CORRELATION BETWEEN PEDICULAR SCREWS POSITIONING ON VERTEBRAL BODY AND ITS PULLOUT STRENGTH

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SUMMARY

The orthopaedic oncology group provides medical and psychosocial care to patients, both in hospital and outpatient facilities, with musculoskeletal tumors. With this research we aimed to know the socioeconomical profile of the patients/families, as well as the changes occurred after such diagnosis is received. The sample was constituted of 25 families of patients with osteosarcoma on lower limbs. The study was conducted between September and October 2005 by means of forms containing open and closed questions, using the collective subject speech for qualitative analysis. The study had a prospective, descriptive design with quanti-qualitative approach. Among the respondents, 68% were females including 44% of mothers; 76% worked, and 28% of these had formal jobs. 60% had a family income amounting 2-5 minimum wages. After diagnosis, 92% faced increased expenses; 80% reported challenges with the chemotherapy; 56% mention transportation as the major factor affecting compliance to treatment. 100% feel desperate when they first know they have cancer. Cancer causes changes in family members' roles. There is always the fear of recurrence, which ultimately lead the family to fear death, thus requiring a joint effort with a multidisciplinary team.

Keywords: *Family; Bone neoplasia; Patient care team*

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INTRODUCTION

Pedicular screws have been widely employed in vertebral spine surgeries. Screws' fixation strength is primarily determined by its shape and property, as well as by its interface with the bone(1,2). Fixation failure can occur as a result of a number of factors, such as pedicle fracture, osteoporosis, micro movements, or pseudoarthrosis(3,4).

Many studies have been conducted aiming to give answers to questions concerning optimal size, width and shape of screws for different pedicle sizes(5-8). The way of preparing a pedicle for the introduction of pedicular screws has also been studied(6).

In literature, we can also find studies addressing the best method to be used in review surgeries(9-13), assessing the exchange of a screw by a wider or longer one, or the use of adjuvant factors in fixation, such as methylmethacrilate(14).

By analyzing the surgical procedure, we sometimes notice the need to reposition some screws. In literature, there are few studies addressing pedicular screws strength change on vertebrae, especially when a position change is required, which is frequently seen during the surgical procedure. This is what drove us to conduct this study.

MATERIALS AND METHODS

For this study, 8 Landrace pigs were selected, with similar weights and ages. Their vertebrae were prepared by removing all soft tissues and by individually separating them. We used only the last five lumbar vertebrae, totaling 40 vertebrae.

The screws employed were made of titanium ELI AL 4V, as per the ASTMF136 guideline, 5.5mm wide, 30 mm long. The length of the screw occupied about 80% of the length of the vertebral body.

We divided the vertebrae into four study groups:

Group 1 – comprised of 10 vertebrae where screws were introduced at zero degree;

Group 2 – comprised of 9 vertebrae where the screws were introduced at zero degree, then removed and reinserted at the same angle (zero degree);

Group 3- comprised by 9 vertebrae. The screws were first introduced at 14 degrees, then removed, and reinserted at zero degree;

Group 4- comprised by 12 vertebrae. Here, the crews were first introduced at 28 degrees, then removed, and reinserted at zero degree.

The vertebrae were randomly divided into 4 study groups. All the screws were inserted by the same surgeon, using the same standardized and carefully reproduced technique. Only the left pedicle was employed for introducing the screws.

We started preparing the pedicles by removing a portion of the facet and flattening it. The screw path was made with a 1-cm deep pedicle marker, after which a 3-mm wide tester was inserted up to halfway the first third of the vertebral body. We introduced the screws under direct view, sparing the pedicle cortex and checking for pedicle's cortical rupture throughout the test. The angle was determined with an external fixed guide to the vertebral body, with the zero degree mark on the guide being aligned with the pedicle's center. All screws were inserted and repositioned using this angle marker. On Group

Study conducted at the Discipline of Orthopaedics and Traumatology, ABC's Medical School
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III and IV, where the angle range at pullout strength was tested, the screws were initially inserted at a given angle and then repositioned to zero degree as it was in the control group.

The screws pullout strength was tested by using a universal assay machine INSTRON model belonging to the materials' characterization and development center (CCDM) of the Federal University of São Carlos (Figure 1). The results pointed out the load required to break cortical walls and spongy bone (secondarily) of the vertebrae, and the resultant implant pullout (Figure 2 A/B).

