STUDY OF PEDICULAR SCREWS POSITIONING FOR THORACIC-LUMBAR SPINE FRACTURES TREATMENT

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SUMMARY

In the last decades, there has been an increasing use of instruments with pedicular screws for treating thoracic-lumbar spine fractures. This kind of fixation has the advantage of stabilizing the Denis' three columns, as opposite to other instruments previously used, but it presents as a possible and feared complication the potential of vertebral channel penetration, pedicular fractures, involvement of nervous roots and vascular injuries. Our study aims to evaluate if computed tomography is a good analysis method for pedicular screws positioning and the potential complications of surgically passing them. Nineteen patients have been studied, totaling 134 screws, during the period ranging from November 2002 to February 2005, regarding X-ray, tomography and pre- and postoperative neurological function analyses. As a result, there were two cases of injury on pedicle's lateral wall at the tomography image, with no clinical repercussion to patients. Regarding neurological deficit, no patient showed a worse condition. Six patients presented with an improved neurological status. We concluded that computed tomography is an excellent imaging test for evaluating pedicular screws, and this kind of fixation was safe and showed low morbidity rates, allowing an early mobilization of the patient.

Keywords: *Spinal fractures; Bone screws/utilization; Fracture fixation.*

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INTRODUCTION

Thoracic and thoracic-lumbar fractures treatment has long been a reason for controversies. With the increased knowledge on biomechanics and anatomy of the thoracic-lumbar region, discussions around treatment have become deeper, especially during the 1980's and 1990's [1,2,3].

During that period, the use of pedicular screws for fixing those fractures has grown, because strong advantages were reported, such as good reduction, stabilization, spinal cord decompression, in addition to enable early mobilization of patients after surgery. However, there are soma disadvantages, mostly inherent to the transpedicular crossing of screws, such as: risks of perforating vertebral channel, pedicle fracture and involvement of nervous roots. Therefore, an accurate evaluation is required regarding screws positioning on the spine [4,5,6].

Magnetic resonance and computed tomography are excellent imaging tests for evaluating screws on pedicles. Computed tomography has a lower cost, and is a faster, non-invasive test that can be performed on a monitored multiple-trauma patient [2,5,7].

The objective of this study is to assess if computed tomography is a good analysis method for screws positioning on pedicles of patients submitted to thoracic and thoracic-lumbar fractures fixation, and its potential complications of surgically passing them.

CASE SERIES AND METHODS

Our group of study is comprised of 19 patients operated at the HC-FMUSP Orthopaedics and Traumatology Institute between November 2002 and February 2005, for unstable spinal fractures at the thoracic and thoracic-lumbar segments, who were submitted to bloody reduction and instrumentation with transpedicular screws and nails.

The patients have suffered car, motorcycle accidents, trampling, and high falls, and have initially received care at the HC-FMUSP Emergency Room according to ATLS.

The patients have been evaluated regarding gender, age, mechanism of trauma, neurological status according to ASIA classification, injury level, fixation levels and amount of used screws. A tomography study has been performed in each patient for surgical planning.

Regarding the surgical technique, the patients were submitted to general anesthesia, positioned at pronation plane,

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in a bed especially designed for spinal surgeries. A median longitudinal incision was made on the back, followed by dissection up to cross-sectional processes and facetal joints, checking for fixation and fracture levels by means of fluoroscopy, orienting the insertion point of the screw through horizontal line intersection tangencial to the upper edge of the cross-sectional process and bisectrix vertical line of the facetal joint and checking with fluoroscopy, performing a tunnel on the pedicle by means of an inserter and probe, and finally passing the titanium transpedicular screw with a medial bent of 5 - 15 degrees and proper cranial-caudal bent [8,9]. Each screw was fixed to a longitudinal nail. A vacuum-aspiration drain was placed for 24-48 hours.

Postoperatively, the patients were evaluated by means of a neurological test, with simple X-ray images and tomography tests.

The postoperative tomography image regarding screws positioning was performed by two orthopaedic doctors (one from the surgical team and another, independent), as well as by a radiologist.

