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Meniscal Healing - Effect of Site of Injury on Meniscal Healing

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ABSTRACT

Background: Meniscus tissue is highly susceptible to injury and tears. As these are intrasynovial and lack cellularity, their healing potential is less. Any knowledge to the factors affecting the meniscal healing can help surgeons in treating meniscal injuries.
Hypothesis: Site of meniscal injury is a predictor of the healing of meniscus tissue.
Study Design: Prospective study. Methods: Gross and histologic evaluation of torn meniscus tissue from 23 patients and 10 control menisci were performed. Histologic scoring system was used to access the tissue healing
Results: Site of meniscal injury had a significant effect on the healing intention of the torn meniscus, inner zone having significantly fewer meniscus cells than did the peripheral zone.
Relevance: Our findings show that meniscus injury in the inner zone may be more vulnerable to degeneration and re tear after repair than meniscus injury in the peripheral zone.

KEYWORDS meniscus, healing, repair

Introduction.
The human meniscus functions as a shock absorber for the normal knee. [10,] It has been observed that meniscectomy results in osteoarthritis of the knee. [29] The interdependence of the ACL and medial meniscus on each other has led surgeons to find new methods to repair torn meniscii. [4,5]

Meniscus tissue being relatively acellular is susceptible to nonhealing of tears, and it is thought that the presence of viable cells in the meniscus is important in the long-term survival of the tissue. The cellularity of the meniscus will help the healing of the meniscus. The factors affecting the cellularity will increase the predictability of success of repair process. Correlation of cellularity with one of these risk factors could facilitate our understanding of the pathophysiology and predictability of meniscus repair failure.

In this study, our hypothesis was that the site of injury will significantly affect the healing rate of the meniscus. This will help the surgeon to predict the chances of meniscus healing preoperatively and to better understand the prognosis of the treatment.

Previous studies have shown that cellularity and healing of tissue have a direct correlation. [23,24,26,].

Materials and methods
Twenty three torn menisci were collected from patients aged 26 to 70 years at the time of arthroscopic meniscectomy. Ten cases following total knee replacement were used as controls. Seven lateral and Sixteen medial torn menisci were included in the study. Five of the menisci were torn at the time of an ACL rupture. Patients with any other history of ipsilateral knee injury were excluded.

The torn menisci were removed arthroscopically using a punch and the meniscus was balanced to remove the entire torn section leaving a stable rim of meniscus tissue. Operative notes were used to document the appearance of the tear tissue as well as the status of the adjacent cartilage at time of partial meniscectomy.

Tear Classification

Torn menisci were classified into 3 major zones

Zone 1 - outer most third

Zone 2 - middle third

Zone 3 - inner most third

Histologic sample preparation
The menisci were fixed in formalin for 3 days. After fixation, specimens were embedded in paraffin and 5mm thick axial sections were cut and fixed on glass slides. Representative sections from each sample were stained with hematoxylin and eosin.

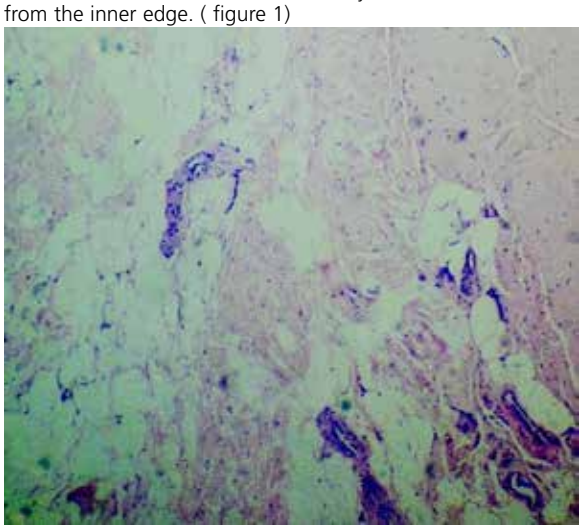
Histologic evaluation
Normal menisci contain two populations of cells: spindle shaped fibroblastic cells on the meniscal surface and rounder fibrochondrocytes in the interior. All menisci were evaluated for overall collagen organisation, presence of synovial layer, measures of cell number density and cell type at site of the meniscus tear. The mean cell number density was calculated counting the total number of cells present in twenty four fields arranged in a radial direction and dividing by the total area analysed.

