

Original Research Article

Pedicle screw dimension in young patients at the national orthopaedic hospital Dala Kano Nigeria

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ABSTRACT

Background: Paediatric spine surgery requires meticulous preoperative planning to select appropriate pedicle screw dimensions, as the immature spine presents unique anatomical challenges. This study aimed to determine the pedicle screw sizes and lengths used in young patients at a Nigerian tertiary hospital and evaluate the influence of preoperative CT-based planning on outcomes.

Methods: A retrospective review of 97 patients aged 6 to <18 years who underwent pedicle screw instrumentation at the National Orthopaedic Hospital Dala, Kano, from January 2019 to December 2025 was conducted. Indications included spinal infection (n=68, 70.1%), trauma (n=21, 21.6%) and scoliosis (n=8, 8.2%). Preoperative CT was used to measure pedicle transverse diameter, pedicle length and vertebral body dimensions to guide screw selection. Outcomes assessed included screw accuracy using the Gertzbein-Robbins classification, complications and need for revision.

Results: A total of 339 pedicle screws were inserted (mean 3.5 screws per patient). Screw diameters ranged from 4.0 mm to 6.5 mm, with 5.0 mm (42.5%) and 5.5 mm (31.0%) being most common. Screw lengths ranged from 25 mm to 45 mm, with 30 mm (34.8%) and 35 mm (29.5%) being most frequent. Preoperative CT measurements demonstrated that pedicle transverse diameter increased with age ($r=0.52$, $p<0.001$). Screw accuracy (Gertzbein-Robbins grades A and B) was achieved in 92.6% of screws. Complications occurred in 8 patients (8.2%), including 3 (3.1%) with screw malposition requiring revision. Factors influencing screw dimension included age, level of instrumentation and underlying diagnosis.

Conclusions: Preoperative CT-based planning facilitates appropriate pedicle screw selection in paediatric patients. Screw diameters of 5.0–5.5 mm and lengths of 30–35 mm were most frequently used in this Nigerian cohort. Age and spinal level are important determinants of screw dimension.

Keywords: CT morphometry, Nigeria, Pedicle screw, Paediatric spine, Spinal instrumentation

INTRODUCTION

Paediatric spinal instrumentation with pedicle screws has become an established technique for managing a wide range of spinal disorders, including trauma, infection and deformity.^{1,2} The biomechanical advantages of pedicle screw fixation including three-column stabilisation, superior pullout strength and improved fusion rates have

made it the preferred method of spinal stabilisation in children and adolescents.^{3,4} However, paediatric spine surgery presents unique challenges. The immature spine has smaller pedicle dimensions, varying morphology with age and the potential for growth disturbance.^{5,6} A CT-based anatomical study of the paediatric spine demonstrated that pedicle transverse diameter increases with age, with most pedicles of the lower lumbar spine and T12 large enough to accommodate a 4.5 mm screw after

age 8.^{7,8} This study highlighted the importance of preoperative imaging to assess feasibility and guide screw selection.

Preoperative planning using computed tomography (CT) has become the standard of care for paediatric pedicle screw placement.^{9,10} CT provides accurate measurements of pedicle width, pedicle length and vertebral body dimensions, enabling the surgeon to select an appropriate screw diameter and length.¹¹ Studies have shown that the diameter of inserted pedicle screws ranges from 4.5 to 5.5 mm in paediatric deformity surgery, with lengths varying from 30 to 40 mm.^{12,13} In adolescents aged 12–15 years, screw lengths of 40–45 mm at L1–L4 and 45–50 mm at L5 have been recommended.^{14,15}

In Nigeria, the burden of paediatric spinal disorders is substantial. Infections such as spinal tuberculosis remain endemic and trauma from road traffic accidents is a leading cause of spinal injury.^{16,17} The National Orthopaedic Hospital Dala, Kano, serves as a major referral centre for paediatric spine surgery in northern Nigeria. However, data on pedicle screw dimensions and outcomes in Nigerian children are lacking. This study aimed to determine the pedicle screw sizes and lengths used in young patients at our institution, describe the influence of preoperative CT-based planning on screw selection and evaluate the outcomes of pedicle screw instrumentation in this population.

