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Age-Related Morphological Changes Of The Menisci In Women

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Article History	Abstract
Received: 7th March,, 2026 Accepted: 6th April, 2026	Age-related changes in joint structures represent an important aspect of musculoskeletal pathology, particularly in women, where hormonal, metabolic, and biomechanical factors influence tissue degeneration. The menisci of the knee joint play a critical role in load distribution, joint stability, and shock absorption. With increasing age, structural and compositional alterations occur in meniscal tissue, contributing to degenerative joint diseases. The present study aims to evaluate morphological changes of the menisci in women across different age groups. A descriptive observational approach was applied, involving clinical and imaging-based assessment of female patients. Morphological evaluation focused on structural integrity, surface characteristics, and degenerative changes such as fiber disorganization and tissue thinning. The findings indicate that age-related changes include decreased elasticity, fragmentation of collagen fibers, and progressive loss of meniscal thickness. These alterations are more pronounced in older age groups and are associated with reduced functional capacity and increased susceptibility to injury. Hormonal influences, particularly estrogen deficiency, may contribute to accelerated degeneration.

In conclusion, age-related morphological changes of the menisci in women are characterized by progressive structural deterioration, which may predispose to degenerative knee disorders. Early detection and preventive strategies are essential for maintaining joint health and reducing the risk of complications [21–23].

Keywords: Meniscus, knee joint, women, aging, morphology, degeneration, collagen structure, joint biomechanics

Introduction

The menisci are fibrocartilaginous structures of the knee joint that play a crucial role in maintaining joint stability, load distribution, shock absorption, and lubrication. They contribute significantly to the biomechanical function of the knee by increasing the congruency between the femoral condyles and the tibial plateau. Any structural alteration in the menisci can disrupt normal joint mechanics and lead to degenerative changes [24].

In women, age-related changes in musculoskeletal tissues occur under the influence of both intrinsic and extrinsic factors, including hormonal fluctuations, metabolic changes, and mechanical loading. Estrogen deficiency, particularly after menopause, has been shown to affect collagen metabolism and tissue elasticity, which may accelerate degenerative processes in fibrocartilaginous structures such as the menisci [25]. These changes increase susceptibility to microtrauma and progressive tissue degradation.

Morphologically, the menisci undergo gradual alterations with aging, including decreased cellularity, disorganization of collagen fibers, reduced water content, and surface irregularities. These structural changes result in reduced elasticity and mechanical strength, making the menisci more prone to tears and degeneration. In addition, age-related vascular changes further impair the regenerative capacity of meniscal tissue [26].

The degeneration of meniscal structure is closely associated with the development of knee osteoarthritis, particularly in women. Studies have demonstrated that morphological deterioration of the menisci contributes to altered load transmission and increased stress on articular cartilage, thereby accelerating joint degeneration [27].

Despite the clinical importance of these changes, comprehensive studies focusing specifically on age-related morphological alterations of the menisci in women

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remain limited. Most research addresses general degenerative processes without emphasizing gender-specific factors.

Therefore, the aim of the present study is to investigate the morphological changes of the menisci in women across different age groups, with particular attention to structural alterations associated with aging and their potential clinical implications.

Materials and Methods

This study was conducted as a descriptive cross-sectional investigation aimed at evaluating age-related morphological changes of the menisci in women. A total of 60 female participants were included in the study and divided into three age groups: 20–35 years (Group I), 36–50 years (Group II), and over 50 years (Group III). This classification allowed comparative analysis of structural changes across different stages of aging.

Magnetic resonance imaging (MRI) of the knee joint was used as the primary diagnostic method due to its high sensitivity in evaluating meniscal morphology. All examinations were performed under standardized conditions using high-resolution imaging protocols. MRI was selected as the gold standard for assessing meniscal structure, integrity, and degenerative changes [28,29].

Morphological evaluation focused on qualitative assessment of the menisci, including surface integrity, homogeneity of structure, presence of degenerative tears, and signal intensity changes. Particular attention was given to collagen fiber organization and structural continuity of the meniscal tissue [30].

Morphometric analysis included quantitative measurement of meniscal thickness, width, and volume using digital imaging tools. Measurements were taken at standardized anatomical points, including the anterior horn, body, and posterior horn of both medial and lateral menisci. Reduction in thickness and irregular contour were considered indicators of degenerative changes [31].