Meniscus Histologic Scoring System
A total histologic score of 0 to 6 points was assigned according to the scale published by Rodeo et al. For cellularity, the intrinsic cellularity was assigned points.

Fibroblasts and fibrochondrocytes were identified when mean nuclear aspect ratio of intrinsic cells was 2.0 or more and less than 2.0 respectively.

Histomorphometry
The torn menisci were evaluated in a radial direction. Analysis in the radial direction was chosen as it was anticipated from previous studies in animals that synovial and vascular cell densities would vary as a function of distance from the peripheral rim. Similarly, in a previous study of intact menisci, 1 higher cell densities were identified near the anterior and posterior

horns. All tears were evaluated radially at 1, 2, 4, and 6 mm from the inner edge. (figure 1)



Statistical Analysis was done to determine the effect of patient age on the perimeniscal cellularity, intrinsic cellularity, intrinsic cell nuclear shape, and histologic score. Descriptive statistics and x2 analysis were used to assess differences between groups. Within each zone, Student t tests were used to compare cell density between patients younger than 40 years and those 40 years and older.

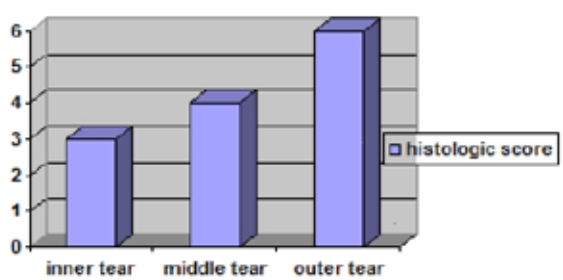
Results

Quantitative Pathologic Characteristics:

Cell Density: 6 patients showed less cell density in the intact meniscus in zone3 compared to 13 patients in zone 2 (P>.001). In zone 1 the Intrinsic cellularity was significantly higher (P < .001). . (table 1)

Meniscal histologic score

Histologic score was related to tear site (P < .001), with worse scores found in inner zone.Meniscus histology score (ranges from 0, which is the worst score, to 6, which is the best score) as a function of site of tear. Histologic score was related to tear site (P < .001), with worse scores found in inner zone tear types compared with controls (both P .01).



Discussion

Research in the past 20 years has further defined and clarified the multifaceted role of the meniscus. It has been shown to play an integral part in force transmission from the lower femur to the upper tibia [30,31,32].

These forces could be a partial explanation of the degenerative changes that occur in articular cartilage and subchondral bone after total meniscectomy. The meniscus role in shock absorption and load transmission has also been clearly demonstrated in several biomechanical studies [13,14].

The effect of site of injury:

Earlier studies in animals have shown that a defect in the vascular zone heals successfully by migration of synovial cells over the surface of the meniscus. This establishes the connection between rates of healing and the cellularity of the meniscus. [9,25] These findings suggest that the intrinsic cells contained within the meniscus in the avascular zone may be incapable of mounting a sufficient repair response and that it is the perimeniscal growth that is more critical to successful healing. [5] In the current study, the factor of site of injury affects the cellularity (which leads to higher risk of degeneration and retear) and may contribute to increased failures of meniscus repair in older patients.

Our study only shows that age influences the way the meniscus responds to injury. Our study did not show the formation of any tissue bridging the tear ends. Further studies are required to study the effect of repair in the healing of meniscus and durability of these repair tissue to further injury, and wear and tear. The other problem of this study was that degenerated meniscus was used as controls.

Summary

The human meniscus shows a response to injury different from that seen in tissues that heal.

1. It does not show any proliferation of macrophages or neutrophils.

2. It does not show any scar tissue between the torn sites. But it shows certain signs of healing like

a. Proliferation of fibroblasts and fibrochodrocytes

b. Hypertrophy and increased cellularity of the synovium

c. Modification of the cells to normal meniscal cells

d. Neovascularisation in the peripheral zone.

These findings suggest that the synovium plays an important role in the healing of meniscus and any repair process requires the synovium to be sutured to the tear to promote healing by bringing neovascularisation, neutrophils and macrophages to the site of injury. Further studies are required to study the effect of repair in the healing of meniscus

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