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Differences between sexes in the standard and advanced dimensioning of lateral meniscal allografts

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ABSTRACT

Background: There are many different methods of meniscal allograft measurements, which depend on individual tissue bank procedures. Due to the lack of a standardised method of dimensioning, measurement results may vary between individual cases. Consequently, allograft may be mismatched to the patient's knee anatomy. The purpose of this study was to measure four meniscal dimensions – two standard and two specific – and then compare them between sexes.

Methods: Fourteen cadaveric lateral menisci (seven male and seven female) were scanned using a microtomography scanner. The obtained three-dimensional (3-D) models of each meniscus were analysed, taking into account four dimensions: circumference, width, central meniscal concavity, and total meniscal volume. The computer researcher was not informed of the original data of the meniscal samples until the calculations were completed.

Results: No statistical between-sex differences were found in the standard dimensions. The specific dimensions, in turn, presented statistically significant between-sex differences ($P > 0.05$). The mean difference between male and female total volume of the meniscus was equal to 36.59%, and the mean difference between male and female central meniscal concavity surface was equal to 31.22%.

Conclusion: This study found that sex should be taken into account as an important factor during a matching procedure performed by tissue bank staff.

1. Introduction

According to a recently published research report [1], meniscal tears are responsible for an estimated 25,000 hospital admissions per year in England and Wales. In the United States, arthroscopic partial meniscectomy caused by meniscal ruptures is the most frequent orthopaedic surgical procedure [1].

Meniscal tear incidence may be as high as six per 1000 people [2], with a two-and-a-half-times to four-times male predominance. The incidence of age peaks at 20–29 years [3]. Furthermore, the medial meniscus is damaged five times more than the lateral meniscus [4,5]. Partial meniscectomy is one of the most commonly performed orthopaedic surgical procedures worldwide

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[6]. Total meniscal transplantation is a procedure that has been growing in popularity in recent years [7]. These data show how important it is to focus on the meniscal replacement problem.

In 1984, Arnoczky et al. first tested the meniscal transplantation procedure in dogs [8]. In 1989, Milachowski et al. performed the first meniscal transplantation in humans [9]. Despite the 25-year experience of meniscal transplantations, technical aspects of this procedure are still being discussed. Successful meniscal transplantation requires two significant factors: correct indication and appropriately sized graft with skilled surgery. Preparation of a meniscal allograft involves two stages: graft dissection and detailed measurements of the allograft. The dissection is quite simple, but graft measurements are much more complicated [10]. Correct meniscal sizing procedure needs an unconventional approach and advanced tools. Both are essential when the measured dimension is unknown and it is difficult to measure it under standard conditions.

The aim of the current study was to measure two standard (circumference and width) and two advanced (surface area of the femoral meniscal part and the total volume of the whole meniscus) lateral meniscal dimensions based on three-dimensional (3-D) computer models of the menisci, and to compare the obtained results between sexes. The hypothesis of this study assumed that the measurements of advanced meniscal dimensions can expose the differences between male and female menisci, which can be overlooked when only taking into account normally measured dimensions.

2. Material and methods

2.1. Menisci

Fourteen dissected lateral menisci were provided by Tissue Bank Katowice, Poland. The menisci were taken from cadaver knees. The mean time between harvesting and analysis of menisci was two months. There were seven female and seven male deep-frozen grafts (at −80 °C). The mean age of the donors was 24.5 years (24.3 for female and 24.7 for male samples). All the samples were described (sex, age, collection date, and orientation in the knee joint) and coded.

2.2. Scanning procedure

The menisci were scanned in an XMT (X-Ray microtomography) scanner Phoenix v|tome|x s (GE Sensing & Inspection Technologies, Wunstorf, Germany) according to the previously fully described procedure [11]. The standard tissue bank procedure in Poland assumes gamma-irradiation of all meniscal allografts intended for transplantation. However, menisci taken for the present study had not been sterilized before the scanning procedure — this did not influence the current results. Menisci were scanned in thin plastic foil to avoid contamination. The scanning parameters were as follows: voltage 130 kV, current 130 mA, power 16.9 W, resolution 29.49 μm, scan time 286 s, and the number of projections was 1000.

2.3. Data segmentation and visualization

The collected data were reconstructed, segmented and visualized to obtain 3-D models of the scanned allografts. During the segmentation process, the visible foil was removed to obtain a ‘clear’ meniscus without background noise. Each model was

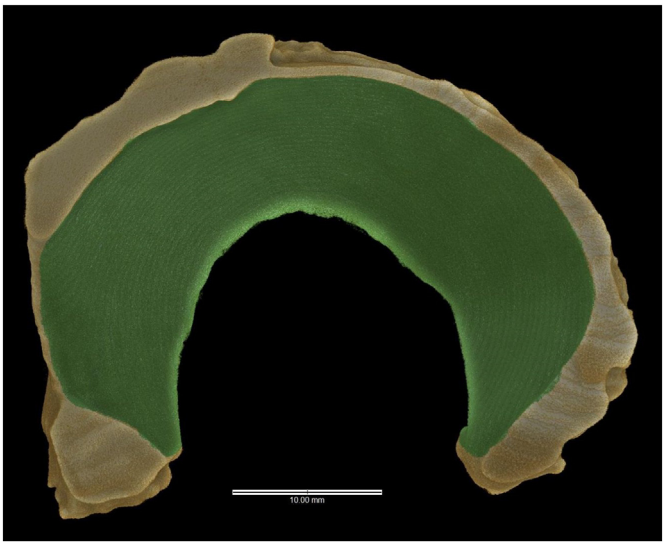

Figure 1. Lateral meniscus with femoral meniscal surface marked (green colour).