To ensure objectivity, all measurements were performed independently by two radiologists, and the mean values were used for analysis. The degree of deviation from normal values was calculated using the formula:

Deviation (%) = [(Observed value − Reference value) / Reference value] × 100

This allowed quantitative comparison of age-related changes.

Table 1. Morphometric Parameters of the Menisci

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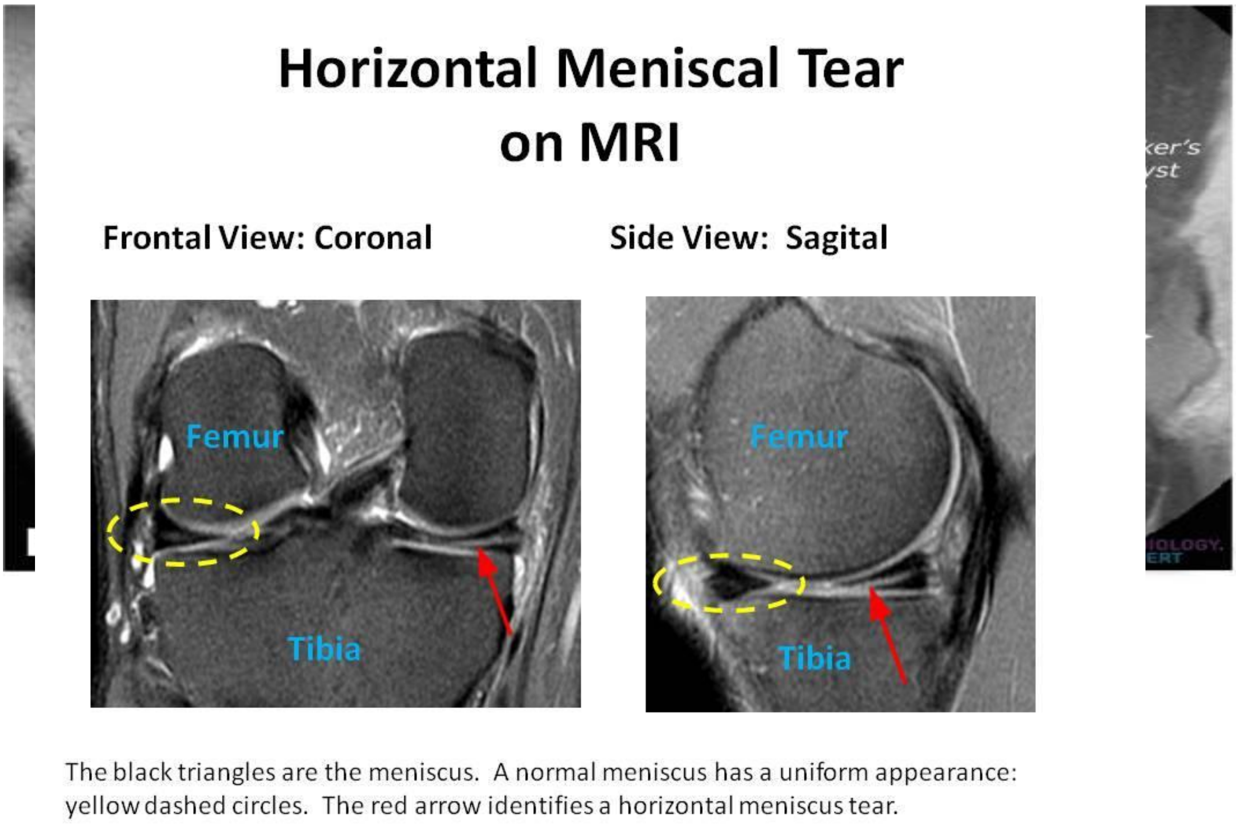
Parameter	Measurement Description	Normal Range	Clinical Interpretation
Meniscal thickness (mm)	Measured at body region	5–7 mm	Decrease indicates degeneration
Meniscal width (mm)	Peripheral measurement	9–12 mm	Reduction reflects tissue loss
Signal intensity	MRI signal characteristics	Homogeneous	Heterogeneity indicates damage

Note. Measurement criteria based on MRI diagnostic standards [28–31].

Figure 1. MRI Assessment of Meniscal Morphology



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Note. Adapted from standard MRI-based diagnostic imaging references [28–30].

All data were analyzed using descriptive statistical methods, and results were expressed as mean ± standard deviation.

