

Aging effect on zonal and sex differences of human meniscus investigated by MR T2 measurements

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Introduction

Human meniscus plays an important role on maintenance of the knee mechanical functions and is strongly associated with early detection of osteoarthritis (OA) which is frequently characterized with degeneration of cartilage and mostly related to aging [1]. Quantitative MR T2 measurement provides a noninvasive method to evaluate the early change of fiber architecture and water content in menisci and monitor the progression of it [2]. Previous report demonstrated that zonal differences in tissue composition and cell metabolism have been observed between the inner and outer areas of the meniscus, also T2 values differed significantly between different zones in the posterior horns menisci in the young population [3]. In addition to regional influence, aging and gender may be other factors that could affect the diagnostic value of quantitative T2 measurements in the menisci. As a result, the purpose of this study was to determine whether the MR T2 values of the knee menisci are variable and whether these variations are related to the different zones of the medial and lateral menisci, in men and women without OA in different age populations.

Method

Sixty asymptomatic subjects, including three different age groups (young-age, middle-age, and old-age; 10 male, 10 female in each group) were enrolled in this study. All volunteers were scanned in a supine position using a 3.0 T MR system (Achieva, Philips, Best, Netherlands). These images were acquired with an eight-channel knee coil using fast spin echo sequence with TR = 2500ms, TE = 6.4, 9.4, 12, and 15 ms; echo train length = 3; slice thickness = 1 mm; slice gap = 1 mm; matrix size = 258 × 324 (zero-filled to 560 × 560); NEX = 2; and acquisition time = 14 min 40 s. Fat suppression was used to improve the contrast of the images and derive the T2 value with sufficient accuracy. The ROIs for measurements of the T2 values in the posterior horn of the knee meniscus on the sagittal MR images of the first echo included the entire meniscus and the three different zones, which divided the meniscus into three equal parts based on the anatomical division as illustrated in Figure 2. To improve the signal-to-noise ratio (SNR) of the meniscus image, analysis of the T2 values of knee menisci was conducted on a zone-by-zone basis using the least-square single-exponential curve-fitting method.

Results

Relationship between T2 values in posterior horns of meniscus and participant age was shown in Fig. 1. The T2 values of the medial meniscus increased quadratically respect to age, and T2 values of the lateral side increased linearly respect to age. These correlations were both statistically significant ($p < 0.05$). Fig. 2 showed gender difference in the T2 values for different zones in the posterior horns of the menisci. Asterisk signs indicate statistical significance between male and female ($p < 0.05$). The white zone in the young population was the only one showing no gender-related difference. In addition, the increasing trend in T2 from the white zone, red/white zone, to the red zone was present in all three age groups for both genders. On the other hand, the age-related T2 changing rates from the young- to the old-age for female subjects were significantly greater in the white and red/white zones than in the red zone ($p = 0.001$) as shown in Fig. 3 (a), but largely similar for male subjects ($p = 0.156$) in Fig. 3 (b).

Discussion

The present study indicated the feasibility of quantitative MR T2 measurements to investigate the aging effect on zonal and sex differences of human meniscus. Our findings showed that the T2 value of the posterior horns in the meniscus increased with increasing age. The higher T2 values of the menisci are thought to reflect possible disruption of the cartilage architecture and consequent changes in water content, as shown in the articular cartilage [4]. Moreover, age, gender, location, and zone are all primary factors showing influences on MR T2 values in the knee meniscus in asymptomatic subjects. Trends in the dependency of T2 on these factors are consistent with literature reports on degenerative abnormalities of the meniscus, suggesting that T2 measurements may provide further information toward an understanding of the role of meniscus on the development of knee OA.

Reference

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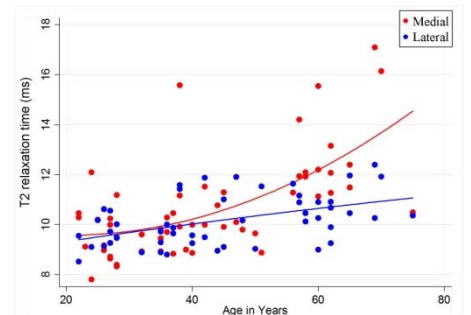


Fig.1 Relationship between T2 values in posterior horns of meniscus and participant age.

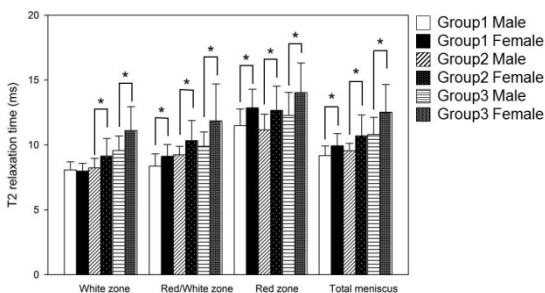


Fig. 2 Gender difference in the T2 values for different zones in the posterior horns of the menisci.

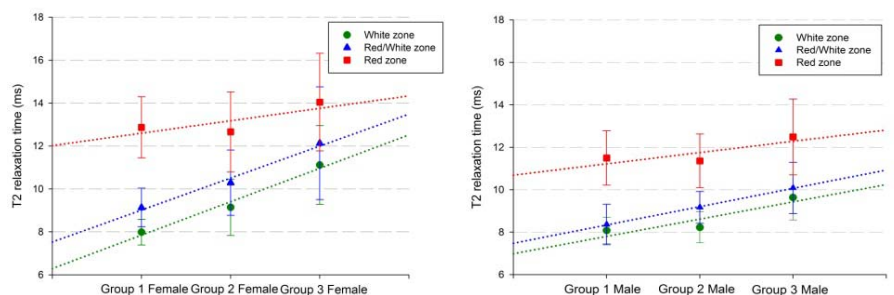


Fig.3 Age-related increasing rates in T2, plotted for the three zones for female (a) and for male (b)