

# EFFECT OF PILOT HOLE TAPPING ON PULLOUT STRENGTH AND INSERTION TORQUE OF DUAL CORE PEDICLE SCREWS

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## ABSTRACT

**Objective:** To evaluate the influence of pilot hole tapping on pullout resistance and insertion torque of pedicle screws with a conical core. **Methods:** Mechanical tests using a universal testing machine were performed on pedicle screws with a conical core that were inserted into pedicles in the fifth lumbar vertebra of calves. The insertion torque was measured using a torque meter with a capacity of 10 Nm, which was considered to be the highest torque value. The pilot holes were prepared

using a probe of external diameter 3.8 mm and tapping of the same dimensions and thread characteristics as the screw. **Results:** Decreased insertion torque and pullout resistance were observed in the group with prior tapping of the pilot hole. **Conclusions:** Pilot hole tapping reduced the insertion torque and pullout resistance of pedicle screws with a conical core that had been inserted into the pedicle of the fifth lumbar vertebra of calves.

**Keywords** – Spine; Bone Screws; Biomechanics

## INTRODUCTION

Most screws used in orthopedic surgery were developed for implantation in holes that had been previously tapped<sup>(1)</sup>, and this technical principle was also applied to some implants that were developed for fixation of the spine<sup>(2)</sup>. While the importance of prior tapping of screws used in cortical bone has been established and is well based, there is controversy regarding the influence of tapping on screws in vertebral fixation systems<sup>(1-3)</sup>. Tapping of the pilot hole for these screws has not been capable

of increasing the pullout resistance of the implants and has even reduced this mechanical property<sup>(2,4)</sup>. Carrying out this additional maneuver for placing implants in the spine has been questioned because of the potential increase in the duration of the operation without providing any mechanical advantages for the implant.

Conical core screws were developed with the aim of improving the mechanical properties of the fixation system screws. The aim of the present study was evaluate the influence of pilot hole tapping on the pullout resistance of pedicle screws with a conical core.

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We declare that there is no conflict of interest in this paper

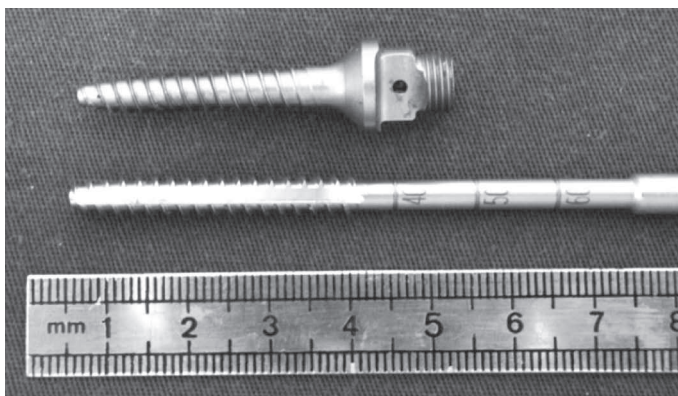
## MATERIAL AND METHOD

Ten lumbar vertebrae (L5) from male calves of Friesian breed, of age six to eight weeks and mean body mass  $50.9 \pm 5.0$  kg, were used. The vertebrae were stored at a temperature of  $-20^{\circ}\text{C}$ . Before the tests were carried out, the vertebrae were removed from the freezer and kept at a temperature of  $5^{\circ}\text{C}$  for 12 hours, and then at room temperature for two hours, so that they would attain thermal equilibrium, and for the physical properties of the bone not to be abnormal. The bone mineral density of the vertebrae was assessed by means of dual X-ray absorptiometry, and a mean of  $0.24 \pm 0.01$  g/cm<sup>2</sup> was found.

Conical core screws from the USS system (Universal Spine System-Synthes®) for vertebra fixation, of length 30 mm and external diameter 5.2 mm (Figure 1), were used. The screws were implanted in both sides of the vertebral pedicles, using a probe of external diameter 3.8 mm and tapping with the same dimensions and thread characteristics as in the implant, in accordance with the manufacturer's recommendations (Figure 1). In the left pedicle, tapping was performed before placement of the implants, and on the right side, the implant was placed directly after making the pilot hole.

The insertion torque of the screws was evaluated by means of a torque meter with a capacity of 10 Nm and the MK software, version 1.0.0.6/2004. The highest torque value obtained while inserting the implant was taken.