Results

The analysis of MRI findings revealed significant age-related morphological changes in the menisci of female participants. Structural alterations became progressively more pronounced across increasing age groups. In Group I (20–35 years), the menisci demonstrated normal morphology, with homogeneous signal intensity, smooth surface contours, and preserved thickness. In contrast, Group II (36–50 years) showed early degenerative changes, including mild heterogeneity of signal intensity and slight reduction in meniscal thickness. The most pronounced alterations were observed in Group III (over 50 years), where clear signs of degeneration such as irregular surface contours, decreased thickness, and structural fragmentation were evident [32,33].

Morphometric analysis confirmed these observations quantitatively. A progressive decrease in meniscal thickness and width was noted with increasing age. Additionally, MRI signal intensity changes indicative of collagen disorganization and reduced water content were significantly more frequent in older patients.

Table 2. Age-Related Morphometric Changes of the Menisci in Women (n = 60)

Parameter	Group I (20–35)	Group II (36–50)	Group III (>50)	Change (%)
Thickness (mm)	6.5 ± 0.8	5.8 ± 0.7	4.6 ± 0.9	−29%
Width (mm)	11.2 ± 1.1	10.3 ± 1.0	9.1 ± 1.2	−19%
Signal homogeneity (%)	95%	72%	48%	−47%

Note. Values interpreted based on MRI diagnostic criteria and age-related degeneration patterns [32–34].

The mean meniscal thickness decreased significantly from 6.5 ± 0.8 mm in Group I to 4.6 ± 0.9 mm in Group III, indicating progressive structural loss. Similarly, meniscal width showed a gradual reduction, reflecting peripheral tissue degeneration. Signal homogeneity decreased markedly with age, suggesting disruption of collagen fiber organization and increased degenerative changes.
Furthermore, degenerative tears were observed in 12% of patients in Group II and 38% in Group III, indicating a strong association between aging and increased susceptibility to meniscal injury. These findings demonstrate a clear correlation between age and both qualitative and quantitative deterioration of meniscal structure [33,35].

Figure 2. Age-Related Changes in Meniscal Thickness and Signal Intensity

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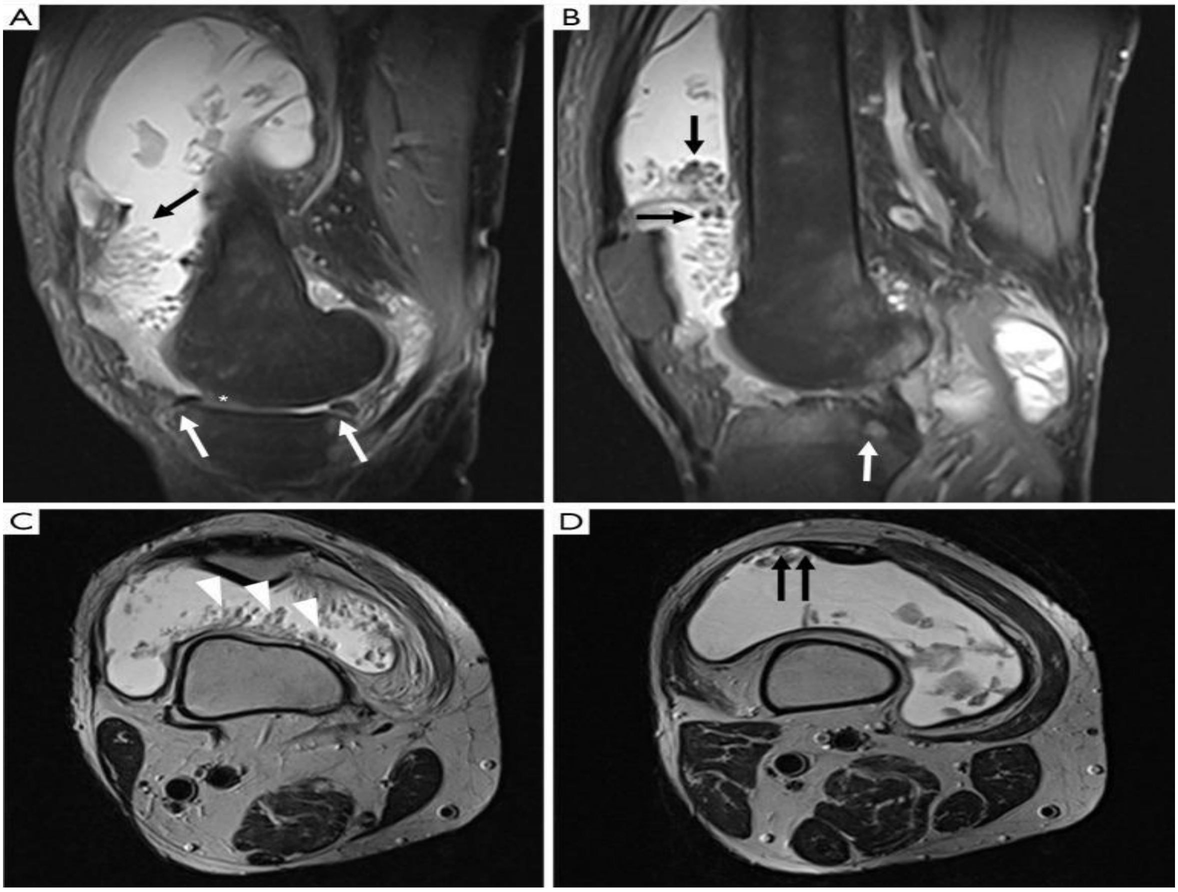

