Morphological changes of the lateral meniscus in end stage lateral compartment osteoarthritis of the knee

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Keywords: Lateral meniscus, osteoarthritis

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Abstract

Objective: The aim of this study was to evaluate the morphological changes of the lateral meniscus in end stage lateral compartment osteoarthritis(OA) of the knee.

Methods: 158 knee joints from 133 patients that subsequently underwent total knee joint arthroplasty from January 2008 to December 2009 were enrolled. There were 26 men and 107 women. Their ages ranged from 56 to 81 (mean 67.4±6.5 yrs). All study participants had complete obliteration of the lateral joint space identified by weight bearing radiography. Meniscal position was assessed by measuring meniscal subluxation and meniscal height. The meniscal morphology was assessed using a modified whole-organ magnetic resonance imaging score (WORMS). The frequency of different meniscal morphologies and their respective positions were calculated.

Results: The predominant type (42.4, 53.8 and 52.5% in the anterior horn, mid body and posterior horn, respectively) of abnormal meniscal morphology was a complete maceration/destruction or complete resection. The anterior horn of non-macerated lateral meniscus was more subluxed than that of the non-macerated medial meniscus in patients with lateral osteoarthritis.

Conclusion: This study suggests that the lateral meniscus in persons with end stage lateral osteoarthritis are mostly macerated or destroyed. Also, unlike isolated end staged medial compartment osteoarthritis, the anterior horn of the lateral meniscus in isolated end stage lateral osteoarthritis is commonly affected.

`**Key words:** Meniscus, Lateral Osteoarthritis

Introduction

Structural changes in knee osteoarthritis are characterized by significant cartilage loss, subchondral sclerosis, osteophytosis, subchondral cysts, meniscal degeneration, and other intraarticular or extraarticular soft tissue abnormalities[1-5]. In addition to extensive investigation of the biology and genetic etiology of osteoarthritis [6-9], investigators have attempted to describe the morphololological characteristics associated with the above structural changes[10-14]. Among them, the meniscus, as one of the soft tissues prominently involved in OA etiopathogenesis, has been evaluated based on its integral role in knee function[15-17]. Several studies have shown that both meniscal subluxation and meniscal tears are common not only in knee OA, but particularly frequent in knees with radiographic knee OA and appear to be related to the degree of joint space narrowing on plain radiographs[11, 15-16, 18-19] Based on prior reports and existing dogma[11], the common consensus is that advanced stage OA of the knee, with complete loss of either the medial or lateral compartment joint space on radiographs, might be associated with a completely macerated/destroyed meniscus and hyaline cartilage. However, a previous published study found no correlation between the radiological and morphological changes of the medial meniscus in end stage medial osteoarthritis[20], where a hypertrophied meniscus was the most prevalent finding. Another recent study showed that OA knees have thicker menisci than those of non-OA knees[21] . In terms of lateral tibiofemoral arthritis, to date, there is one study comparing the prevalence of lateral tibiofemoral (TF) osteoarthritis in Asian and western population[22] suggesting that Asian knees have more lateral TF OA. What accounted for this lateral TF increase in Asian knees is not currently known. Furthermore there is little known of the morphological and positional changes of the lateral meniscus in patients with advanced lateral OA. Therefore, the aim of this study was to examine the morphological and positional changes of the lateral meniscus in patients with advanced lateral compartment OA.

Materials and Methods

Study participants

The research design used in this study was a consecutive series of persons presenting with end-stage lateral tibiofemoral (TF) OA to an orthopedic specialty hospital. 143 potential patients participated in this study. All potential patients presented with lateral compartment osteoarthritis. A series of knee radiographs (weight bearing posteroanterior radiographs, weight bearing 30 degrees posteroanterior, lateral, and skyline views) were obtained for each patient to determine whether advanced lateral TF compartment radiographic OA was present. The radiographs were graded using the Kellgren-Lawrence (K&L) grading scale[23] and scored for lateral joint space narrowing (JSN) on a scale of 0 (normal)—3 (total loss of the joint space) with the help of the Osteoarthritis Research Society International (OARSI) atlas[24] by two experienced clinicians (SHH, WJL with 7 and 6 years of musculoskeletal radiology experience respectively).. If patients had complete lateral joint space obliteration (K&L = 4 and JSN = 3) on the weight-bearing posteroanterior radiograph, they were eligible for this study. The inter-rater reliability of KL and OARSI grading were determined by calculating the intraclass correlation coefficients (ICCs), which was 0.96 and 0.95, respectively. 10 patients were excluded due to the diagnosis of secondary OA (i.e., OA associated with fracture, prior knee associated arthroscopic or open surgery, or another disease process), simultaneous medial compartment OA with medial joint space narrowing, and systemic inflammatory arthritis.(e.g., rheumatoid arthritis, gout), based on medical records. Patients without contraindications to MRI underwent MRI of their abnormal knee joints. Finally, a total of 158 knee joints among 133 patients were included for this study from January, 2008 to December 2009. The study was approved by the hospital ethics committee at our institution and all patients gave written informed consent to use their anonymised data

