

Analysis of precision in the insertion of pedicular screws in the thoracolumbar spine

Abstract

Objective: To evaluate the positioning of the pedicle screws in thoracic, lumbar and sacral spine surgeries with the usual technique of intraoperative radioscopic control using postoperative axial computed tomography.

Materials and methods: A retrospective study that analyzed the positioning of the pedicle screws by means of a tomography in the postoperative period of all patients submitted to thoracic, lumbar and sacral spine surgery between March 2009 and October 2013, making up a sample of 251 patients, in whom a total of 1531 pedicle screws were instrumented.

Results: Of the 251 patients studied, 147(58.5%) were male, and 104(41.5%) were female. The etiologies that led to the surgical indications were grouped into the following categories, with their respective Prevalences: 175 cases of degenerative conditions (69.7%), 70 fractures (27.9%), 3 spondylodiscites (1.2%), 2 scoliosis (0.8%) and 1 tumoral metastasis (0.4%). Of the 1531 screws evaluated, 224(14.6%) were in thoracic vertebrae, and 1307(85.4%) in lumbar vertebrae. 1363(89%) of the screws were considered well positioned, and 168(11%) were considered poorly positioned.

Conclusion: The instrumentation of the thoracic, lumbar and sacral spine with pedicular screws, with the use of intraoperative fluoroscopic control, in a school hospital, proved to be a safe technique for pedicular fixation in the most diverse pathologies of the vertebral column due to the large percentage properly positioned screws.

Keywords: arthrodesis, pedicular screws, computed tomography

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Introduction

The pedicle screws used for fixing the thoracic spine, lumbar and sacral have become a widely used around the world from the 90's for the treatment of various disorders of the spine. Its insertion, however, is not totally free of risks, since visualization of the pedicle is limited when approaching posteriorly.¹⁻¹⁵ Various techniques have been developed in order to make this fixation more precise, as the use of X-rays during surgery, fluoroscopy, electromyography with evoked potential, and neuronavigation, which would decrease the incidence of complications attributed to this procedure.⁴ Although not entirely accurate, pedicle fixation has been reported with a high success rate and few complications when performed by trained surgeons.^{1,16-20} The literature demonstrates different indexes of misplaced screws, which vary according to the surgical technique used.²¹⁻²³ Good results in pedicular fixations using intraoperative fluoroscopy can be observed in 96% of the cases.²¹ Different techniques studied also include free-hand fixation, used mainly in corrective surgeries of scoliotic deformities, with 77% of good results in the positioning of the screws;²² and fixation using simple radiographs during the procedure, with satisfactory results in 48% of the thoracic screws and 64% of the lumbar screws.²³

The correlation between the correct positioning of the screws and the incidence of complications has motivated several studies to evaluate the ideal position of the pedicle screws and the correct technique for their fixation.^{11,24} The objective of this study was to evaluate the accuracy of the method of fixation and arthrodesis of the thoracic, lumbar and sacral spine under intraoperative fluoroscopic

control, through the analysis of the positioning of the screws with examinations of computed axial tomography (CT) in the post-operative.

Methodology

In the period between March 2009 and October 2013, 251 consecutive patients submitted to thoracic, lumbar and sacral spine surgery were evaluated at the Hospital do Trabalhador (HT-UFPR), a reference hospital for spinal pathologies. The Hospital has five specialist surgeons, members of the Brazilian Society of Spine (SBC), who since 2002 have used pedicular screws for instrumentation of pathologies of the spine. By having a spine surgeon training service, you also have two orthopedists under supervised activities each year. Being a Hospital-School, and having spine surgeons in training, performing a computed tomography is part of the protocol of postoperative evaluation of patients undergoing spinal surgery. Criteria used for inclusion in the present study were: patients submitted to fixation and arthrodesis of the thoracic, lumbar and/or sacral spine, regardless of etiology, at Hospital do TrabalhadorHC/UFPR, during the proposed period. It was adopted as exclusion criterion: Patients who did not have a postoperative CT scan at the Hospital-School. CT were evaluated in 2.5mm cuts.