METHODS

Study design and setting

This was a retrospective descriptive study conducted at the National Orthopaedic Hospital Dala, Kano, Nigeria—a 250-bed tertiary orthopaedic referral centre. The study period was 1 January 2019 to 31 June 2025. Ethical approval was obtained from the institutional research ethics committee and individual patient consent was waived due to the retrospective nature.

Participants

All consecutive patients aged 6 years to less than 18 years who underwent spinal surgery with pedicle screw instrumentation during the study period were eligible. Inclusion criteria age 6 to <18 years pedicle screw instrumentation for trauma, infection or scoliosis preoperative CT scan of the involved spinal segments complete operative and follow-up records. Exclusion: patients with congenital spinal anomalies, previous spinal surgery or incomplete records. A total of 97 patients met the inclusion criteria.

Preoperative CT measurement and screw selection

All patients underwent preoperative CT of the involved spinal segments using a 16-slice or 64-slice scanner (GE

Healthcare, USA). The following measurements were performed on axial and sagittal reconstructions.

Pedicle transverse diameter

The narrowest width of the pedicle measured on axial CT.

Pedicle length

The distance from the posterior cortex to the anterior cortex along the pedicle axis.

Vertebral body depth

The anteroposterior distance of the vertebral body.

Screw diameter was selected as the largest size that would occupy 70–80% of the pedicle transverse diameter without breaching the cortex.¹⁸

Screw length was selected to achieve 75–85% of the vertebral body depth.¹⁹ The available screw sizes at the institution included diameters of 4.0 mm, 4.5 mm, 5.0 mm, 5.5 mm, 6.0 mm and 6.5 mm and lengths of 25 mm, 30 mm, 35 mm, 40 mm and 45 mm.

Surgical procedure

All surgeries were performed by fellowship-trained spine surgeons using a freehand technique with intraoperative C-arm fluoroscopy. The approach was posterior midline with subperiosteal dissection. Pedicle screws were inserted using standard anatomical landmarks and intraoperative fluoroscopic guidance. Screws were placed from the thoracic to lumbar spine as indicated by the underlying pathology.

Outcome assessment

Postoperative CT scans were obtained within 48 hours of surgery to assess screw position using the Gertzbein-Robbins classification.²⁰

Grade A

No breach (screw entirely within pedicle).

Grade B

Breach <2 mm.

Grade C

Breach 2–4 mm.

Grade D

Breach 4–6 mm.

Grade E

Breach >6 mm.

Screws graded A or B were considered accurately placed. Complications recorded included screw malposition requiring revision, neurological deficit, dural tear, surgical site infection and implant failure. Patients were followed up for a minimum of 6 months.

Statistical analysis

Data were analysed using SPSS version 26. Continuous variables are presented as mean±SD, categorical as frequencies (%). Pearson correlation assessed the relationship between age and pedicle dimensions. Comparisons between groups used chi-square or Fisher's exact test. Statistical significance was set at $p < 0.05$.

RESULTS

Patient characteristics

A total of 97 patients were included. The mean age was 12.8 ± 3.1 years (range 6–17). There were 52 males (53.6%) and 45 females (46.4%). The indications for surgery were spinal infection ($n=68$, 70.1%), trauma ($n=21$, 21.6%) and scoliosis ($n=8$, 8.2%). The most commonly instrumented levels were L3–L5 (45.4%), followed by T11–L2 (32.0%) and T6–T10 (22.6%).

Table 1 presents the demographic and clinical characteristics. Pedicle transverse diameter increased with age ($r=0.52$, $p < 0.001$). At age 6–8 years, mean PD was 4.6 ± 1.1 mm; at 9–12 years, 5.3 ± 1.2 mm; and at 13–17 years, 6.1 ± 1.3 mm. Pedicle length also increased with age ($r=0.48$, $p < 0.001$). Vertebral body depth showed a similar trend ($r=0.50$, $p < 0.001$). Table 2 presents CT measurements by age group.

Screw dimensions

A total of 339 pedicle screws were inserted (mean 3.5 screws per patient; range 2–8). Screw diameters ranged from 4.0 mm to 6.5 mm. The most commonly used diameters were 5.0 mm (144 screws, 42.5%) and 5.5 mm (105 screws, 31.0%).

Screw lengths ranged from 25 mm to 45 mm. The most common lengths were 30 mm (118 screws, 34.8%) and 35 mm (100 screws, 29.5%). Table 3 presents the distribution of screw diameters and lengths.

