

BONE DECORTICATION IN SPINAL GRAFT INTEGRATION – AN EXPERIMENTAL STUDY

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SUMMARY

An experimental study was conducted aiming to evaluate the influence of bone decortication for autologous bone graft integration. Fifteen undefined-race adult dogs of both genders, supplied by the General Animal Lab of the Medical School, University of São Paulo, in Ribeirão Preto, were used. The first lumbar vertebra was selected for study purposes, with surface decortication of the vertebral layer through the right side. Bone grafts removed from L1 and adjacent vertebrae's spinous processes were bilaterally apposed on the L1 layer. The animals were divided into experimental groups according to the period of sacrifice (1 month, 3 months, and 6 months), with each

group comprising 5 animals. Histological evaluation by means of microscopy was the method employed in the study, and it has shown differences in bone graft incorporation between decorticated and non-decorticated surfaces of the vertebral layer. Those differences were seen on animals sacrificed within 1 month and 3 months postoperatively, with a stronger bone integration seen at the place where the vertebral layer was decorticated. Within 6 months postoperatively, no differences were seen among vertebral layers' surfaces (decorticated and non-decorticated), with full bone repair on both surfaces.

Keywords: Arthrodesis, Bone graft, Spine

INTRODUCTION

Spinal cord surgery history and development are closely related to the arthrodesis of this segment of the locomotive apparatus, and since the first descriptions of upper arthrodesis of the spinal cord, reported by Albee and Hibbs in 1911, as a treatment for deformities caused by vertebral tuberculosis, this procedure has been largely used in the scope of spinal cord surgery⁽¹⁾. In 1924, Hibbs was the first to describe the joint facets' and vertebral lamina's decortication technique to hasten arthrodesis incorporation process, and such decortication of the

arthrodesis area surface over which bone graft is placed, has been used as an important stage of the surgical technique in vertebral arthrodesis procedures⁽²⁾. However, although decortication is largely employed during arthrodesis, and although it is frequently mentioned on surgical technique descriptions, its influence is not totally clear, therefore, this was the reason for performing the present study, of which major objective was to assess the influence of bone surface decortication in the integration of a bone graft placed over it.

Study conducted at the Department of Biomechanics, Medicine and Locomotive Apparatus Rehabilitation, of the Medical College of Ribeirão Preto – USP.

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MATERIALS AND METHODS

Eighteen adult, undetermined-strain dogs of both genders, supplied by the General Animal Lab of the Medical College of Ribeirão Preto – USP were used.

The first vertebra of dogs' lumbar spine was selected for the study due to its easier surgical access and also due to its dimensions. The experimental model employed consisted of the bilateral exposure of this vertebra's laminae, with decortication being performed on the right side with the use of an osteotome with thin and narrow blade, while the left lamina surface remained intact.

The surgical procedure was performed with the animals under anesthesia via endovenous with Sodium Nembutal * 33 mg/Kg and positioned in ventral decubitus on the surgical table.

After asepsis, antisepsis and surgical drapes placement, an 8-cm incision was performed on L1, which was bilaterally exposed and prepared as described above. Spinal processes of L1 and L2 were dried and prepared for being used as a bone graft, which was placed on the decorticated vertebra lamina at the right side, and on the intact vertebra lamina at the left side. (Figure 1)

After bone graft placement and homeostasis, muscles were bilaterally placed close to each other at the medial direction and sutured with Vicryl 2.0**. Subcutaneous tissue and the skin were also sutured with Vicryl 2.0**. At the immediate post-operative period, 1,200,000 IU penicillin benzatin were administered via intramuscular and no ambulation restraints were imposed to animals. Animals were divided into experimental groups according to the sacrifice period, which was performed within one, three and six months after the procedure.