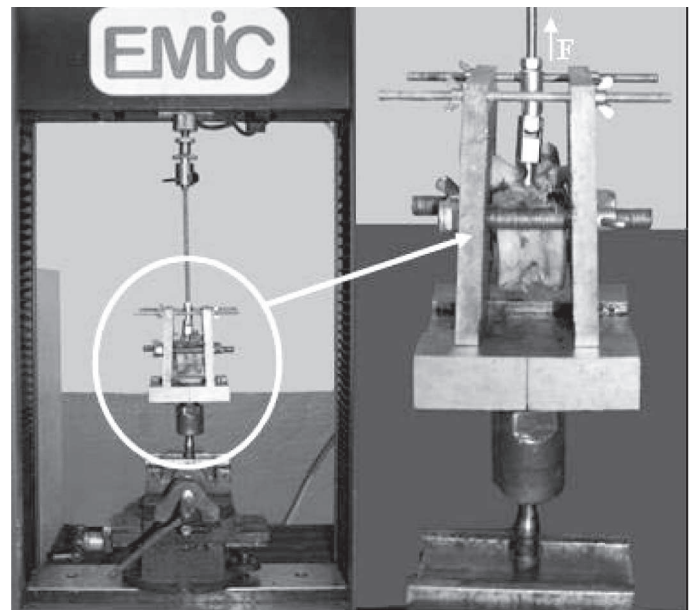
The mechanical pullout tests were performed using an Emic universal testing machine, with the Tesc 3.13 software to analyze the results, a load cell with a capacity of 2,000 N and a force application velocity of 2 mm/min. In all the mechanical tests, a preload of 50 N and accommodation time of 10 seconds were used



**Figure 1** – Pedicle screws with a conical core (above) and their respective tapping (below).

(Figure 2). The property evaluated in the mechanical tests was the maximum pullout force.

The results from the maximum pullout force were subjected to statistical analysis of normality, in order to determine the behavior of the data (ANOVA). To compare the results between the groups, the Bonferroni post hoc method was used. The significance level was taken to be 5% ( $p < 0.05$ ).



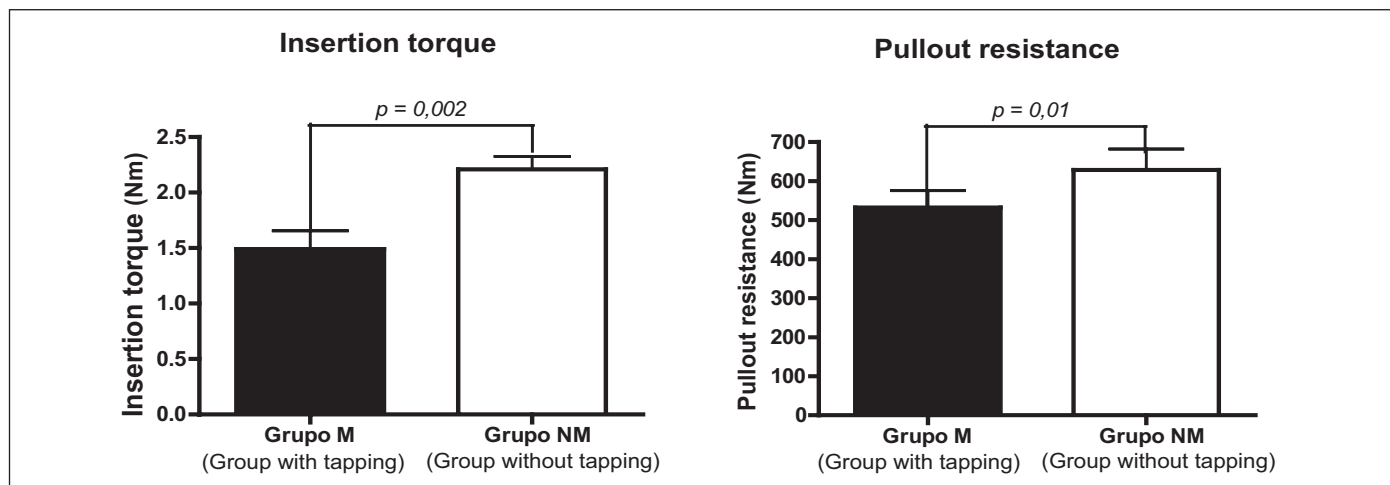
**Figure 2** – Photograph illustrating the device used to carry out the pullout test on the screws.