Screw dimensions by diagnosis

Patients with scoliosis received larger diameter screws (mean 5.8 ± 0.5 mm) compared with trauma (5.2 ± 0.6 mm) and infection (5.0 ± 0.6 mm) ($p < 0.001$). Screw length also varied by diagnosis: scoliosis (mean 37.5 ± 3.2 mm), trauma (34.2 ± 4.1 mm) and infection (32.5 ± 3.8 mm) ($p < 0.001$). Table 4 presents screw dimensions by diagnosis.

Screw accuracy and complications

Overall screw accuracy (Gertzbein-Robbins grades A and B) was 92.6% (314/339 screws). Grade A (no breach) was achieved in 78.5% (266/339), Grade B in 14.1% (48/339), Grade C in 5.0% (17/339), Grade D in 1.8% (6/339) and Grade E in 0.6% (2/339). The breach rate was highest in the thoracic spine (9.2%) compared with the lumbar spine (5.8%).

Complications occurred in 8 patients (8.2%). Screw malposition requiring revision occurred in 3 patients (3.1%). There were 2 cases of dural tear (2.1%), 2 cases of superficial surgical site infection (2.1%) and 1 case of transient neurological deficit (1.0%). No patient developed permanent neurological deficit or implant failure.

Table 1: Demographic and clinical characteristics of 97 patients.

Characteristics	Category N (%)
Age (in years) mean±SD	12.8±3.1
6–8	22 (22.7)
9–12	38 (39.2)
13–17	37 (38.1)
Sex	
Male	52 (53.6)
Female	45 (46.4)
Indication	
Infection (spinal TB)	68 (70.1)
Trauma	21 (21.6)
Scoliosis	8 (8.2)
Levels instrumented	
T6–T10	22 (22.6)
T11–L2	31 (32.0)
L3–L5	44 (45.4)

Table 2: Preoperative CT measurements by age group.

Age groups (in years)	N	Pedicle transverse diameter (mm) Mean±SD	Pedicle length (mm) Mean±SD	Vertebral body depth (mm) Mean±SD
6–8	22	4.6±1.1	28.4±3.2	32.5±3.5
9–12	38	5.3±1.2	31.2±3.5	35.8±3.8
13–17	37	6.1±1.3	34.5±3.8	39.2±4.1

Correlation with age: PD $r=0.52$ ($p<0.001$); PL $r=0.48$ ($p<0.001$); VBD $r=0.50$ ($p<0.001$).

Table 3: Distribution of screw diameters and lengths (n=339) screws.

Screw diameters	N (%)	Screw length	N (%)
4.0 mm	22 (6.5)	25 mm	30 (8.8)
4.5 mm	35 (10.3)	30 mm	118 (34.8)
5.0 mm	144 (42.5)	35 mm	100 (29.5)
5.5 mm	105 (31.0)	40 mm	65 (19.2)
6.0 mm	22 (6.5)	45 mm	26 (7.7)
6.5 mm	11 (3.2)	40mm	

Table 4: Screw dimensions by diagnosis.

Diagnosis	N	Mean screw diameter (mm)	Mean screw length (mm)
Infection	68	5.0±0.6	32.5±3.8
Trauma	21	5.2±0.6	34.2±4.1
Scoliosis	8	5.8±0.5	37.5±3.2
P value	<0.001	-	<0.001

DISCUSSION

This study provides the first description of pedicle screw dimensions used in young Nigerian patients undergoing spinal instrumentation. The findings demonstrate that preoperative CT-based planning is effective in guiding screw selection, with screw accuracy rates comparable to international benchmarks.

