

Viability of Periosteal Tissue Obtained Postmortem

Shawn W. O'Driscoll, Borna Meisami, Yasushi Miura, and James S. Fitzsimmons

The Cartilage and Connective Tissue Research Laboratory, Mayo Clinic, Mayo Foundation, Rochester, MN

Periosteal autografts have the potential to regenerate articular cartilage defects, but this potential is limited by the patient's age. Allograft transplantation from a young donor to an older recipient might bypass this limitation. The effect of the time delay, between death and harvesting of a periosteal graft, on the chondrogenic potential of periosteum is important not only for transplantation but also for studies dealing with tissues retrieved postmortem (i.e., including the periosteal explant model). The purpose of this study was to investigate the chondrogenic potential of periosteum obtained postmortem and a possible beneficial effect of hypothermia. Thirty NZ white rabbits (2 months old) were sacrificed and stored at room temperature or 4°C for 0, 4, 6, 8, 12, 16, 18, or 24 h. Periosteal explants were then obtained and a standard cartilage yield assay performed by culturing them for 6 weeks using the periosteal organ culture model as previously published. TGF- β 1 (10 ng/ml) was added for the first 14 days of culture. Histochemical analysis and quantitative collagen typing were performed. In the explants from the animals kept for 4 h at room temperature growth and chondrogenesis were dramatically reduced. Little or no chondrogenesis was seen in explants from rabbits maintained at room temperature after 4–8 h (or more) postmortem. Cooling the rabbits to 4°C partially prevented this loss of viability and continued to do so for 24 h. Even storage at 4°C did not eliminate the decrease in chondrogenic potential, though it did permit partial preservation of chondrogenic potential. If periosteum is to be used for allograft transplantation, or if it is used for experimental study, its viability must be assured. This is best accomplished by harvesting it immediately postmortem. Preservation techniques, cryopreservation, or hypothermia might be useful in preserving periosteal chondrogenic potential.

Key words: Articular cartilage repair; Periosteum; Chondrogenesis transplant; Tissue engineering

INTRODUCTION

Periosteal transplants have been shown to have the potential for neochondrogenesis and can be used to repair articular cartilage defects in experimental animals (3,8,15,19,20,23,24,26,28–34). The regenerated cartilage demonstrates long-term durability (20). It also has histological, histochemical, and biochemical characteristics that are similar to those of normal articular cartilage (19). The subchondral bone is restored (19,20).

Periosteal transplantation is being used currently to treat patients with damaged articular cartilage surfaces. The feasibility and potential benefits of this treatment have been documented in several series of human patients (2,4,6,9,16). The major limitations are the variability of cartilage repair and the decline in this chondrogenic potential of periosteum with age, particularly after skeletal maturity (19). However, the main patients in need of such treatments are past skeletal maturity.

The age-dependent decline in chondrogenic potential of the periosteum naturally leads one to consider the possibility of allotransplantation of periosteum from

younger donors. Kreder et al. (10) showed that cryopreserved periosteum can be stored for allotransplantation, and maintain its chondrogenic potential for up to 4 months. Kreder et al. further demonstrated that cartilage repair in adult rabbits could be enhanced by transplanting fresh or stored cryopreserved periosteum from younger rabbits (11). The quality of the regenerated cartilage in adult rabbits that received periosteum from immature donors was comparable to that seen in immature rabbits. In fact, the donor age had a greater effect than did the recipient age or whether the allografts were transplanted fresh or after having been stored frozen. The authors interpreted their observations to suggest that the extracellular matrix produced by the transplants conferred a degree of immunoprotection. This would be consistent with the fact that normally chondrocytes are "isolated" from the body's immune system by the dense, avascular extracellular matrix.

It has been shown that even without their dense, extracellular matrix, it is possible to transplant chondrocytes into articular defects and grow cartilage without eliciting an infiltrative, immunological response from

Accepted June 8, 1999.

Address correspondence to Shawn W. O'Driscoll, Ph.D., M.D., Director, Cartilage and Connective Tissue Research Laboratory, Mayo Clinic, Mayo Foundation, Rochester, MN 55905. Tel: (507) 284-2266; Fax: (507) 284-5075; E-mail: odriscoll.shawn@mayo.edu