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Biomaterial Implants in Bone Fractures Resulting from Rat Fibulae

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Abstract

To assess the role of collagen and hydroxyapatite in the healing of experimentally generated fractures in rat fibulas. 15 rats were utilised as the method. Surgery was performed on these to reposition a fragment from the fibula. A silicone tube graft containing hydroxyapatite and collagen was then applied to this location. Results: Almost no new bone growth Third-year medical student at Brazil's Judie School of Medicine. A fourth-year medical student at Brazil's india School of Medicine. PhD. Adjunct Professor at the Judie School of Medicine in Jundia, SP, Brazil in the Department of Morphology and Basic Pathology, Discipline of Anatomy. Work created in the Morphology and Basic Pathology Department at the undia School of Medicine in Jundia. Occurred inside the biomaterial-filled tubes. In the tubes containing colla- gen, there was greater neoformation. Conclusion: Even in bones with secondary mechanical and morphological functions, like the rat fibula, the biomaterials used demonstrated biocompatibility and osteoconductive capacity that was able to stimulate ontogenesis.

Keywords: Durapatite; Fibula; Collagen; Ontogenesis

Introduction

Traumatic fractures have become more common in recent years, mostly as a result of car accidents and conditions that impact the bone metabolism. As a result, numerous orthopaedic treatments have been researched for stimulating and speeding bone regeneration. Among these, the use of basic bone grafts has been highlighted in clinical situations of comminute or explosive fractures where a graft may be required due to the significant loss of bone mass, depending on the trauma energy or severity of the bone disease. The use of biomaterials has been highlighted because of their oestrogenic qualities and biocompatibility, together with the possibility of association with autogenously bone transplants or other variables that induce ontogenesis, as an alternative to treating these fractures. given the improvements in transportation engineering, with the ease of construction. In many studies looking for synthetic implants that might be ideal for osteoconduction, biocompatibility, and biomechanics resistance during the repair process on bone defects or in regeneration from fractures, hydroxyapatite- tite and collagen are among the various materials that have been receiving special attention [1-5].

Methods

Good bone conductibility in hydroxyapatite affects the rate of absorption and is mostly controlled by the porosity of the substance. Ontogenesis and Osseo integration of the biomaterial are stimulated by direct steady contact between this biomaterial and the bone. In a study by Nandi to test the effectiveness of porous hydroxyapatite in filling in goats' diaphysis of the radius bone defects, the material's inherent biological osteoconductive properties were confirmed by the good bone growth and revascularization in the treated area. Hydroxyapatite is indicated for the treatment of cranial maxillofacial abnormalities, traumatic injuries, and congenital malformations. It can also be utilised in cosmetic surgery [4].

Collagen is a key component of medical applications due to its biocompatibility and stability, which are a result of its biological properties of biodegradability and bio absorbability, antigenic debility, and ease of manipulation into various shapes. To cure inherited and acquired orthopaedic abnormalities, Takaoka combined hydroxyapatite and collagen from demineralized bone. According to their findings, hydroxyapatite and collagen from demineralized bone grafts were good osteoinductive materials when combined with bone morphogenetic protein (BMP). The current study's objective was to assess the osteoconductive capacity of hydroxyapatite and collagen in bone repair deficiencies brought on by the partial excision of the middle third of the rat fibula [6].

Silicone tube in the Fibula

In this study, 15 adult albino Wistar rats from the vivarium of India School of Medicine were employed. Following is how the animals were divided: Animals in Groups TS, TH, and TC each received a silicone tube in the fibula defect that was filled with either collagen or hydroxyapatite. Group TS received an empty silicone tube, Group TH received a silicone tube filled with hydroxyapatite, and Group TC received an empty silicone tube [7].