*Nembutal- Abbott ** Vicryl-Ethicon

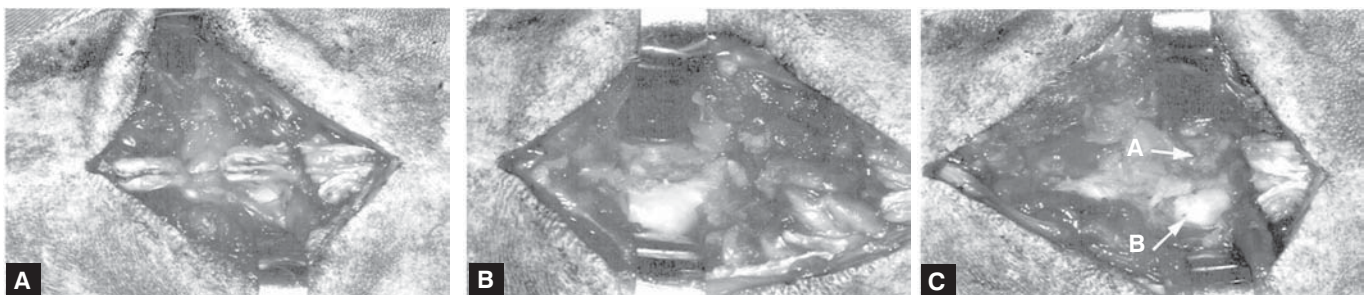


Figure 1 - Photograph showing key phases of the surgical procedure. Surgical exposure of the first lumbar vertebra. A) Spinous process removal. B) Bone graft placement. C) on the decorticated surface (arrow A) and on the non-decorticated surface (arrow B) of the vertebral lamina.

The histological study of the interface between bone graft and vertebral lamina was the assessment method chosen, with the histological study being performed by means of light microscopy with 5 -6 μ sections and staining with HE (hematoxylin-eosin) and Gomori's Trichromic.

RESULTS

The results of the histology analysis will be presented according to animals' sacrifice period (one, three, and six months postoperatively), by comparing the results of the vertebral lamina's decorticated surface to the contralateral one, in which the lamina remained intact.

In animals sacrificed within one month after surgery, a bone neoformation was seen at both sides. Both bone surfaces (decorticated and non-decorticated) showed bone neoformation and fibrosis (Figures 2 and 3). Decorticated surface presented with fibrous tissue trespassing host bone and adhering the graft to the receptor bed, with this fibrosis not being observed on the non-decorticated surface. The lack of bone graft adhesion to receptor bed was the difference noticed between the non-decorticated surface and the contralateral side. The staining with Gomori's Trichromic stains collagen tissue in blue and high-lighted the fibrosis presence on the decorticated surface of the vertebral lamina (Figure 4).

In animals sacrificed within three months, a bone neoformation was observed in the interface between the graft and the receptor bed on both sides of the vertebral lamina, and the neoformed bone tissue presented with thicker and more interlaced trabecula (Figure 5A). The decorticated surface of the vertebral lamina presented bone neoformation with thinner and more interlaced tra-

