ORIGINAL RESEARCH

MORPHOLOGICAL STUDY OF THE MENISCUS OF THE KNEE JOINT IN ADULT CADAVERS OF THE SOUTH INDIAN POPULATION

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ABSTRACT

Objective: To estimate the incidence of different shapes of the medial and lateral meniscus and the incidence of discoid meniscus in the South Indian population.

Methods: The study included 108 menisci from 54 adult cadaveric knee joints which were preserved in 10% formaldehyde solution. After the dissection procedure, the morphological variants of the shapes of menisci were macroscopically noted and classified. The medial meniscus was subgrouped as crescent-shaped, sided U-shaped, sided V-shaped, sickle-shaped and C-shaped. The lateral meniscus was subgrouped as crescent-shaped, C-shaped and discoid-shaped.

Results and Conclusion: From our observations, 50% of the medial menisci were crescent-shaped, 38.9% were sided V-shaped and 11.1% were sided U-shaped. The percentages of the different types of lateral menisci were 61.1%, C-shaped and 38.9%, crescent-shaped. No discoid medial or lateral meniscus (0%) was observed in the study.

Keywords: Knee, Lateral meniscus, Medial meniscus, Shape, Side
INTRODUCTION

The menisci are two crescentic lamellae, which serve to deepen the surfaces of the articular fossae of the head of the tibia for reception of the condyles of the femur. The anatomical abnormalities and variations of the intraarticular structures of the knee joint have recently become significant because of new techniques such as arthroscopy, computed tomography and magnetic resonance imaging. Also the investigation of these variants is important in order to define the morphological features for clinical diagnosis and surgical procedures. The frequency and severity of knee injuries in organized and recreational sports industry are well-documented. In American football, the knee is the most commonly injured joint. Stocker et al in 1997 reported that meniscal injuries accounted for 12% of all football knee injuries in a recent high school injury survey. The meniscus has several roles that contribute to the successful function of the knee. Injuries to the meniscus are common in work, sports and everyday activities, and can be disabling. In meniscus allograft transplantation, it has been stated that providing a meniscal allograft that matches the size and shape of the meniscus to the recipient’s knee is the responsibility of the tissue bank providing the graft. In both anatomical and orthopedic literature, attention to the form of the menisci of the knee joint has been directed for the most part to the occurrence of a discoid type of lateral meniscus. No attempt has been made, heretofore, to classify the menisci of the knee joint according to their shapes or to consider possible racial or sexual differences. In the present study, the objectives were to estimate the incidence of different shapes of medial and lateral meniscus and also to estimate the incidence of discoid meniscus in the South Indian population.

MATERIAL AND METHOD

Human adult knee joints, available in the anatomy laboratory, were used for the present study. The study included 108 menisci from 54 knee joints of the South Indian population. Among them, 37 were right-sided and 17 left-sided isolated lower limbs. All specimens were preserved in 10% formaldehyde solution. After the dissection of the skin and muscles, the approaches to the menisci were performed, opening anteriorly by a longitudinal incision on each side of the joint capsule, cutting the patellar ligament and the collateral ligaments transversely. In order to expose the menisci clearly, the joint capsule and the intra-articular ligaments were cut, and the condyles were circumferentially detached from their soft tissue attachments and removed, exposing the tibial plateau. All dissections were performed in a systematic fashion and the data were recorded on a standardized collection sheet.

Morphological variants of the shapes of the menisci were macroscopically noted and classified. The medial meniscus (MM) was sub-grouped as sickle shaped, sided V-shaped, sided U-shaped, crescent-shaped and C-shaped. The lateral meniscus (LM) was sub-grouped as crescent (semilunar)-shaped, C-shaped and discoid-shaped (Fig.1). When the meniscus covers the tibial plateau circularly, the meniscus is said to be a discoid type. Menisci, which had thin anterior and posterior horns and thin bodies, were defined as crescent (semilunar)-types. Menisci, which had thin anterior, posterior horns and thick bodies, were defined as sickle-shaped types. Menisci which resembled sided U, sided V and C were named as sided U, sided V and C shaped respectively.

RESULTS

From our observations, four morphological types of the shape of menisci were determined. 50% of the medial menisci (MMs) were crescent-shaped, 38.9% were sided V-shaped and 11.1% were sided U-shaped (Table I, Figs.2, 3, 4). The percentages of the lateral menisci types (LMS) were 61.1% C-shaped and 38.9% crescent-shaped (Table II, Figs 5, 6). Discoid medial or lateral menisci were not observed in the present study (0%).
Table I: Showing the incidence of different shapes of medial meniscus (n = 54).

<table>
<thead>
<tr>
<th>Shape</th>
<th>Total no. &amp; Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent</td>
<td>27 (50%)</td>
</tr>
<tr>
<td>Sided V</td>
<td>21 (38.9%)</td>
</tr>
<tr>
<td>Sided U</td>
<td>6 (11.1%)</td>
</tr>
<tr>
<td>Discoid</td>
<td>nil (0%)</td>
</tr>
</tbody>
</table>

Fig 1: Diagram showing the various shapes of the menisci (source of classification - Kale A et al, 2006) a. Crescent-shaped, b. Sickle-shaped, c. C-shaped, d. sided U-shaped, e. sided V-shaped, f. incomplete discoid, g. complete discoid. (A-anterior & P-posterior)

Fig 2: Left tibial plateau showing crescent-shaped medial meniscus, observed in 50% of the specimens (M – medial meniscus, L – lateral meniscus, A – Anterior, P – Posterior)

Fig 3: Right tibial plateau showing sided V-shaped medial meniscus, observed in 38.9% of the specimens (M – medial meniscus, L – lateral meniscus, A – Anterior, P – Posterior)