First, the animals were weighed and given an intramuscular dose of 0.10 ml/100 grammes of body weight of a solution containing xylazine hydrochloride and ketamine hydrochloride (Francotar), at a ratio of 1:1. A longitudinal incision was performed in the skin of the anterolateral region of the left leg while the animals were in dorsal decubitus. The muscles were pushed aside to reveal the fibula. A defect was created by removing around 2 mm from the middle section of the fibula with the help of surgical supplies. Silicone tubes were installed here. The silicone tube's interior in the animals of group TS was observed to be partially filled with connective tissue, with no signs of bone neoformation. In addition, bone tissue proliferated from the fibular fragment toward the implanted tube's end. Along with connective tissue, patches of bone information were seen in the silicone tubes of the animals in groups TH and TC, along with young bone sprouting from the end of the fibular fragment [8].

Clinical restrictions on the use of autogenous bone grafts in

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fractures with bone loss have prompted several studies to advances in the field of tissue engineering and biomaterials, with the goal of creating synthetic materials that would be able to promote rapid ontogenesis and incorporation with bone tissue through osteoconductive and osteoinductive stimulation, without generating rejection complications associated with their use, as an essential bio comparison tool. These prerequisites are met by hydroxyapatite and collagen, which are attracting a lot of attention in the disciplines of plastic surgery, orthopaedics, and dentistry [9].

Osteoblasts proliferated rapidly and there was significant neovascularization when the implant was present. Camilli placed hydroxyapatite implants subperiosteally in the femurs of rats and noted good bone neoformation and biocompatibility there. Pinheiro similarly reported similar outcomes from the implantation of hydroxyapatite in an experimentally produced bone deficiency in the distal third of rats. Cunha placed collagen in rat femur deformities and observed that the area had healed well since a lot of bone had grown there. Biomechanical studies revealed that the regenerated area had acceptable mechanical quality, they concluded. In addition to the significance of biomaterial implants exhibiting osteoconductive and biocompatible properties for the process of bone regeneration, the mechanical quality and kind of Fundamentals include embryological ossification of the bone. The femur, an endochondral bone, responded to hydroxyapatite implantation better than the skull cap, which develops from membranous ossification, according to Camilli. According to Raab, the resistance and development of the bone tissue were impacted by the mechanical function of the bone. As a result, it is clear from the literature that the majority of investigations on biomaterials have utilised the rat femur and tibia due to their excellent biomechanical capacity and endochondral origin, which is crucial for the bone's oestrogenic function [10].

Since the axis of the distal diaphysis of the tibia merges postnatally with the fibula, it is clear that the fibula in rats exhibits morphological characteristics. Around the seventh day, this process begins with the development of secondary cartilage, which is later replaced by endochondral ossification. As a result, the biomechanical quality and significance of the fibula are minimal. According to definition, the rat fibula plays a reciprocal role in controlling the tibia's growth. Due to the fibula's limited biomechanical influence and the minimal gravitational force it experiences, fractures may not heal properly because of insufficient antigenic and oestrogenic activity.

Oestrogenic Activity

We learned through our inquiry through the previously described anatomical characteristics of the fibula Compared to the results reported in the literature utilising the femur and tibia, the amount of bone that formed inside the tubes with biomaterials that had been implanted in the bone defects of the fibula of the rats was little. Moreover, the empty tubes that were inserted had no bone neoformation. This might have happened due to the fibula's secondary biomechanical role brought on by its fusion with the tibia and the resulting poor antigenic and oestrogenic activity. These fibula morphological traits indicate that in the current investigation, the amount of time the implant was left in place before the animals were sacrificed was insufficient for the full process. Despite the small amount of bone neoformation in our investigation, the biomaterials employed demonstrated osteoconductive capacity. However, other elements that are crucial to the ontogenesis process include the embryology, ossification type, shape, and biomechanics of the investigated bone.

Conclusion

Therefore, in cases of bones like the rat fibula for which the biological qualities and mechanical parameters are not yet well defined, there is a need to develop a better standardised and more scientifically based experimentation protocol because these are factors that directly interfere with the anticipated results regarding the bone regeneration process.

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