The fixation of the screw on the machine was provided with a device screwed on the upper portion of the pedicular screw (adjusting thread of the insertion key), fixating the opposite end to the assay machine, allowing that the whole pullout strength provided by the apparatus was transferred to the screw (Figure 3).

Another device fixated the vertebra on the machine base, allowing the model to move during tests performance. The device also enabled a cross-sectional adjustment of the pedicular screws direction, assuring the vertical positioning of the device for fixating the screws (such vertical direction is important in order to prevent against vectorial pullout strengths' dispersion).

Figure 1 *- Universal assay machine for testing pedicular screws' pullout strength.*

Figure 2A *- Vertebra with pedicular screw before the pullout test.*

Figure 2B *– Vertebra after screw's pullout test. Here, we can notice the cortical rupture.*

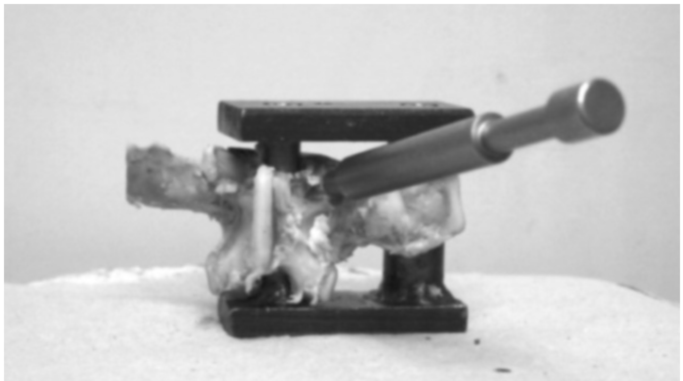

Figure 3 *- Screw fixation device on the assay machine for pullout testing.*

RESULTS

The vertebrae were divided into 4 groups with 10 vertebrae assigned to group I, 9 to group II, 9 to group III and 12 to group IV(Table 1). Group I showed a mean pullout strength of 146.85N, ranging from 131.81N to 165.93N; group II showed a mean pullout strength of 77.34N, ranging from 67.28N to 85.85N. Group III had a mean pullout strength of 97.75N ranging from 88.55N to 105.24N. Group IV had a mean pullout strength of 110.02N, ranging from 93.42N to 119.34N.

Type	Group I		Group II		Group III		Group IV	
	n	%	n	%	n	%	n	%
L1	4	40.0	1	11.1	1	11.1	2	16.7
L2	2	20.0	2	22.2	2	22.2	2	16.7
L3	1	10.0	2	22.2	3	33.3	2	16.7
L4	1	10.0	2	22.2	1	11.1	4	33.3
L5	2	20.0	2	22.2	2	22.2	2	16.7
Total	10	100.0	9	100.0	9	100.0	12	100.0

Table 1 *– Distribution of the types of vertebrae employed on study samples.*

As shown on Table 2, a statistically significant difference was found between experimental groups for mean pullout load of pedicular screws on animal vertebrae ($p < 0.001$), where all groups showed significant differences between each other according to the following sequence of values: Group I > Group IV > Group III > Group II (Figure 4). The control group showed a much higher pullout strength than the other groups. Groups III and IV showed the closest results, but also with a significant statistical difference when compared to each other. Group II showed to have a weaker pullout strength evidencing that the reinsertion at the same angle substantially reduces screws' strength on the vertebra.

Group	Load (Kgf)					
	Mean	s.d.	Median	Minimum	Maximum	n
I	146.85	11.67	143.91	131.81	165.93	10
II	77.34	5.67	78.68	67.28	85.85	9
III	97.75	5.68	98.72	88.55	105.24	9
IV	110.02	7.44	110.16	93.42	119.34	12

Variance analysis: $p < 0.001$*

Table 2 – *Distribution of the values for pullout strength on the different study groups*