## RESULTS

It was found that the insertion torque and maximum pullout force were lower in the group of screws with prior tapping of the pilot hole. The results relating to the insertion torque and the pullout force of the screws inserted in tapped pilot holes and untapped pilot holes are represented in Table 1 and Figure 3.

## DISCUSSION

Placement of screws in the vertebrae is a prominent technical step towards spine fixation that may or may not be preceded by tapping the pilot hole. Pilot hole tapping is an additional technical step during the surgical procedure, and it consequently increases the time required for the operation, which is only justifiable through the benefits provided. If there are no benefits, this procedure would be an unnecessary stage within the surgical procedure. In osteosynthesis of the long bones, the importance of cortical bone tapping is well esta-



**Figure 3** – Mean insertion torque and mean pullout resistance of the screws in the groups with tapping and without tapping of the pilot hole.

**Table 1** – Insertion torque values of the screws in the groups with tapping and without tapping of the pilot hole.

Vertebra	Insertion torque (Nm)		Pullout resistance	
	Group with tapping	Group without tapping	Group with tapping	Group without tapping
1	1.36	2.06	469.13	501.57
2	1.35	1.82	723.47	793.22
3	1.73	1.94	456.49	424.08
4	1.32	2.39	481.11	800.26
5	1.69	2.53	446.62	558.83
6	1.95	2.65	456.49	546.66
7	1.17	1.49	478.93	512.14
8	1.6	2.34	634.81	898.18
9	0.39	2.4	376.88	448.96
10	2.36	2.45	796.74	774.19
Mean	1.49	2.21	532.07	628.79
Standard deviation	0.52	0.37	137.21	168.64

blished and the technique has been used classically<sup>(5)</sup>. However, within the field of spinal surgery, it has been demonstrated that pilot hole tapping does not increase the pullout resistance of the screws<sup>(2)</sup> and that it could reduce this resistance in the spongy bones and in the lumbar spine<sup>(6,7)</sup>, without altering the resistance of the screws inserted in the thoracic spine<sup>(4)</sup>.

Among the different types of pedicle screws available for use in orthopedic surgery, the great majority were developed with the method of prior tapping of the pilot hole<sup>(8)</sup>. In a study using screws with different designs of thread pitch, produced by different manufacturers, a reduction in the pullout resistance after tapping was

observed after tapping in most of them<sup>(8)</sup>.

Fixation of screws in human vertebrae to perform mechanical tests would reproduce the natural surgical conditions. However, acquisition of vertebrae to perform this test presents numerous medical-legal difficulties relating to obtaining them. Thus, we used spines from calves in this study, since this model is well accepted in the literature and is considered to be appropriate for assessing instrumentation of the spine<sup>(1,9,10)</sup>.

Conical core screws were developed to increase the pullout resistance. The conical core screw used in this study had two different diameters that were joined by a zone of conical transition. The smaller diameter of the screw was closer to its tip, and the larger diameter was closer to its head. The smaller diameter facilitated screw insertion and the larger diameter provided greater stability for the implant located inside the vertebral pedicle<sup>(11)</sup>. Theoretically, the conical core of the screw compacts the adjacent spongy bone, thereby increasing the insertion torque of the implant and its pullout resistance<sup>(12)</sup>.

The results obtained from the present study showed that pilot hole tapping significantly reduced the insertion torque and pullout resistance of the conical core screws. This reduction in screw pullout resistance has been well demonstrated, especially in soft materials or in spongy bone, and it is related to weakening on the spongy bone at the interface between the implant and the bone tissue.

The stability of the fixation system is dependent on the implant anchorage strength in the vertebra, and pilot hole tapping may compromise the stability of the fixation system through reducing the pullout resistance of the implant.

Pilot hole tapping to implant conical core screws in the spine is disadvantageous because it increases the duration of the operation and reduces the pullout resistance of the implant.

## CONCLUSION

Pilot hole tapping reduces the insertion torque and

pullout resistance of pedicle screws with a conical core that have been implanted in the pedicle of the fifth lumbar vertebra of calves.

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