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Paper #184

# Composition of the Developing Human Meniscus

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**Summary**:
Vascularity, cellularity, collagen content, and proteoglycan content of the developing human meniscus with age and region

**Abstract**:

## Introduction

Repair of meniscal tears is difficult and important for the long-term health of the knee joint. Compositional elements have been shown to help with the healing of meniscal tears and repairs. The overall vascularity and cellularity of the meniscus has been observed to decrease with skeletal development. Collagen content has been observed to increase. However, regional differences in vascularity, cellularity, and collagen content have not been studied in the developing human meniscus. Further, proteoglycan content has not been studied in the developing human meniscus. Thus, we sought to describe the vascularity, cellularity, collagen content, and proteoglycan content by age and region in the meniscus through skeletal development.

## Methods

28 medial and lateral menisci from pediatric cadavers aged one month to 11 years were stained/immunostained for vascular endothelium, cell density, collagen content, and proteoglycan content. 5 regions were assessed: anterior root, anterior horn, body, posterior horn, and posterior root. We analyzed stained/immunostained sections with an image processing program for compositional elements with respect to age and region. Various statistical analyses (reported in parenthesis with p and R2 values when pertinent) were done with R statistical software.

## Results

Vascularity significantly decreased with age in medial (log transformed, fit on a regression; $p<0.001$, $R2=0.79$) and lateral (log transformed, fit on a regression; $p<0.001$, $R2=0.60$) specimen. Significant regional differences were also observed throughout age for both medial (repeated measures ANOVA; $p=0.012$) and lateral (repeated measures ANOVA; $p=0.011$) menisci. Medially, vascularity increased in the following order: posterior horn<anterior horn<body<anterior root=posterior root. Laterally, vascularity increased from: posterior horn<body<posterior root<anterior horn<anterior root. Cellularity decreased significantly with age in both medial (log transformed, fit on a regression; $p<0.001$, $R2=0.79$) and lateral (log transformed, fit on a regression; $p<0.001$, $R2=0.71$) menisci. Significant regional differences were also observed in medial (repeated measures ANOVA; $p=0.013$) and lateral (repeated measures ANOVA; $p<0.001$) menisci. The least cellular density was observed in the body and this increased from the

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horns to roots. Collagen content significantly decreased until about 6 years, then increased in lateral ($p=0.033$, quadratic) menisci. Medial menisci had no significant overall patterns. Further, no regional differences were observed. Proteoglycan content significantly increased until about the age of 6 and plateaued in both medial ($p<0.001$, quadratic) and lateral ($p=0.033$, quadratic) menisci. Significant regional differences were observed for proteoglycan content in both medial ($p<0.001$, ANOVA) and lateral ($p<0.001$, ANOVA) menisci. The body generally had the greatest proteoglycan content and this decreased from body to horns to roots.

## Conclusion

We observed significant changes with age for all compositional elements except the collagen content of the medial meniscus. Regional differences were observed with respect to vascularity, cellularity, and proteoglycan content in developing human menisci. Meniscal tears, a common sports injury, are shown to heal better with increased vascularity. Increased sports participation in children and young adults, are likely to increase the occurrence of meniscal tears. Understanding compositional changes with age and regional differences can aid physicians regarding treatment of meniscal tears and provide greater knowledge of the basic science of the meniscus.