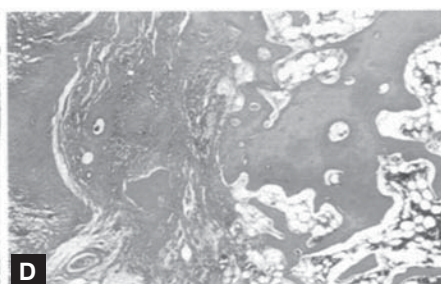
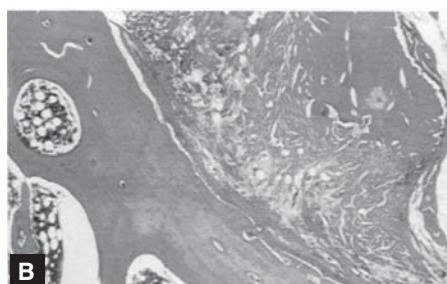
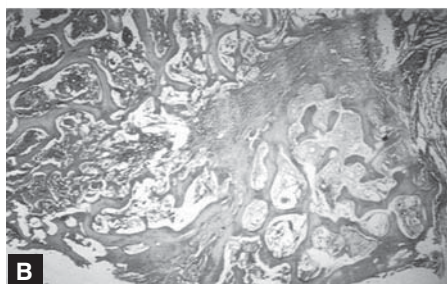
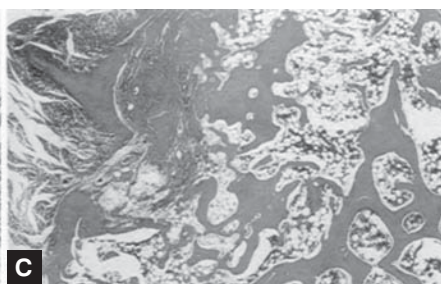
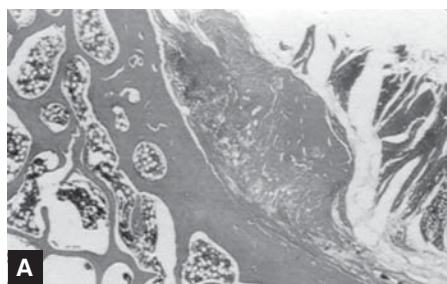
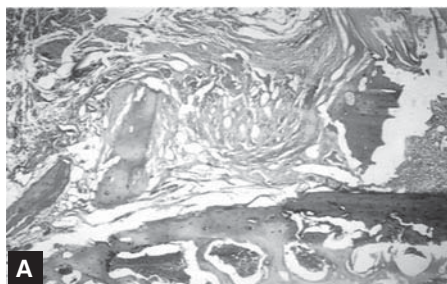


Figure 2 – Photomicrograph of an animal sacrificed one month after the surgical procedure (HE.200x). **A)** shows a non-decorticated side. **B)** shows a decorticated side of the vertebral lamina.

Figure 3 – Photomicrograph of an animal sacrificed one month after surgery **A/B)** Correspond to the non-decorticated surface of the vertebral lamina, stained with HE and magnification of 200x (A) and 400 x (B). **3C/D)** Correspond to the decorticated surface of the vertebral lamina, stained with HE and magnification of 200 x (C) and 400 x (D).

becula, more intensively accompanied by fibrosis and adhesion to host bone when compared to the contralateral non-decorticated side (Figure 5B). In animals sacrificed within three months it was still possible to differentiate between the decorticated and the non-decorticated sides of the vertebral lamina, and the neoformed bone tissue on the decorticated surface more strongly penetrated in the host bone (Figures 6 and 7). In animals sacrificed within six months, the differentiation between the decorticated and the non-decorticated surface of the vertebral lamina was no longer possible, and the fibrous tissue had been reabsorbed, indicating bone graft incorporation to the receptor bed, both on decorticated and non-decorticated surfaces. Bone graft was totally incorporated to receptor bed and the interfa-

ce between bone graft and receptor bed was no longer present (Figures 8 and 9).

The histological study enabled to observe differences on animals group sacrificed within one and three months after bone graft placement, suggesting that the decortication of the bone receptor surface influenced on union process. In the group of animals sacrificed within six months, bone graft and the receptor bed formed a single bone block and decortication or maintenance effects on vertebral lamina's cortical bone could not be noticed.

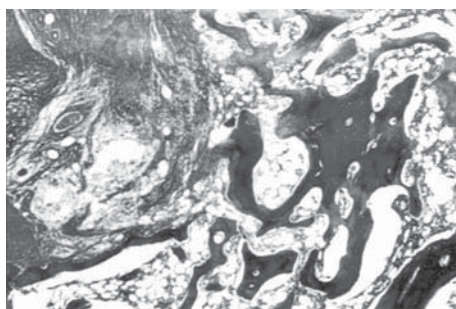


Figure 4 - Photomicrograph of a decorticated surface in an animal sacrificed one month after surgery (Gomori's T. 200x).