Limb alignment assessment

The degree of valgus deformity was measured as the femorotibial angle (FTA) by two experienced raters (SHH, WJL) using a standing long limb radiograph. Femorotibial angles (FTA) were measured by drawing a line along the axis of the femoral shaft to intersect the corresponding line drawn through the tibial shaft. During the assessment, the readers were blinded to MRI results. The inter-rater reliability of the FTA measurements were determined by calculating the intraclass correlation coefficients (ICCs), which was 0.93.

MRI acquisition Meniscus changes were assessed using a 1.5 T MRI system in the sagittal and coronal planes with spin-echo (proton density weighted acquisition) and fast scan (T2-weighted images) techniques. The sagittal and coronal spin-echo proton density weighted acquisition images were acquired using the following parameters: 1800/15/2(TR/TE/NEX), slice thickness 4 mm, inter-slice gap 0.4 mm for coronal images and 0.3 mm for sagittal images, slice thickness 3 mm, and matrix 256 X 256. T2-weighted images were also acquired using the following parameters: 3700/100/2(TR/TE/NEX), slice thickness 4 mm, inter-slice gap 0.4 mm for coronal images, and a slice thickness of 3 mm with an inter-slice gap of 0.3 mm for sagittal images.

MRI interpretation

The anterior and posterior horns and mid-bodies of menisci were examined for (1) meniscal morphology, and (2) meniscal position (Figs. 1, 2). During the assessment, the readers were blinded to radiographic results, patient symptoms, patient age, and other clinical data. Meniscal morphology (integrity) was measured independently by two experienced observers (SHH, WJL), and the overall ratings were determined by consensus when necessary. The morphology at each portion of the meniscus was assessed, using a modification of the whole-organ magnetic resonance imaging score (WORMS) assessment system [25]. According to the modifications reported in a previous study[20]: 0 = intact, 1 = minor radial tear or parrot-beak tear, 2 = non-displaced tear, 3 = displaced but no tear, 4 = displaced tear or partial resection, 5 = hypertrophied displaced, 6 = hypertrophied displaced tear, and 7 = complete maceration/destruction or complete resection (Fig. 1). The meniscal integrity of the anterior and posterior horns of the menisci was measured in the sagittal and coronal planes, in which the meniscal morphology was best observed. The mid-body height was measured where the medial and lateral tibial spine volume was maximal [11-12, 17]. ‘‘Hypertrophy’’ was considered present when the lateral meniscus height was 2 mm greater than the medial meniscus, regardless of the medial meniscus width, using reference values of the normal meniscus height in which those of the lateral meniscus are normally smaller than the medial meniscus[17] . The inter-rater reliability of meniscal morphology ratings was 0.87 (kappa) for meniscal morphology at the anterior horn of the lateral meniscus, 0.80 at the mid-body of the lateral meniscus, and 0.86 at the posterior horn of the lateral meniscus.