In the surgical technique used, the patients were submitted to general anesthesia, being positioned in the ventral decubitus, with cushions in the thoracic and pelvic region, being supported on the antero-superior iliac crests, leaving the abdomen completely free in order to avoid venous stasis. The arms are positioned at 90 degrees

flexion of the shoulder and elbow, protecting bony protrusions with adequate padding. The access route used was the posterior median standard, from a level up to one below the vertebral segments to be fixed, with subperiosteal dissection by the Cobb technique, assisted by electric scalpel until adequate exposure of the posterior arches and the transverse processes of the vertebrae. In order to insert the pedicle screws, the same technique was used for all, ie, pedicle puncture, pedicle perforation with a 5mm probe, integrity test of the medial, lateral, superior, inferior and anterior walls associated with intraoperative fluoroscopic control. Initially in the incidence in profile, and as final control after the placement of all the screws in the position in antero-posterior (AP) in neutral angulations, and inclinations of 30° in the cranial and caudal directions.

Postoperative tomographic evaluation was performed by one of the four specialist physicians, during which a specific protocol for the evaluation of the position of the screws was filled. No deviations were accepted in their position, and all who violated any cortical of the pedicles were considered as poorly positioned, except for the cortical breach of the S1 body.

Results

The distribution of patients according to the gender was 41%(104) women and 59%(147) men. 1531 pedicle screws were analyzed, 1307(85.4%) in the lumbosacral region and 224(14.6%) in the thoracic region. Regarding the location of the screws (Chart 1), a higher prevalence of instrumentation in the L4, L5 and S1 vertebrae was observed.

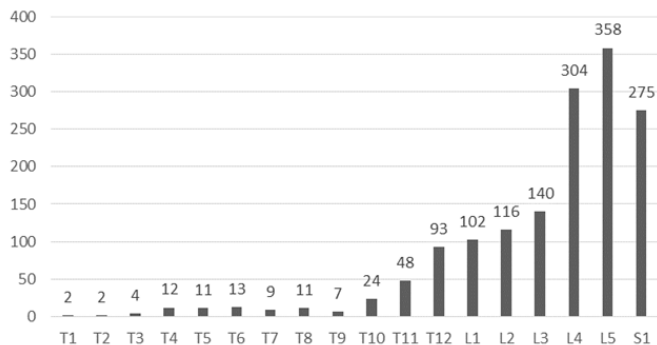


Chart 1 Incidence of the screws in each level.

Of the pathologies involved, 175 cases (69.7%) were degenerative diseases, 70 cases (27.9%) were fractures, 2 cases (0.8%) were scoliosis, 3 cases (1.2%) were spondylodiscitis and 1 case (0.4%) was a metastatic pathological fracture. 1363 (89%) screws were considered well-positioned, while 168(11%) were considered as poorly positioned (Figure 1).

The patterns of inadequate positioning of the screws that are considered to be poorly positioned can be observed in Chart 2, which shows that 33 screws (19.6%) invaded the anterior cortical (all in the lumbar vertebrae) (Figure 1), 66(39.3% (1 thoracic and 65 lumbar), 60(35.7%) had a lateral cortex (4 thoracic and 56 lumbar). It was observed that 3 screws (1.8%) were very lateral (outside the pedicle) and 6(3.6%) were intra-canal medullary (of these, 3 were lumbar and 3 were thoracic).

Among the misplaced screws, those with potential for neurological damage were those that violated the medial, intra-canal (screws whose total diameter was within the medullary canal), lateral and end-lateral

(outside the pedicle) for a total of 135 screws (9% of all studied) in 62 patients.²⁵⁻³⁰

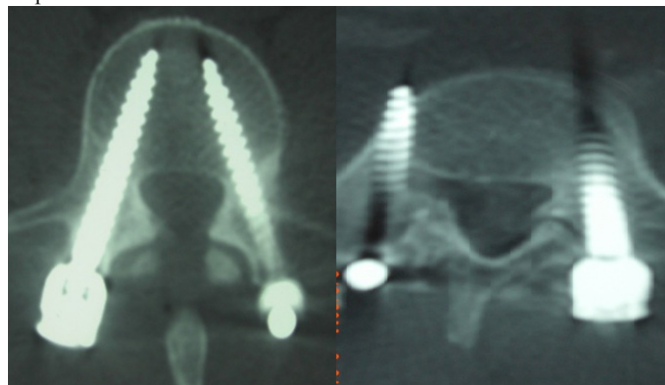


Figure 1 Screws well positioned to the left and poorly positioned to the right.

