BIORESORBABLE POLYMERIC MENISCAL PROSTHESIS: STUDY IN RABBITS

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ABSTRACT

Objective: To induce growth of a neomeniscus into the pores of a prosthesis in order to protect the knee joint cartilage. Methods: 70 knees of 35 New Zealand rabbits were operated. The rabbits were five to seven months old, weighed 2 to 3.8 kilograms, and 22 were male and 13 were female. Each animal underwent medial meniscectomy in both knees during a single operation. A bioabsorbable polymeric meniscal prosthesis composed of 70% polydioxanone and 30% L-lactic acid polymer was implanted in one side. The animals were sacrificed after different postoperative time intervals. The femoral condyles and neomeniscus were subjected to histological analysis. Histograms were used to measure the degradation and absorption of the prosthesis, the growth of meniscal tissue in the prosthesis and the degree of degradation of the femoral condyle joint cartilage. Results: The data obtained showed that tissue growth histologically resembling a normal meniscus occurred, with gradual absorption of the prosthesis, and the percentages of chondrocytes on the control side and prosthesis side. Conclusion: Tissue growth into the prosthesis pores that histologically resembled the normal rabbit meniscus was observed. The joint cartilage of the femoral condyles on the prosthesis side presented greater numbers of chondrocytes in all its layers.

Keywords – *Knee; Cartilage; Prostheses and implants*

INTRODUCTION

It has long been known that meniscectomy on the human knee has medium and long-term harmful effects, especially considering that the force distribution becomes significantly modified. The contact area decreases, thereby producing increased concentration of contact forces in a smaller area. This may accelerate degeneration of the joint surface, thus resulting in early osteoarthrosis[1-5].

In the absence of better alternatives, meniscal injuries have been treated over the years purely and simply by removing the meniscus, independent of the type and duration of the injury or the patients' activities and ages. Young, physically very active patients who are sports players sometimes injure the meniscus so badly that there is no way out other that total meniscectomy.

Over the last 25 years, particularly since the advent of arthroscopy, many authors have shown concern regarding meniscus salvage[6-10].

Different techniques have been used over recent decades with the aim of preserving the healthy parts of menisci. Sutures, transplants and meniscal prostheses have been among these. Tissue engineering suggests a very promising future. As new knowledge within the fields of medical genetics, immunology, biochemistry and bioengineering is acquired, further alternatives for treating various human diseases are emerging.

Research on the use of meniscal prostheses composed of nontoxic, biocompatible and bioabsorbable material seems to be a field of great interest, since this brings the hope of mechanical protection for knee joint cartilage following loss of the menisci. If such hopes were proven, these patients' joints would present greater longevity, with better quality of life for them.

The aim of this study, which was conducted on rabbits, was to evaluate the growth of a neomeniscus into the pores of a meniscal prosthesis and the degree of

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protection given to the joint cartilage of the medial femoral condyle. This prosthesis was developed from a membrane composed of bioabsorbable polymers. With degradation of the prosthesis, its components would be absorbed, thereby making room for the growth of fibrocartilaginous tissue that would histologically resemble the normal medial meniscus of rabbits.

METHODS

Rabbits

Operations were performed on 70 knees of 35 New Zealand rabbits of ages ranging from five to seven months and weights from two to 3.8 kilograms. There were 22 males and 13 females. Two groups were formed. In group A, consisting of 17 rabbits, arthrotomy and juxtacapsular medial meniscectomy were performed on the left knee, while the right knee received these procedures plus implantation of a meniscal prosthesis. In group B, with 18 rabbits, the implant was inserted in the left knee, while the right knee only received arthrotomy and medial meniscectomy.

Prosthesis

The prosthesis implanted was composed of a polymeric mixture of 70% polydioxanone and 30% L-lactic acid polymer, with 3% sodium triethyl citrate as a plasticizer. The prostheses were individually packed in small envelopes and were sterilized with ethylene oxide.