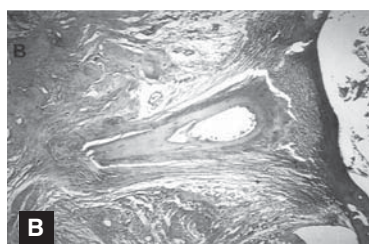
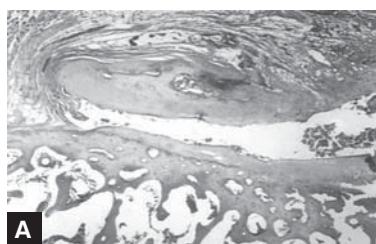


Figure 5 – Photomicrograph of an animal sacrificed three months after surgery (HE 200 x). **A)** corresponds to the non-decorticated surface of the vertebral lamina. **B)** corresponds to the decorticated surface of the vertebral lamina.

DISCUSSION

Bone tissue presents the ability to regenerate after being injured, so that injuries repair does not show cicatricial tissue in its late phase, as occurs with other body tissues. Such bone tissue repair occurs through bone

neof ormation and that repair can be widened by means of bone graft use. Those bone tissues' properties have been well-known for years, and have been used as a rationale basis to uncountable surgical therapies in the locomotive apparatus scope ⁽³⁾.

The early events of non-vascularized bone graft union, whether they come from cortical or spongy bones, are identical and histologically characterized by early bleeding, followed by a nonspecific inflammatory process. Bone graft is filled with fibrovascular tissue from a host tissue, which drives osteogenic cells and blood vessels into the bone graft. At the moment of bone graft placement, viable cells exist within bone marrow, and those cells are subjected to a fast necrosis process.

However, those few surviving bone graft cells may strongly contribute to bone graft union ^(4,5). Spongy tissue exposure by means of bone lamina decortications could ease this bone graft union phase, because, according to studies by Heiple et al ⁽⁶⁾, spongy bone grafts show a faster incorporation when compared to cortical bone grafts. However, one must consider that the variable studied here was the receptor bed, not the graft employed.

Although histological differences on cortical and spongy bone grafts incorporation are well established, the role of

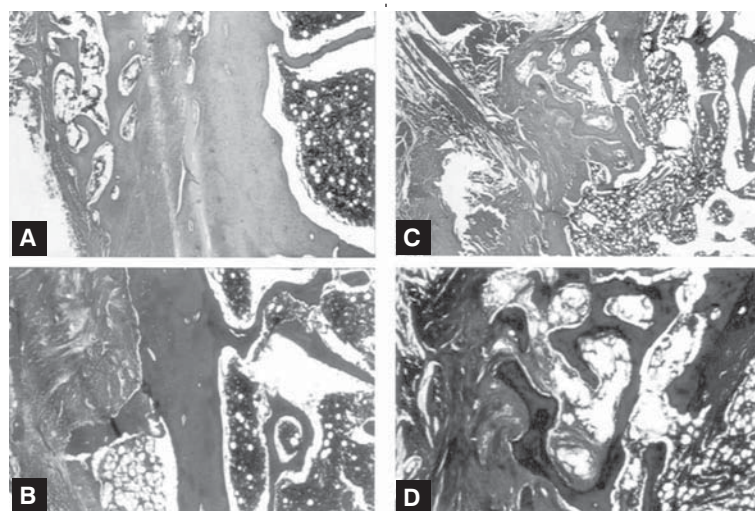


Figure 6 - Photomicrograph of an animal sacrificed three months after surgery. **A/B)** correspond to the non-decorticated surface of vertebral lamina with 400 x magnification (A) and 200x(B), stained with HE (A) and Gomori's T. (B). **C/D)** correspond to the decorticated surface of the vertebral lamina. Stained with HE and with 200 x magnification (C) and Gomori's T. with 400 x magnification (D).