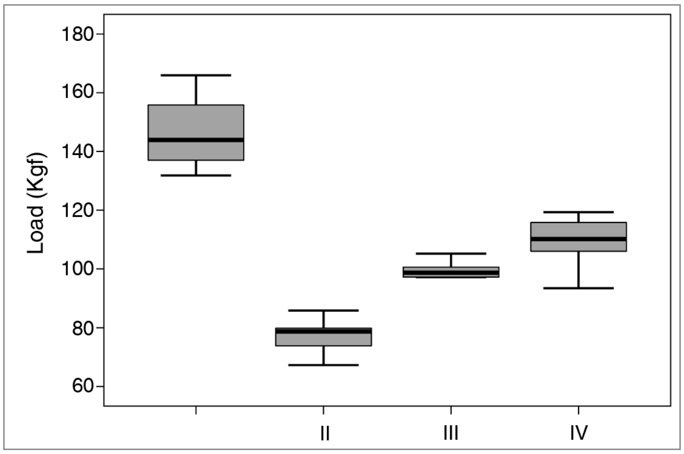

Figure 4 - *Bonferroni's multiple comparisons: I > IV > III > II*

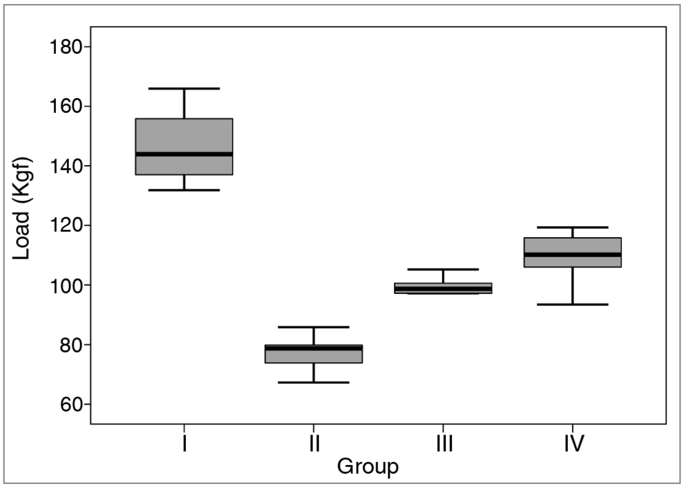

Figure 5 - *Bonferroni's multiple comparisons: I > IV > III > II*

DISCUSSION

Different studies show that the strength presented by a screw, after being inserted into the vertebra, varies according to the interface of the implant with the bone(15). This takes pedicular screw and vertebra into account.

Width is the major factor for stability concerning screws, being the ratio pedicle width vs. screw extremely important(16). The shape (either tapered or cylindrical), length, and kind of thread have a lower significance on apprehension strength(2,12).

The different bone densities among the vertebrae change the vertebral fixation strength(17). Also, on the same vertebra, we find variable bone densities on the different portions of the vertebral body often found in human vertebrae(18); however, this variation is not verified in synthetic models and seldom found in animal models. Hence, we used swine vertebrae, limiting their interindividuality, which was very important in the study, because during angle variation, we need a more homogenous bone density between vertebrae and their difference portions for achieving more accurate outcomes. We must outline the fact that swine lumbar vertebrae show a more homogenous pedicle width, differently from human beings, where there is an increase at craniocaudal direction(19).

Screws positioning towards the head or the tail does not influence pullout strength(9) but, under cyclic load, an increased stress was noted on screws introduced towards the head(20). In this study, we positioned the screws at a caudal angle, following the directions of the best biomechanical construction to subsequently reposition them parallel to the vertebral plateau. The difference from previous studies was that we did not test the angled implants; this was just the first position fixated after reinsertion at zero degree.

The use of adjuvant factors such as methylmethacrilate to increase apprehension strength of the screws in review surgeries and in osteoporotic patients(14), was shown to be a good alternative to increase fixation strength, but always with the risk of cement escaping into the vertebral canal. The association of angle change when inserting screws in these kinds of surgery can be an alternative, requiring comparative studies between the different review techniques and their potential associations.

Due to the wider vertebral pedicle of the swine employed in the study, we should use wider screws for achieving contact between screws and spongy and cortical bone(19). In the current study, we avoided contact with the cortical bone by using narrower screws, because we would not be able to measure how much such contact would influence the results.

On Group II of our study, an important reduction occurred on pullout strength – about 47.33% - even though we expected no significant change, since we reinserted the same screw. This is a result of the torque change at screws reinsertion shown by previous studies: a strength reduction of about 34%(12).

When the angle was changed at screws reinsertion, a reduced pullout strength loss was found since there is more bone around the screw, thus weakening less the interface between the implant and the surrounding bone, thus reducing less the implants' pullout resistance. This study suggests that, in review surgeries, the insertion path should be changed, and not simply using wider or longer screws with the purpose of accomplishing a better implants fixation.

CONCLUSION

Pedicular screws repositioning should be avoided. Should the repositioning is necessary, it must be done by changing the repositioning angle. It is recommended to increase the repositioning angle.

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