INTRODUCTION

Tendon roll implantation is widely used for advanced stage of the Kienböck’s disease. However, the tendon roll collapsed and as a natural consequence, carpal height ratio decreased after the surgery. For better treatment outcome, the tendon roll should be required to satisfy two conditions below:

(1) Tendon roll should have hardness like bone in early period.
(2) Tendon roll should be elastic like a hyaline cartilage.

The purpose of this study was to apply the tissue-engineering technique for advanced Kienböck’s disease. We developed a new tendon roll combined with bone marrow derived mesenchymal stem cells on collagen ceramic composite (Hybrid tendon roll).

MATERIALS AND METHODS

Preparation and culture of marrow cells

From the humerus of 10 weeks Japanese White Rabbit, bone marrow was aspirated and primary culture was done in a 75 cm² flasks. Primary culture was maintained in standard culture condition for 2 weeks. After confluence, cultured cells were released from substratum and reseded in collagen ceramic composite (C.C.) sheets. The subculture was done for 2 weeks with 4 mL of medium supplemented with 10 mM Na β-glycerophosphate, 82 μg/mL vitamin C phosphate, and with 10⁻⁷ M dexamethasone. The culture medium was renewed 3 times a week. After that, using collagen ceramic composite combined with cultured cells (C.C.C.), in vivo experimental study was performed.

Treatment model for Kienböck’s disease

Twenty-one Japanese white rabbits, 14 weeks old, were used for the treatment model of Kienböck’s disease. The lunate of right hand was extirpated carefully using electrical shaver, and three kinds of the tendon roll were interposed into the excision space of lunate as below;

(1) Group A (conventional tendon roll): tendon roll was made of the Achilles tendon.
(2) Group B (cored tendon roll): the tendon roll have a core made by C.C. without cultured cell (The size of core C.C. was 2.0x2.0x2.0 mm³).
(3) Group C (Hybrid tendon roll): tendon roll was made of the Achilles tendon same as group B and C, but C.C.C. was rolled in the tendon (The size of core C.C.C. was 2.0x2.0x2.0 mm³).

In all group, the right wrist was immobilized with cast 6 weeks after surgery. After 12 weeks from surgery, all rabbits were sacrificed.

In radiographic evaluations

The right wrist radiograph was taken after 0, 4, 6, and 12 weeks after surgery to detect callus and bone formation during follow up period.

In histological evaluations

Histological analysis was performed to observe that the cultured cells in C.C.C. differentiates in cartilage and bone tissue after implantation. The specimens were sectioned and evaluated with standard hematoxylin and eosin, safranin O, and toluidine blue stain to revealed bone and cartilage formation in tendon roll at 12 weeks after surgery.

RESULTS

In radiographic findings

Figure 1 show the wrist radiograph of three experimental models. In group A, the deficit areas of the lunate remained radiographic lucent for 12 weeks after surgery. In group B and C, the area of C.C.C. shows a shadow of hydroxyapatite granule in the deficit area of the lunate after surgery. However, the shadow of hydroxyapatite granule decreased gradually. On the other hand, in group C, the small shadow was revealed in the area of the deficit of the lunate after surgery. The shadow gradually increased until 12 weeks after surgery.

In histological findings

In group C, new bone formation has occurred at the center of the hybrid tendon roll. In addition, safranin O was stained at peripheral site of the hybrid tendon roll and fibrous cartilage tissue was present in the area. It suggests that C.C.C has not only osteogenic potential but also capacity of cartilage matrix production. In group A and B, no cartilage matrix was shown intra- and extra- tendon roll (Fig. 2).

DISCUSSION

The results of this study indicated that hybrid tendon roll has not only good osteogenic potential but also capacity of cartilage matrix production in peripheral site of implantation. As well known, cartilage matrix make an important role in biomechanical property of cartilage, therefore, hybrid tendon roll have elastic property like an artificial cartilage. We concluded that this hybrid tendon roll will prevent a collapse of the tendon roll and stop the advancement of wrist osteoarthritis.

In vivo study was performed.

TREATMENT OF KIENBOCK’S DISEASE WITH TISSUE ENGINEERED HYBRID TENDON ROLL IMPLANTATION ARTHROPLASTY -EXPERIMENTAL STUDY -

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