A Retrospective Analysis of Pedicle Screw Placement in the Surgical Treatment of Adolescent Idiopathic Scoliosis – An Analysis of 10 Years of Cases

Sophie J Griffiths, Michael J H McCarthy and Stuart James

Objectives

- Review intra and post-operative imaging for adolescent idiopathic scoliosis (AIS) patients
- Comparison of rate of screw malplacement between various surgical techniques
- Analysis of revision rates following instrumented fusion

Introduction

AIS is the most common form of scoliosis, presenting in children between the ages of 10 and 18. It is a diagnosis of exclusion that is more prevalent in girls, and approximately 30% of children have a family history of the disease[1].

Posterior fusion with instrumentation is the most common surgical intervention for severe AIS, involving placement of metal screws into the pedicles, attachment of rods and application of correctional force to rectify the abnormal curvature[2]. Malpositioning of pedicle screws can result in serious complications, such as permanent neurological deficit and vascular injury[3].

Various surgical techniques were used over the 10-year period. Between 2013 and 2016, a freehand technique, reliant on the use of anatomical landmarks to determine the entry point for the screws, was used without any additional intraoperative imaging. Intraoperative image intensification (II) was introduced in 2017, used alongside the freehand technique. In 2023, the use of MySpine® guides, created with pre-operative CT imaging, became routine, replacing the freehand technique[4].

Methods

- Obtained complete list of operations carried out between January 2013 and December 2023 from the Bluespier database
- Patients undergoing primary instrumented fusion to treat AIS between the ages of 10 and 18 were included in the study
- Radiological imaging stored on the Synapse database was interpreted by a consultant spinal surgeon to assess screw placement
- Data analysis carried out through the use of IBM SPSS Software Version 27

Results

226 girls and 39 boys (N=265 were included in this study, with a mean age at operation of 14.6 years. A total of 5070 screws were placed over the 10-year period, with a mean of 19.13 screws per patient (SD±3.98, range 11-29). Of total screws placed, 516 (10%) were malpositioned, with an overall average of 1.95 malpositioned screws per patient (SD±1.85, range 0-8). 71% of patients had at least one malplaced screw.

Between 2013 and 2016, where a freehand technique was used without any intraoperative imaging, 14% (260/1866) of screws placed were malpositioned. Between 2017 and 2022, where intraoperative II was used alongside a freehand technique, 9% (238/2627) of screws were malpositioned. In 2023, with the use of MySpine® guides, malplacement was reduced to 3% (18/577). This is represented in Figure 1.

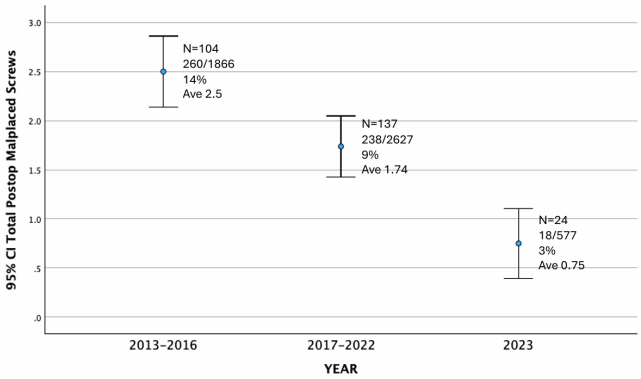

Figure 1: Depicts the decrease in average number of malplaced screws per patient between 2013 and 2016, 2017 and 2022, and in 2023.

23 patients (9%) underwent revisional surgery following their primary surgery. The mean number of months from the date of surgery to revisional operation was 27.2 months (SD±27.2). Revisional operations performed are summarised in Figure 2.