Prosthesis manufacture and characteristics

To manufacture the prosthesis, pieces of PDS®[1] suture thread of 2 cm in length were cut and placed in a solution of methylene chloride at room temperature. This solution was stirred mechanically for 24 hours, in order to extract its violet pigmentation. The resulting polymer [poly(p-dioxanone)] was dissolved in 6 ml of hexafluoroisopropanolol (HFIP) solvent at room temperature and was stirred mechanically for one hour. The other polymer used in the composition of the prosthesis was poly(L-lactic acid)®[2], which was obtained commercially in liquid form.

The two polymeric solutions were mixed and stirred for a further hour, until completely homogenized. The plasticizer sodium triethyl citrate was then added, with stirring for another hour. The final mixture was poured into a glass mold of 1,500 mm^2 in area (50 x 30 mm) and was left to evaporate slowly in an evaporating chamber overnight, in order to form a thin porous membrane. This membrane was then dried under vacuum until the solvent had completely evaporated. It was then cut using a puncturing instrument into half-moon shapes with the following dimensions: length of 0.8 cm along the longitudinal axis, width of 0.4 cm along the transverse axis and thickness of 1 mm uniformly along the entire length (Figure 1).

Surgical technique

The animals were kept under absolute fasting conditions for 12 hours before the operation. They were subjected to general anesthesia, with intramuscular administration of 5% ketamine hydrochloride at a dose of 30 mg/kg of weight, in association with 2% xylazine at a dose of 3 mg/kg of weight and atropine at a dose of 0.2 mg/kg de peso. The area of the incision was shaved immediately before starting the surgical procedure.

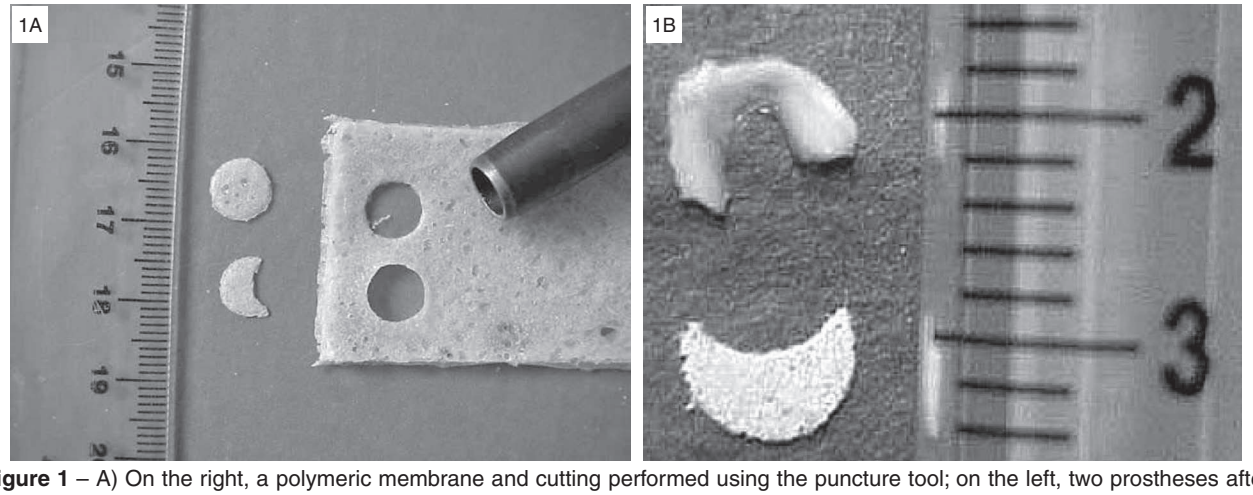

Figure 1 – A) On the right, a polymeric membrane and cutting performed using the puncture tool; on the left, two prostheses after cutting them out. B) On the right, a meniscal prosthesis; on the left, a rabbit's normal medial meniscus