The increase in pedicle transverse diameter with age observed in our study is consistent with previous anatomical studies. A CT-based anatomical study of the paediatric spine found that virtually all pedicles of T12 and L3–L5 are large enough for screw placement in both genders after age 8, estimating a minimum pedicle width of 4.5 mm.^{21,22} The finding that mean PD ranged from 4.6 mm at age 6–8 years to 6.1 mm at age 13–17 years supports this observation and confirms that pedicle screw instrumentation is feasible across this age range. A similar trend was reported by Zindrick et al who found that lumbar pedicle width increased with age and spinal level.¹³

The most commonly used screw diameters in the cohort were 5.0 mm and 5.5 mm, which aligns with findings from a study on paediatric deformity surgery where inserted screw diameters ranged from 4.5 to 5.5 mm.^{12,13} Ebraheim et al reported that the mean lumbar pedicle width in adolescents ranged from 6.5 mm at L1 to 9.2 mm at L5, supporting the use of 5.0–5.5 mm screws in this population.²³ The screw lengths of 30–35 mm is also consistent with the 30–40 mm lengths reported for paediatric pedicle screws. Krag et al found that pedicle

screw length should be approximately 80% of the vertebral body depth, which in the cohort translated to 30–35 mm screws.⁸ These dimensions appear to be appropriate for the Nigerian paediatric population, taking into account the smaller stature observed in some patients.

The variation in screw dimensions by diagnosis is noteworthy. Patients with scoliosis received larger diameter and longer screws compared with those with trauma or infection. This likely reflects the different levels of instrumentation and the need for greater correction in deformity surgery. In scoliosis, screws are often placed in the thoracic spine where pedicles are smaller, but longer screws are required to achieve adequate purchase in the vertebral body.¹² Conversely, in infection and trauma, the instrumentation is often more segmental and may involve the lumbar spine where pedicles are larger but vertebral bodies may be shorter.

The overall screw accuracy of 92.6% (grades A and B) in the series is comparable to international benchmarks. A meta-analysis of robot-assisted pedicle screw insertion in paediatric spine surgery reported high screw accuracy and low complication rates.¹ The breach rate of 7.4% (grades C–E) is within the acceptable range for freehand techniques, particularly in the paediatric population where pedicle morphology is more variable. Belmont et al, reported a 6.2% breach rate in thoracic pedicle screws using freehand technique, which is similar to our findings.²⁴

The complication rate of 8.2% is consistent with other paediatric spine series. A study on robot-assisted pedicle screw insertion reported a low complication rate, with mean estimated blood loss of 145.71 ml.²⁵ The finding of 3.1% screw malposition requiring revision is comparable to rates reported in the literature. The higher breach rate in the thoracic spine (9.2%) compared with the lumbar spine (5.8%) is consistent with the smaller pedicle dimensions and more complex anatomy of the thoracic region, as noted by Zindrick et al.²³

The findings have several clinical implications. First, preoperative CT measurement of pedicle dimensions is essential for safe and effective screw placement in paediatric patients. The strong correlation between age and pedicle dimensions allows surgeons to anticipate appropriate screw sizes based on the patient's age. This is consistent with the recommendations of Kim et al, who advocated for routine preoperative CT for paediatric pedicle screw placement.⁴

Second, the most commonly used screw dimensions in this Nigerian cohort 5.0–5.5 mm diameter and 30–35 mm length can serve as a reference for surgeons planning paediatric spinal instrumentation. These dimensions are similar to those reported in a CT-based anatomical study of the paediatric spine from China, where mean pedicle width at L4 was 6.1 mm and mean screw length was 32.4 mm in the 10–14-year age group.²¹ A South African study on paediatric spine morphometry reported mean pedicle widths of 5.2–6.8 mm in the lumbar spine, consistent with the findings.²⁶

Third, the variation in screw dimensions by diagnosis highlights the need for individualized preoperative planning based on the specific pathology and level of instrumentation. This is particularly important in scoliosis surgery where longer and larger screws are often required, as demonstrated by a study from India that reported mean screw lengths of 38.5 mm in adolescent idiopathic scoliosis.²⁷

CONCLUSION

In conclusion, this study provides the first normative data on pedicle screw dimensions and outcomes in young Nigerian patients undergoing spinal instrumentation. Preoperative CT-based planning facilitates appropriate pedicle screw selection, with screw diameters of 5.0–5.5 mm and lengths of 30–35 mm being most frequently used. Age, spinal level and underlying diagnosis are important determinants of screw dimension. The high screw accuracy (92.6%) and low complication rate (8.2%) support the continued use of CT-based planning for paediatric spinal instrumentation. These findings advance understanding of paediatric spinal morphometry in the Nigerian population and provide a reference for surgeons planning similar procedures in resource-limited settings. Future prospective studies with longer follow-up are

needed to assess fusion rates and long-term implant survival.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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