It is important to highlight that the patients included in the study are those with spinal fractures from T1 to L1, as well as the analysis of pedicular screws, which were considered only for those levels.

On Chart 1, the early characteristics of the patients included in the study are shown.

Figure 1 - *Case 2: fracture T6/T7.*

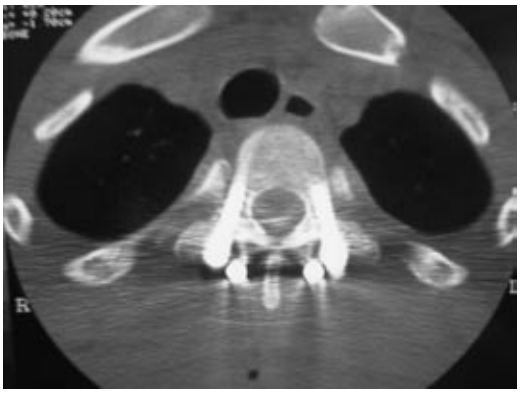

Figure 2 - *Case 2: T4 fixation, good pedicular screws positioning.*

RESULTS

Follow-up period for those 19 patients ranged from 2 to 22 months (average: 10 months). Seventy three levels were fixed and 134 pedicular screws were used on the thoracic-lumbar region (Figures 1 and 2).

The X-ray analysis did not evidence any case of loose or broken screws.

The tomography analysis evidenced 2 cases (11% of patients and 1.5% of all screws) of lateral pedicular wall injury caused by the screw (cases 13 and 18), although not clinically relevant. There was no invasion of the vertebral channel or of the upper or lower pedicular wall (Chart 2).

There was no worsening of the neurological status in none of the patients, with 6 patients presenting with recovery/ improvement of the neurological deficit, as shown on Chart 3.

DISCUSSION

In the last decades, a significant increase was noticed on surgical treatment indication for unstable thoracic and thoracic-lumbar fractures, i.e., those presenting rupture of the 3 columns, progressive kyphosis or above 20°, vertebral body flattening higher than 50% and channel stenosis higher than 50% [2,3,10] . The Harrington instrument, the Luque linear fixation, consisting of nails fixated with sublaminar wires, the Cotrel-Dubousset technique with hooks, screws and nails have been the most frequently employed surgical techniques [1,2,5,11,12].

In 1963, Roy-Camille started using pedicular screws and plates as routine, reporting excellent results regarding the stiff stabilization provided on those severe fractures [1,2,7]. This kind of fixation provides stabilization to the 3 Denis' columns, enabling early mobilization and reduced levels of respiratory complications and pressure sores/ decubitus ulcers.

Recent biomechanical studies proved that the use of pedicular screws with plates or nails are extremely effective for thoracic and thoracic-lumbar spine fixation, being superior to other techniques, but it is worthy to highlight that the surgeon's experience with the technique is crucial and the learning curve is long, once thoracic pedicles are narrow and its convergent and cephalic orientation, especially in its uppermost portion,

Chart 1 - *Initial characteristics of patients.*

Patient	Gender	Age(y)	Mec.trauma	Diagn.	ASIA	Follow-up
1	M	30	High fall	Fx L1	E	9 months
2	M	16	Motorcycle	Fx dis T6/T7	A	10 months
3	M	38	High fall	Fx L1	B	11 months
4	M	25	Car	Fx dis T9/T10	A	14 months
5	M	20	Car	Fx L1	A	13 months
6	M	30	High fall	Fx T12 & L4	A	20 months
7	F	19	Trampling	Fx dis T12/L1	A	14 months
8	M	49	High fall	Fx T11/T12	D	22 months
9	M	58	High fall	Fx L1	B	15 months
10	M	51	High fall	Fx L1	E	17 months
11	M	24	High fall	Fx L1	E	19 months
12	M	38	High fall	Fx T9/T10	A	5 months
13	M	41	Car	Fx L1	B	4 months
14	F	44	High fall	Fx L1	C	3 months
15	M	43	Motorcycle	Fx T8/T9	A	5 months
16	F	40	High fall	Fx L1	E	2 months
17	M	35	High fall	Fx L1	D	4 months
18	M	32	High fall	Fx T7/T8/T9	A	8 months
19	M	37	High fall	Fx L1	D	3 months