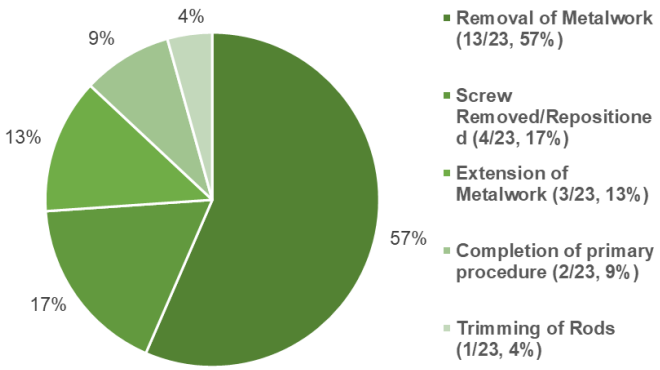

Figure 2: Pie chart representing the proportion of different revisional procedures carried out.

Conclusion

Overall, this study demonstrates that intraoperative image intensification alone reduces the average number of malpositioned screws per patient from 2.5 to 1.7. The addition of MySpine® guides further reduces this average to 0.75. These findings hold significance for guiding surgical techniques in order to reduce screw malplacement as it demonstrates that the use of surgical guides combined with intraoperative II is an effective method. Special thanks to Mr McCarthy, Mr James for supporting the creation of this project.

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Background

Adolescent idiopathic scoliosis (AIS) is the most common form of scoliosis, presenting in children between the ages of 10 and 18. It is a diagnosis of exclusion that is more prevalent in girls, and approximately 30% of children have a family history of the disease.

Surgical intervention is considered in patients with severe scoliotic curves and those that progress despite orthotic intervention, with the aims of providing 3-dimensional realignment of the spine and adequately fusing the vertebrae to prevent further progression. Posterior fusion with instrumentation is the most common procedure, which involves placement of metal screws into the pedicles, attachment of rods and correctional force applied to rectify the abnormal curvature. Determining and reducing the rate of malplacement of pedicle screws is crucial as potential complications of pedicle screw placement include permanent neurological deficit and vascular injury.

The aim of this study was to analyse scoliosis corrections that took place between January 2013 and December 2023 in order to determine whether there was a difference in pedicle screw malplacement between the various surgical techniques used.

Methods

A complete list of operations carried out between January 2013 and December 2023 was obtained from the Bluespier database. Patients between the ages of 10 and 18 that had a primary instrumented fusion through either anterior or posterior approach to treat idiopathic scoliosis were included in the study. Radiological imaging stored on the Synapse database was used to record the presence/absence of image intensification intraoperatively, whether post-operative computed tomography (CT) was performed, and the date of the most recent post-operative x-ray for each patient. These modalities were interpreted by one of the consultant spinal surgeons to assess screw placement, which was recorded as either correct, lateral, medial, superior or inferior. Data analysis was carried out through the use of IBM SPSS Software Version 27.

Results

226 girls and 39 boys (N=265) were included in this study, with a mean age at operation of 14.6 years (SD±1.65). A total of 5070 screws were placed over the 10-year period, with a mean of 19.13 screws per patient (SD±3.98, 95% CI [18.65, 19.61], range

11-29). Of all 5070 screws, 516 (10%) were determined to be malpositioned, with an overall average of 1.95 malpositioned screws per patient (SD±1.85, 95% CI [1.72, 2.17], range 0-8) and 71% of patients had at least one malplaced screw.

Between 2013 and 2016, a freehand technique, reliant on the use of anatomical landmarks to determine a suitable entry point for the screws, was used without any intraoperative imaging. 14% (260/1866) of the screws placed were malpositioned. Intraoperative image intensification (II) was introduced in 2017 and used alongside the freehand technique until the end of 2022. The malplaced screw rate for this period was 9% (238/2627). Then, in 2023, the use of surgical MySpine® guides, created with pre-operative computed tomography (CT) imaging, became routine. These guides reduced the malplacement to 3% (18/577).

Conclusions

Overall, it is demonstrated that intraoperative image intensification reduces the average number of malpositioned screws per patient from 2.5 to 1.7. When screws are placed using MySpine® guides in addition to intraoperative image intensification, the average number of malpositioned screws further decreases to 0.75. These findings hold significance for guiding surgical techniques to reduce the incidence of screw malplacement, demonstrating that the creation of surgical guides from pre-operative imaging combined with intraoperative image intensification is an effective method.