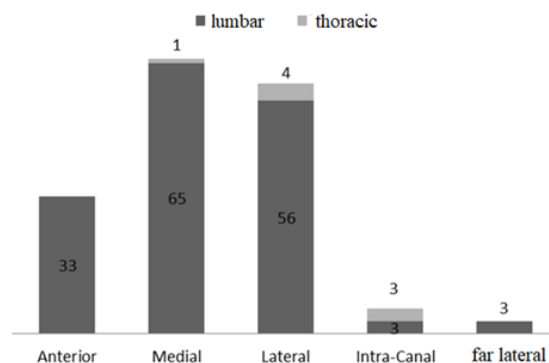


Chart 2 Poorly positioned screws.

A review of the medical records of these 62 individuals was carried out, looking among the medical reports of their hospital admissions and outpatient follow-ups, if there was any type of neurological deficit that could be attributed to these misplaced screws. We found 3 patients (approximately 1% of the total sample) who had some type of sensory and/or motor worsening in the postoperative period. Of these, one was the patient submitted to corpectomy of the thoracic vertebra due to bone metastasis, a procedure of great technical difficulty and morbidity, which does not allow us to establish a causal link between the deficit of global strength of the lower limbs with the screws in question. A second patient had a mild motor deficit, but who presented spontaneous improvement in the days following the surgery, arriving at his first outpatient clinic already reporting an appreciable improvement. The last patient presented a sensory deficit, which persisted throughout the outpatient follow-up.

Discussion

Because the screws allow for more stable arthrodesis, it provides a higher consolidation rate.¹⁴ Correct positioning of the implant is critical to the success of the surgery. Regarding the positioning of the pedicle screws, there are controversial results in the literature. In their study, Roy-Camille^{31,32} reported correct position of the implants in 90% of cases in the lumbar region. Vaccaro et al.,³³ reported only 59% correctly positioned screws in their initial study. Castro³ in his study reported 60% of correct position of the implants. In the present study, it was observed that 89% of the pedicle screws were well positioned, which is similar to that found by Roy-Camille in his classic study.

This difference between the correct location of the screws, observed in the mentioned works, can be explained by the improvement of the technique of insertion and greater experience of the surgeons. In order to improve the surgical technique, several methods have been described, but all have their limitations.¹⁴ For example, results reported in the literature for the free hand insertion were lower than those found in the present study, with 76% of screws well positioned in free hand instrumentation to correct scoliosis.²² Similarly, in techniques using simple intraoperative radiographs, only 64% of the lumbar screws and 48% of the thoracic screws were considered to be well positioned.²³ It is known that medial pedicular violations are the ones that have the greatest neurological consequences due to nerve root injury, dural damage with potential development of fistulas and pain symptoms. These potential complications may lead the surgeon to tend to lateral error, as seen in the literature where lateral cortical violation corresponds to up to 63% of all misplaced screws, in contrast to 19% of medial violations.²¹ In contrast, in the series studied, the highest incidence of pedicular violation was to medial (39.3%), followed by lateral (35.7%) and anterior (19.6%). No upper or lower violations were observed, probably due to the ease of observing this type of invasion by intraoperative fluoroscopy, allowing its immediate correction. We note here an observation about the violation of the anterior cortical of S1 because its violation is not considered problematic.

Some authors^{7,10,11} consider normal a small margin of deviation of 2mm medial to the pedicle and 6mm lateral, considering the screws in this region as correctly positioned. In contrast, the present study aimed for greater rigor, considering any cortical violation as positional deviation. Patient symptomatology is probably the factor to be considered in determining the actual positioning of the implant (adequate versus not adequate).^{8,11} Small violations of the pedicle cortex are not uncommon and the vast majority are asymptomatic.⁸ Improvement of the technique and adequate training are of paramount importance for insertion of pedicular screws. This study presents data obtained in patients submitted to surgical treatment performed by surgeons with experience in this type of procedure and also by surgeons in training, which is very close to the reality found in the services of School Hospitals in other institutions.⁵

Conclusion

The use of intraoperative fluoroscopic control proved to be a safe technique for pedicular fixation in the most diverse pathologies of the spine. The misplaced screws were more frequently violating the medial cortical, followed by lateral, anterior and intra-canal breach in that order.

Acknowledgements

None.

Conflict of interest

The authors declare that there is no conflict of interest.

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