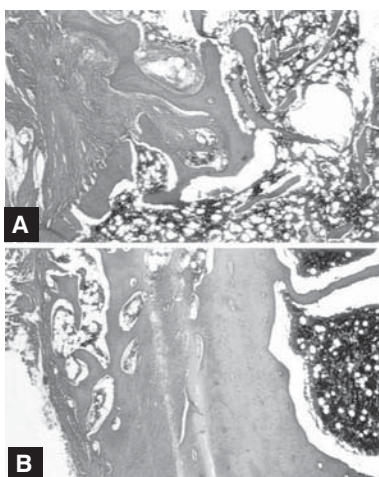


Figure 7 - Photomicrograph of a decorticated surface in an animal sacrificed within three months, stained with HE and with 400 x magnification. **A)** (200x magnification) and **B)** (400x magnification)

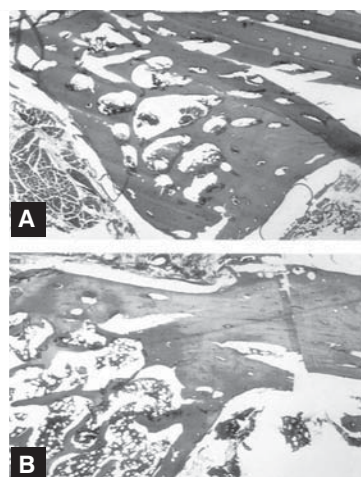


Figure 8 - Photomicrograph of an animal sacrificed six months after surgery (HE 200x). **Figure A)** corresponds to the decorticated surface of the vertebral lamina. **Figure B)** corresponds to the non-decorticated surface.

the bone graft's receptor bed has not been clearly evidenced in literature, and, even so, the receptor bed decortication remains as a currently used procedure, despite increasing bleeding and the time for performing the surgical procedure ⁽²⁾.

Performing decortication is not an absolute pre-requirement for bone graft incorporation occurrence, and as experimentally observed, its performance didn't change arthrodesis' incorporation rates in the presence of stiff fixation of the vertebral segment in arthrodesis ⁽⁷⁾. Nonetheless, its influence was observed in vertebral arthrodeses of unstable segments and without stiff fixation ⁽⁷⁾. The release of local growth factors, which would be caused by receptor bed decortication, has also been suggested as

one of the factors explaining the hastening of bone graft incorporation process ⁽⁸⁾. In our study, we could see that the bone graft's receptor bed decortication has influenced on the early phases of the bone graft incorporation process, allowing for a greater union of the graft to the host tissue. However, no differences were seen in longer follow-up periods, with a full graft incorporation to host being observed, regardless of decortication. Those observations suggest that the influence of decortication occurs only at the early phases of the bone graft incorporation, so that

the advantages related to its use, although common in clinical practice, still lack scientific proofs.

CONCLUSIONS

Receptor bed decortication has influenced bone graft incorporation in its early phases, with incorporation process hastening being observed. However, after the third month, no differences were seen, and in the animals sa-

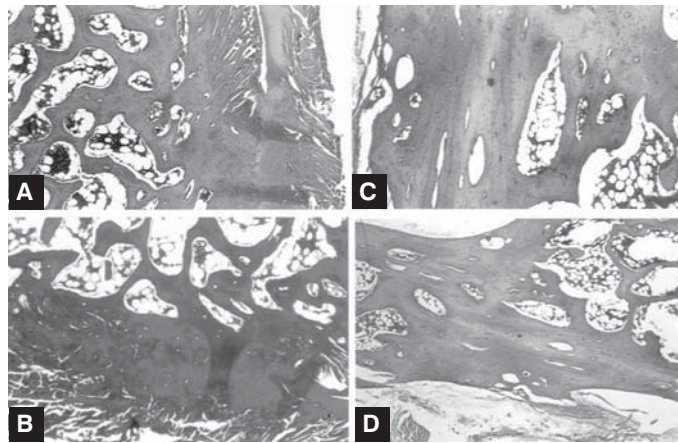


Figure 9 – Photomicrograph of an animal sacrificed six months after surgery. Figures **A/B** correspond to the non-decorticated surface of the vertebral lamina, stained with HE and 200 x magnification (A) and stained with Gomori's T and 400 x magnification (B). Figures **C/D** correspond to the decorticated surface of the vertebral lamina, stained with HE and 400 x magnification.

crificed within 6 months the decorticated receptor bed could not be distinguished, with the full incorporation of the bone graft to the receptor bed being seen both at the decorticated and the non-decorticated sides.

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