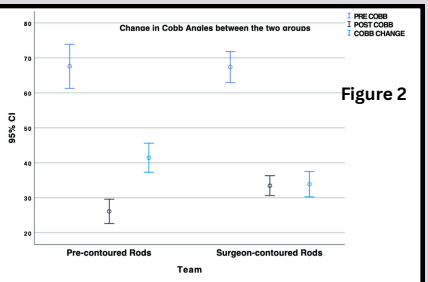

Figure 2

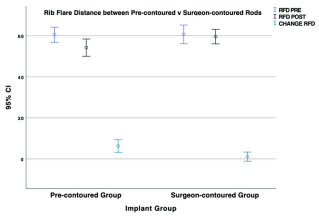

Figure 3

Figure 3 outlines that pre-operative Rib Flare Distance, shown by Figure 4, were insignificant between the two groups (60.5 vs 60.7 mm, p=0.95) however pre-contoured implants yielded significantly greater correction in rib symmetry (6.28 ± 8.18 vs 1.10 ± 5.88 mm, p=0.007). This had a moderate-to-large effect size (Cohen's d = 0.724), indicating a clinically meaningful advantage in thoracic correction for pre-contoured implants.

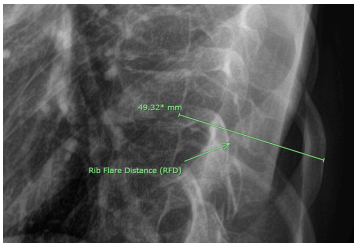

Figure 4

Screw density was significantly higher in the pre-contoured implant group (71.9% vs 64.1%, p=0.003) whereas Risser grade had shown no significant difference (p=0.297) though patients in the pre-contoured implant cohort were non-significantly less skeletally mature.

CONCLUSION

Pre-contoured rod constructs with apical monoaxial screws demonstrated significantly greater coronal and lateral correction compared to manually contoured dual-innie systems. Although the novel derotation metric showed a favourable but non-significant trend, established standard metrics consistently supported superior three-dimensional correction achieved with apical monoaxial screw based en masse correction. However, this group had insignificantly lower Risser grades and significantly higher screw densities which may have contributed to the stronger derotation observed. Despite this, the study's extensive use of established metrics and a large cohort supports the reproducibility and reliability of these findings. This study's findings also suggest that implant choice are crucial for achieving optimal derotation and deformity correction. Furthermore, it highlights the potential of using different radiographic metrics to guide future surgery. Going further, there are gaps for future research to evaluate how these implants perform in scoliosis of different Lenke classifications and different origins to improve best practices and deliver greater patient outcomes.

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