Abbreviations: y - years, Mec. - mechanism, Diagn. - diagnostic, M - male, F - female, Car - Car accident, Fx - fracture, Dis - dislocation.

makes this technique very difficult to perform [9,13,14]. Those anatomical studies also outline the huge risk of neurological, vascular and visceral injuries when passing a screw through the pedicle [1-5,11,15-17]. We must avoid penetration of the anterior cortical of the vertebral body, vertebral channel invasion, and injuries to the pedicular walls. This is why is so important to be familiar with the appropriate technique. On thoracic segment, the insertion site is located at the crossing of a vertical line passing through the middle of joint facets with another horizontal line, passing at a tangential plane to the upper edge of the cross-sectional processes [2,8,18].

Chart 2 - *Evaluation of pedicular screws.*

Patient	Fixed levels	Screws T1-L1	Pedicle Fracture (CT)
1	3	6	0
2	5	8	0
3	3	5	0
4	7	14	0
5	3	6	0
6	3	6	0
7	6	11	0
8*	1	2	0
9	3	4	0
10	3	4	0
11	3	4	0
12	5	8	0
13	4	8	+
14	4	8	0
15	5	10	0
16	3	6	0
17	4	8	0
18	5	10	+
19	3	6	0

* Mixed fixation: pedicular + hooks
Abbreviations, CT - computed tomography, (0) absence, (+) presence.

Chart 3 - *Neurological status (ASIA).*

Patient	Preop	Postop
1	E	E
2	A	A
3	B	B
4	A	A
5	A	C
6	A	C
7	A	A
8	D	E
9	B	D
10	E	E
11	E	E
12	A	A
13	B	B
14	C	D
15	A	A
16	E	E
17	D	D
18	A	A
19	C	D

Abbreviations: preop - preoperative, postop- postoperative.

Thoracic pedicles present important characteristics with which the surgeon must be familiar in order to avoid iatrogenic neurological, vascular, and visceral injuries. The saggital diameter is crescent from T1 (8.8 mm) to T12 (17.1 mm). The cross-sectional diameter ranges from 4 to 6 mm from T3 to T9, and from 6 to 8.5 mm in T1, T2, T10, T11, T12. The distance between the insertion point and the anterior cortical of vertebral body is crescent from T1 (30 mm) to T12 (45 mm). The medial cortical of the pedicle is thicker than the lateral cortical. Pedicular cross-sectional bent is medial, and, at T1, it ranges from 27 to 30°, at T2 it ranges from 17 to 20°, and from T3 to T12 it is lower than 15°. Saggital bent is cephalic; at T1, it has 7.7° in average, at T2, 10.4° in average, and from T3 to T10, it decreases up to 5.5° [8,18,19].

Concerned about that, we performed, in all patients, a detailed study using X-ray and computed tomography imaging tests preoperatively, assessing pedicular length, diameter, and orientation. Postoperatively, we repeated the same imaging tests, confirming that computed tomography was efficient in evaluating transpedicular screws, because we managed to analyze, in a simple and objective manner, the integrity of medial, lateral, lower and upper corticals of the pedicles and vertebral channel, with no interference by the presence of the screw, Furthermore, this test is time-saving, not leading to damages to a newly-operated patients who, most of the cases, are monitored.

In our experience, the incidence of a pedicular screw inappropriately passing through, which is 11% of patients and 1.5% of all screws, is similar to that reported in international literature and even lower than it is in some articles [4]. The inappropriate screw insertion, in our study, occurred only laterally to the pedicle, with no injuries to medial, upper, and lower walls. We saw no penetration of the anterior wall of the vertebral body.

The treatment of unstable thoracic and thoracic-lumbar spine fractures using pedicular screws has shown to be efficient and appropriately technically accurate.

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