Fig 4: Right tibial plateau showing sided U-shaped medial meniscus, observed in 11.1% of the specimens (M – medial meniscus, L – lateral meniscus, A – Anterior, P – Posterior)
Morphological study of the menisci of the knee joint in adult cadavers of the South Indian population

**DISCUSSION**

In primates, Parsons noted that the MM always has a crescentic shape but that the LM may have either a crescent or a disc shape. Vallois confirmed this observation and studied the whole morphology of the knee joint in primates. Since then, numerous papers on the variations of human knee menisci have been published, revealing fundamental elements. Fick & Rudolph described the MM as a half, two thirds or three-fourths ellipse and stated that the lateral could be compared to an almost complete circle. In contrast, C.M. Charles classified the menisci, both on the basis of the relative size of the anterior and posterior cornua and also on the degree of curvature. It has been reported that the LM has a crescentic shape. In 1889, Young described a discoid lateral meniscus in a cadaver specimen. Discoid meniscus is an atavistic anomaly in which the meniscus of the knee, predominantly the LM, is discoid rather than semilunar in shape. Additional anomalies of the meniscal shape have been classified as hypoplasia or hyperplasia. The meniscal hyperplasia or discoid menisci have

**Table II:** Showing the incidence of different shapes of lateral meniscus (n = 54).

<table>
<thead>
<tr>
<th>Shape</th>
<th>Total no. &amp; Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>C shaped</td>
<td>33 (61.1 %)</td>
</tr>
<tr>
<td>Crescent</td>
<td>21 (38.9 %)</td>
</tr>
<tr>
<td>Discoid</td>
<td>nil (0%)</td>
</tr>
</tbody>
</table>

**Fig 5:** Left tibial plateau showing crescent-shaped lateral meniscus, observed in 61.1% of the specimens (M – medial meniscus, L – lateral meniscus, A – Anterior, P – Posterior)

**Fig 6:** Right tibial plateau showing C-shaped lateral meniscus, observed in 38.9% of the specimens (M – medial meniscus, L – lateral meniscus, A – Anterior, P – Posterior)
been the object of many studies, because they are frequently the source of symptoms. The vast majority of discoid menisci are lateral; the discoid medial meniscus is extremely rare. Rare cases of it have been reported by the researchers as case reports. This fact was mentioned in the research of Kelly and Green as the discoid meniscus was most likely a congenital deviation and usually occurred laterally. Moreover, it was reported that the discoid shape resulted in a greater coverage of the tibia and was usually associated with increased thickness of the meniscus that might lead to abnormal shearing forces across the knee joint.

The reported incidence of discoid meniscus has ranged from 0.4 to 17% with the vast majority occurring on the lateral side of the knee. The most common congenital abnormality of the meniscus in man is a discoid meniscus with a frequency of 1.5-4.6% for the lateral and 0.3% for the medial one. Cadaver studies have reported the prevalence of lateral discoid menisci to be between 0 and 7%, whereas arthroscopic studies have demonstrated ranges from 0.4 to 16.6%. But racial differences do exist among the incidence rates. Kale A et al studied 22 fetal knee joints, reporting that 73% of the cadavers they studied had the same shape of meniscus on each side. In their study, they also did not determine any discoid medial meniscus. According to their observations, 18.18% of the MMs were crescent-shaped, 22.72% of the MMs were sided V-shaped, 9.09% of the MMs were sided U-shaped, 36.36% of the MMs were sickle-shaped and 13.63% of the MMs were C-shaped. In the same study, 13.63% of the LMs were crescent-shaped, 9.09% of the LMs were C-shaped and 77.27% of the LMs were discoid-shaped. Among the discoid shaped, 54.54% of the LMs were incomplete discoid and 22.72% were completely discoid. The variations of the shape of the menisci were explained by the embryological meniscal development. The meniscus arises from the differentiation of mesenchymal tissue within the limb bud and becomes a clearly defined structure by the eighth week of fetal development. The meniscus arises from the eccentric portion of the articular interzone during the O’Rahilly stage, however until week 9 of development, the menisci are not easily distinguishable. On the other hand, during embryologic development, the blood supply of the meniscus enters from the periphery and extends throughout the entire width. However, by the ninth month of life, the central third will be avascular and by adulthood, only the peripheral one third will receive any blood supply. At 9 week’s development, they are already perfectly formed. From that point on, the menisci grow at the same rate as the rest of the intra-articular structures, without undergoing any macroscopic structural changes and assume the normal adult relationships with the rest of the knee by the 14th week. The differences in the shape of the meniscus may be due to the mesenchymal differentiation or to the development of the vasculature early in embryonic life.

In the present study, four morphological types of the shape of menisci were determined and there was no discoid medial or lateral meniscus (0%) observed. The present study recorded the incidence of discoid meniscus as 0%, from the South Indian population. This is a very low incidence rate. The study included a small number of specimens and needs to be researched further with a large sample size. In contrast, from a study conducted by P.S. Rao and S.K.Rao in South India, based on 3,167 knee arthroscopies done between the years 1993 & 2004, 177 (5.59%) discoid lateral menisci were encountered. In conclusion, our results show that, in the majority of the specimens (50%) the MM was crescentic in form and the most common shape of the LM was ‘C’ shape (61.1%). The discoid medial or lateral meniscus was not observed in our series. We believe that our study will provide support to the meniscal anatomy, concerning the surgical procedures and arthroscopy of the knee joint. The study has provided additional information on different shapes of the medial and lateral meniscus with contribution to a better delineation of meniscal anatomy and implications in regard to allograft meniscus transplantation.
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REFERENCES