The peri-meniscal capsule is a segregated structure with distinct morphologic and biomechanical characteristics

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Introduction: Integration of meniscus with capsules

Axial compression

Since the **surrounding capsule** is also subject to axial compression, its structure should be **robust** enough to **sustain constant and repeated axial loads**.
Introduction: Hypothesis & Purpose

❖ Hypothesis
➢ The tissue of peri-meniscal capsular junction could be histologically and biomechanically different to that of the surrounding capsule, thus enabling it to withstand higher level of stress.

❖ Purpose
➢ to analyze the morphological and biomechanical characteristics of the juxta-meniscal capsule and evaluate its functional role in knee joint
Materials and Methods

- 6 human cadavers (12 knees)
- Medial meniscus & adjacent surrounding capsules harvested
- Section: axial & coronal
- Histology & Morphological analysis using SEM

**Materials and Methods**

- MM: Medial Meniscus
- JC: Joint capsule
- MC: Meniscus capsule

**Diagram**: Axial and Coronal sections with labels MM, JC, and MC.
Results: Histological Analysis

In Safranin-O staining, Meniscus showed abundant GAG contents, whereas both MC and JC revealed no evident GAG staining. In comparison between MC and JC, MC has shown significantly distinct collagen fiber orientation from JC in Picro Sirius Red staining.
When comparing the axial sections of MC and JC, the peripheral MC showed multiple thick and rosary-shaped collagen fibers in circumferential orientation; whereas the upper JC revealed thinner collagen fibers arrayed in vertical orientation.
Results: Morphological analysis by SEM

In morphological comparison between medial meniscus and MC, both medial meniscus and MC showed nearly identical collagen fiber orientation in coronal section indicating morphological similarity between the two.
Results:

3D structure of “the juxta-meniscal capsule”

An illustration showing the three-dimensional structures of the medial meniscus and peri-meniscal capsule with distinct collagen fiber orientations.
Results: Biomechanical analysis (Tensile Modulus)

Overall, MC has shown about 4.2 ~ 30.0% circumferential tensile modulus of the corresponding adjacent meniscus.
Conclusion

❖ "The juxta-meniscal capsule" is the adjacent capsule located just peripheral to the meniscus.

❖ The juxta-meniscal capsule has different fiber orientation according to its anatomical position.
  ➢ Meniscus capsule: thicker & circumferentially oriented
  ➢ Joint capsule: thinner & vertically oriented

❖ The meniscus capsule also yielded significantly greater tensile modulus compared to the joint capsule biomechanically.

❖ with the greater tensile modulus, the circumferentially-oriented and thick peripheral juxta-meniscal capsule fibers are presumed to perform a supportive role in maintaining the circumferential hoop tension of the meniscus.
The peri-meniscal capsule has different fiber orientation according to its anatomical position. Also, with the greater tensile modulus, the circumferentially-oriented and thick peripheral peri-meniscal capsule fibers may aid in maintaining the circumferential hoop tension of the meniscus.