

Clinical Sheet

EQUINE-DERIVED BONE SUBSTITUTES IN GUIDED BONE REGENERATION OF A SEGMENTAL DEFECT

In-vivo comparison between autologous and heterologous bone grafts in bone regeneration of a rat femur.



From the Bioteck Academy Editorial Staff

Guided Bone Regeneration (GBR) is a surgical bone regeneration technique that entails placing a membrane between soft tissues and bone graft. The membrane acts as a barrier, in order to prevent colonization of the graft site by the more rapidly proliferating soft tissue cells, which might interfere with the osteogenesis process. It also stabilizes the graft and prevents the micromovements that may hinder the regenerative process. Ideally, the membranes used in the GBR technique should have features that allow them to suitably protect the bone tissue long enough for complete regeneration. Although the autologous bone graft is considered the gold standard for regenerative procedures thanks to its osteoconductive, osteoinductive and osteogenic properties, equine-derived bone grafts can be considered viable substitutes, especially considering the risks associated with the removal of autologous bone. In fact, it requires a second surgical site for its harvesting and the quantity of tissue that can be taken is limited.

This study compares the effectiveness, in terms of bone regeneration, among the use of an autologous bone graft and an equine-derived bone graft protected with a resorbable membrane only, in the case of GBR procedures performed on segmental defects in rat femur.

Materials

Before performing GBR surgeries, rats were distributed into 3 groups according to the biomaterial used: a negative control group (NG) in which the segmental defect was not filled; a positive control group (GP) in which the defect was filled with fragmented autologous bone, derived from the defect itself; a group in which the defect was filled with equine-derived bone substitutes

(GE) composed of a 1:1 mixture of cancellous and cortical granules (Bio- Gen, Bioteck) of size 0.5-1 mm, obtained through the exclusive Zymo-Teck enzymatic process, capable of completely removing antigenic components, without applying high temperatures or using organic solvents. Resorbable membrane obtained from equine tendon collagen (Biocollagen, Bioteck) was used in each group.

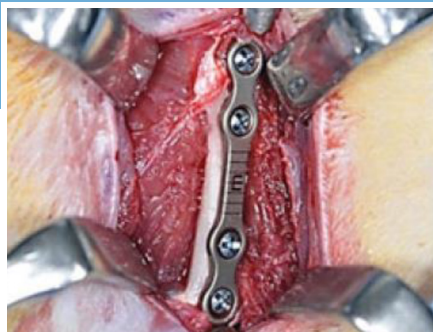


Fig. 1 - Mini-plate fixed to the anterolateral portion of the femur before creating the segmental defect.

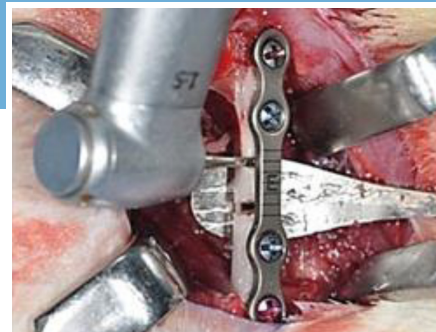


Fig. 2 - 5mm segmental defect created along the femoral diaphysis by means of a bur.

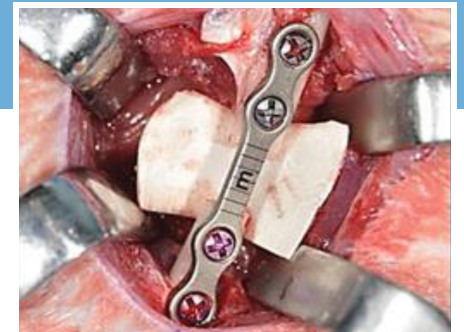


Fig. 3 - Resorbable collagen membrane placed around the defect, in all study groups.

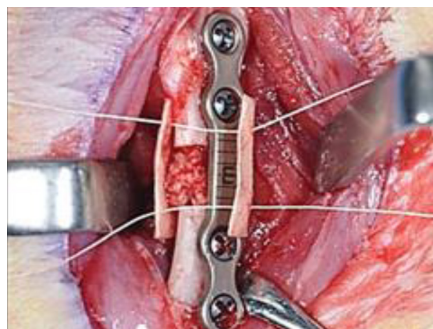


Fig. 4 - Autologous bone graft placed on the defect.

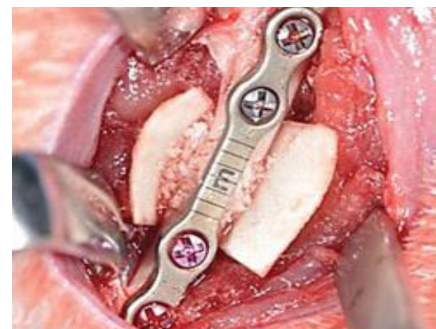


Fig. 5 - Equine-derived bone graft placed on the defect.

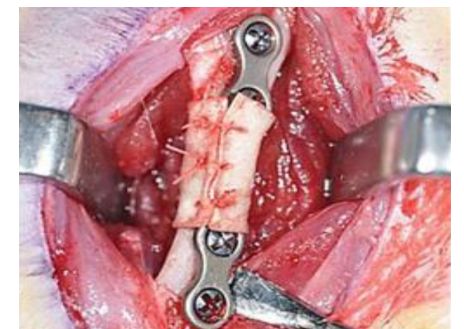


Fig. 6 - Membrane stabilized around the defect by means of resorbable sutures.

