MENISCAL TRANSPLANTATION WITH POROUS POLYMER SCAFFOLD SEEDED WITH ALLOGENEIC SYNOVIAL CELLS IN RABBIT

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**Introduction:** The meniscus has been recognized as a crucial structural element in the knee joint that is responsible for load distribution, shock absorption, knee stabilization, and lubrication. However, it is commonly injured and meniscal insufficiency due to tear or resection is known to induce degeneration of the articular cartilage, hence the importance of restoration of the integrity of meniscus. In that meniscal repair does not necessarily yield satisfactory result, replacement of resected meniscus by allograft has been tried, only to be limited by its availability and potential disease transmission, and the long-term outcome remains to be proved. Artificial prosthetic meniscal replacement with tissue engineering technique is being attempted.

We utilized the biodegradable porous polymer scaffold made of polycaprolactone (PCL) seeded with allogeneic synovial cell to replace the meniscus. The purpose of this study is to evaluate the result of the replacement of the medial meniscus of the rabbit knee with the scaffold made of polycaprolactone for 6 month period by morphological, biochemical, and mechanical aspect, and to assess the efficacy of allogeneic synovial cell seeding into the scaffold. Our hypothesis is that the meniscal replacement with PCL scaffold will enhance the regeneration of the meniscus and that the synovial cell seeding will facilitate the regeneration of the replaced meniscus.

**Materials and Methods:** Biodegradable PCL scaffold with pores sized 100-150 \(\mu\)m and with compression modulus 400kpa were fabricated by melt-molding particulate-leaching method. The molds were made using the native meniscus. To enhance the bonding between the scaffold and the adjacent tissue, the scaffold was dipped into collagen solution. The scaffold was seeded by the allogeneic synovial cell for 2 weeks to compare the efficacy of seeding.

The rabbits were New Zealand White Rabbit, about 12 weeks old, weighing 2.6-3.0 kg. The medial meniscus of the right knees was implanted seeded meniscus and the articular cartilage was assessed by Masson-trichome, and Safranin-O staining. The seeded synovial cells were tracked by PKH-26 fluorescent dye. Biodegradation of the meniscus and the mechanical property seemed favorable.

At 1, 3, 6 months, the regenerated meniscus and the adjacent articular cartilage was harvested and evaluated. Histomorphologically, the gross morphology of the meniscus and the articular cartilage was assessed by Masson-trichome, and Safranin-O staining. The seeded synovial cells were tracked by PKH-26 fluorescent dye. Biochemically, the content of water, collagen, and glycosaminoglycan (GAG) were analyzed. Mechanically, the stiffness on the stress-strain curve was compared to that of the native meniscus.

**Results:** The gross morphology of the regenerated meniscus became more matured with time.

**Discussion:** The regeneration of the meniscus through the synovial-cell seeded PCL scaffold was ascertained, and the maturation proceeded with time. Successful tissue ingrowth and bonding with adjacent tissue were observed. The problem of extrusion of the meniscus remained to be worked out as is the case of meniscal allograft transplantation in humans. The articular cartilage seemed to be protected with the replacement of the meniscus. The result of the analysis of the chemical constituents and the mechanical property seemed favorable.

It has been reported by many authors that the synovial cells play an important role in the healing of the meniscal tear, and the cell proliferation and the GAG production was comparable to the meniscal Fibrochondrocyte in our preliminary study, which is the rationale for the combination of the scaffold with synovial cell in our study.

Meniscal transplantation by PCL scaffold, which is seeded with synovial cell, casts a remarkable prospect on the regeneration strategy of the meniscus, although supplementary studies are needed in the future.

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**Fig 1.** The histology of the regenerated meniscus between femur and tibia (Masson-trichrome staining). The maturation proceeded with time.

**Fig 2.** The histology of the articular cartilage at 6 month. The degeneration proceeded with time, and the degeneration was more severe in the meniscectomy group.

**Fig 3.** Until the 6th month the seeded synovial cell was observed at the inner portion of the regenerated meniscus surrounded by the ingrown viable cells, hence the proven longevity and the supposed function of the seeded synovial cells up to 6 month.