Note. Adapted from MRI-based comparative studies of meniscal degeneration [32–34].

Discussion

The findings of the present study demonstrate that age-related morphological changes of the menisci in women are progressive and involve both structural and compositional alterations. The observed decrease in meniscal thickness, increased signal heterogeneity, and higher incidence of degenerative tears confirm that aging significantly affects meniscal integrity and function [36].

One of the key observations is the gradual reduction in meniscal thickness across age groups. This finding reflects the loss of extracellular matrix components, particularly collagen fibers and proteoglycans, which are essential for maintaining structural stability and elasticity. Similar studies have reported that age-related degeneration leads to decreased water content and reduced mechanical resilience of meniscal tissue [37]. These changes contribute to diminished shock-absorbing capacity and increased susceptibility to mechanical stress.

The increase in MRI signal heterogeneity observed in older patients is indicative of collagen disorganization and microstructural damage. This phenomenon has been widely associated with early degenerative changes and precedes visible structural disruption. In addition, the higher prevalence of meniscal tears in older age groups suggests that weakened tissue becomes more vulnerable to both minor trauma and cumulative mechanical loading [38].

Hormonal factors, particularly estrogen deficiency, may play a significant role in accelerating degenerative processes in women. Estrogen is known to influence collagen metabolism and tissue repair mechanisms. Its decline, especially after menopause, is associated with reduced regenerative capacity and increased tissue fragility. This may explain the more pronounced degenerative changes observed in women over 50 years of age [39].

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The results of this study are consistent with previous research demonstrating a strong association between meniscal degeneration and the development of knee osteoarthritis. Structural deterioration of the menisci alters load distribution within the knee joint, leading to increased stress on articular cartilage and subsequent joint degeneration [40]. Therefore, early identification of meniscal changes is essential for preventing progression to more severe joint pathology.

From a clinical perspective, MRI remains the most effective diagnostic tool for detecting early morphological changes in the menisci. The integration of qualitative morphological assessment with quantitative morphometric analysis provides a comprehensive evaluation of meniscal health. This combined approach enhances diagnostic accuracy and supports the development of targeted preventive and therapeutic strategies.

Despite the strengths of this study, certain limitations should be acknowledged. The cross-sectional design limits the ability to assess longitudinal progression of degenerative changes. Additionally, the sample size, although adequate for descriptive analysis, may not fully represent broader population variability. Future studies should include larger cohorts and longitudinal follow-up to better understand the dynamics of age-related meniscal degeneration.

In conclusion, age-related morphological changes of the menisci in women are characterized by progressive structural deterioration, decreased tissue integrity, and increased susceptibility to injury. These findings highlight the importance of early detection and intervention in maintaining knee joint function and preventing degenerative joint diseases.

Conclusion

In conclusion, age-related morphological changes of the menisci in women are characterized by progressive structural and compositional alterations that significantly affect knee joint function. The study demonstrates that meniscal thickness reduction, increased signal heterogeneity, and a higher incidence of degenerative tears are key indicators of aging-related degeneration.

The integration of morphological and morphometric analysis provides a comprehensive understanding of meniscal health and allows for early detection of degenerative changes. These findings emphasize the importance of timely diagnosis, particularly in women, where hormonal factors may accelerate tissue degeneration.

Early identification of meniscal alterations using MRI can help prevent the progression to more severe joint disorders, including osteoarthritis. Preventive strategies and targeted interventions are essential to preserve joint function and improve quality of life in aging populations.

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