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In-vivo comparison between autologous and heterologous bone grafts in bone regeneration in the rat femur.

Results

The sheet illustrates the results of a study published in 2018¹ in which 30 male albino Wistar rats underwent GBR following the creation of a 5mm segmental defect along the femoral diaphysis surgically. The defect was created at the median portion of the femur after placing an osteosynthesis plate.

Immediately after the GBR procedure and after 2, 4, 6 and 8 weeks, *in-vivo* micro-Computed Tomography (micro-CT) scans were performed in order to measure some parameters characterizing the newly formed bone tissue, i.e. volume (in mm³) and mineral density (in g/mm³) of the newly formed bone (NFB) and those of the residual biomaterial (remaining bone graft particles – BGP). The surgery, the micro-CT procedures and the post-operative course were without complications. Micro-CT analyzes showed an increase in NFB volume in each study group, although very limited in GN.

From the fourth week onwards, the average NFB volume in the GE group was greater than in the control groups, and by the eighth week it reached the value of 53.24 mm³ against 26.07 mm³ of the positive control and 5.60 mm³ of the negative control. The largest volume increase related to the formation of new bone tissue was observed in the GE group. The NFB mineral density increased in all groups.

In the GE and GP group, both the volume and mineral density of BGP underwent a significant reduction over the entire time period considered (8 weeks).

The study shows that the use of equine-derived grafts is associated with a significant increase in bone volume and mineral density as early as from the first 2 weeks after GBR surgery.

1. Binsalah, M.A., et al. Guided Bone Regeneration of Femoral Segmental Defects using Equine Bone Graft: An In-Vivo Micro-Computed Tomographic Study in Rats. *J Invest Surg*, 1-11 (2018).

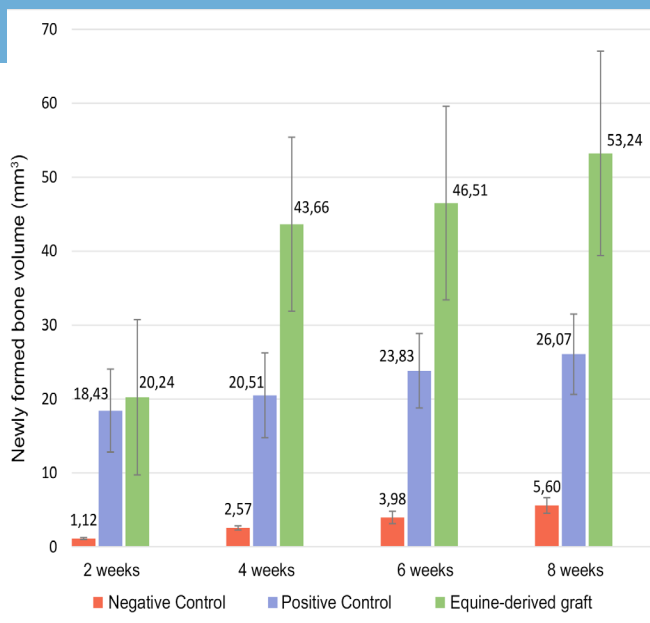


Fig. 7 - Volume of the newly formed bone tissue in mm³, measured in the 3 groups 2, 4, 6 and 8 weeks after the procedure. Note how the group treated with equine grafts shows a significantly higher increase than the positive and negative control groups.

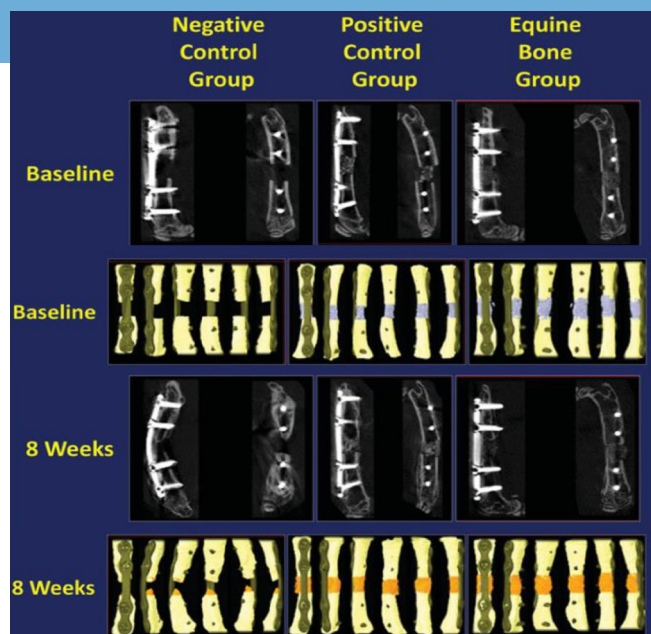


Fig. 8 - *In-vivo* longitudinal and coronal scans and reconstructed three-dimensional micro-Computed Tomography images at the segmental defect generated along the femoral diaphysis in the 3 groups immediately after GBR surgery and after 8 weeks. Note how in both the GP and GE groups, the graft (baseline, lilac) was replaced by newly formed bone (8 weeks, orange).