Macroscopic And Histological Evaluation During Repair Process Of Porcine Meniscus Defect Treated By Mechanically Reinforced Atellocollagen Substitute From 1 To 9 Months After Implantation.

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Problems of treatment for meniscal defect

✅ The defect remains after meniscal repair.
   → Difficult to restore meniscal function

✅ The risk of knee osteoarthritis increases after meniscectomy

Fairbank TL. JBJS-B 1948
Novel mechanically-reinforced atelo-collagen substitute for meniscal defect treatment

- Since currently there is no gold standard treatment for meniscal defect, we have newly developed a mechanically reinforced atelocollagen substitute applicable for such defect.

**Atelo-Collagen Meniscal Scaffold - ACMS -**

- **Material:** Bovine Type-I atelo-collagen
- **Structure:** 30-200μm inter-connected pore structure
- **Stiffness:** Comparable to the normal meniscus

Materials & Methods

- Fourteen miniature pigs (28 knees) (10-12 months old, 35-57 kg)
- 3x8 mm defect at the anterior segment of MM
- Fill the defect with ACM by suture.
- Evaluate macroscopically and histologically at 2, 4, 8, 12, 24, 36 weeks after surgery. (n = 4 / group, n = 8 / only 24 week group)
Macroscopic evaluation — grade —

- Healing maturity were macroscopically evaluated and graded from grade I to grade III.

1: Adjacent synovial tissue

- grade I: Nearly normal
- grade II: Reactive
- grade III: Proliferation

2: Remodeling of ACMS

- grade I: Complete replaced
- grade II: Partially replaced
- grade III: Remaining the ACMS

3: Bonding to the host tissue

- grade I: Complete bonding
- grade II: Partial bonding
- grade III: No bonding

4: Meniscal deformation

- grade I: Nearly normal
- grade II: Mild deformation
- grade III: Extensive deformation
Results 1

Macroscopic evaluation

<table>
<thead>
<tr>
<th>Time (W)</th>
<th>Remained ACMS</th>
<th>synovial proliferation</th>
<th>Boundary indistinctness</th>
<th>Replace from the periphery part</th>
<th>Replaced with repaired tissue</th>
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<tbody>
<tr>
<td>2W</td>
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<td>4W</td>
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<td>12W</td>
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<td>36W</td>
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</table>

1: Adjacent synovial tissue

2: Remodeling of ACMS

3: Bonding to the host tissue

No meniscal deformation at all time points
The border of substitute was filled with synovial tissue and the substitute were infiltrated with cells at 1 month. The central part of the substitute was infiltrated with cells, and the substitute was absorbed partially at 2 month.
The majority of the substitute was replaced with fibrous tissue at 3 months. The substitute was almost replaced with a meniscus like tissue containing fibrocartilage-like cells, which was positive with safranin O staining at 9 months.
The ideal role of meniscus material

1. Scaffold for migrating cells

2. Compensation for the meniscal function
   - Maier D et al. J Orthop Res. 2007
Effectiveness of ACMS as scaffold for infiltration cells

① Synovial tissue proliferated and filled ACMS

② Cells infiltrated and ACMS was replaced

③ Regeneration to meniscus-like tissue
Effectiveness of ACMS as compensation of meniscal biomechanical function

No meniscal deformation
Conclusion

The ACMS was infiltrated by newly synthesized cell-rich tissue after 2 weeks and was replaced with meniscal-like tissue from 12 weeks to 36 weeks without deformation, suggesting that the ACMS might function as a scaffold for migrating cells and a load transfer material.