Two experienced observers (SHH, WJL) independently measured the meniscal position; the mean values were used for the analysis. The meniscal position was assessed by measuring the meniscal subluxation and height of each knee (Figure 2). To determine the meniscal height, the anterior and posterior horns of the menisci were measured in the sagittal plane, which allowed the best visualization of the greatest meniscal size. The mid-body height was measured in the coronal plane, where the medial and lateral tibial spine volume was maximal. The meniscal height was measured at the most peripheral edge of each meniscus, regardless of whether the meniscus was "in-place", subluxed or extruded. To determine meniscal subluxation, anterior subluxation of the anterior horn of the medial and lateral meniscus was assessed in the area where the subluxation was most prominent through multiple sagittal slices. Lateral subluxation of the mid-body of the lateral and medial subluxation of the medial meniscus was measured where the volume of the medial and lateral tibial spine was greatest. Posterior subluxation of the posterior horn was not measured, because this could not be performed accurately in the sagittal plane. For completely macerated or destroyed menisci, meniscal subluxation and the meniscal height could not be measured (Fig. 2) and were handled as missing values and 0 mm, respectively, for statistical analysis. The inter-rater reliability of the meniscal position measurements were determined by calculating the intraclass correlation coefficients (ICCs). An ICC of 1 suggests perfect reliability, and an ICC > 0.75 and ICC < 0.4 is generally considered to represent excellent and poor reliability respectively. For the cases that could be measured, the ICCs for the meniscal height and meniscal subluxation were the height at the anterior horn 0.74, mid-body 0.81, and posterior horn 0.80; anterior subluxation at the anterior horn 0.85, and lateral subluxation at the mid-body 0.84.

Statistical analysis

First, the frequency of the meniscal morphology for each portion of the meniscus was determined. Second, the medial meniscus height and subluxation in cases with a non-macerated lateral meniscus were compared with those in cases with a macerated lateral meniscus using the independent T-test. Third, the lateral meniscus height and subluxation in cases with a non-macerated lateral meniscus were compared to those of the medial meniscus using the paired sample t test at each meniscal portion, including the anterior horn, midbody, and posterior horn. The differences in FTA valgus angle was evaluated according to each meniscal morphological type at anterior, midbody and posteror horn, respectively with one-way analysis of variance with post hoc comparison (Turkey's test). For height and subluxation in the cases with a macerated lateral meniscus, where each value was unmeasurable, comparison with the cases that had a non-macerated meniscus could not be performed. Correlations between the BMI (Body mass index), FTA (femorotibial angle), gender with meniscus parameters, such as meniscal height and meniscal subluxation were carried out using correlation coefficients (spearman) for each knee. If $r < 0.3$, it was regarded as week correlation, if $r > 0.3$ and < 0.7, it was regarded as intermediate correlation, and if $r > 0.7$, it was regarded as strong correlation between variables.

All analyses were performed using SPSS 11.0 (SPSS Inc., Chicago, IL, USA). The p values of 0.05 or less were considered significant.

Results

26 patients were men and 107 were women (ages ranged from 56 to 81, mean age 67.4 ± 6.5 years). The average patient weight was 60.3 ± 9.6 kg (range; 42-93), average body mass index (BMI) was 25.2 ± 3.4 (range; 17.2–32.4), and average height was 154.5 ± 8.5 cm (range; 140–173).

Meniscal morphology

The meniscal morphology for the study sample is summarized in Table 1. The most frequent morphology observed was complete maceration or complete resection (Grade 7) in the anterior horn (42.4%), mid-body (53.8%), and in the posterior horn (52.5%) of the lateral meniscus.

Meniscal position

The mean values for subluxation and height of the medial and lateral meniscus for the study patients are summarized in Table 2. The anterior horn of the medial meniscus in cases with macerated lateral meniscus showed significantly more subluxation than that in non- macerated lateral meniscus. The height of midbody of medial meniscus in cases with macerated lateral meniscus was significantly smaller than that in non-macerated lateral meniscus.

In the analysis of cases only with non-macerated lateral meniscus, the anterior horn and midbody of lateral meniscus showed significantly more subluxation than that of medial meniscus in same cases Also, the height of the anterior horn and midbody of the lateral meniscus had a significantly smaller size than the medial meniscus in same cases.

FTA angle

The FTA valgus angle was not related with each meniscal morphological grade at anterior and posterior horn. However, in terms of mid-body, FTA angle showed differences between grade 5 and grade 2(*p*=0.030), between grade 5 and grade 4 (*p*=0.012) and between grade 5 and grade 6(*p*=0.018) (Table 3).

Gender was not found to be correlated with the meniscal position, and FTA except subluxation of the midbody of the medial meniscus (Table 4). The BMI was not found to be correlated with the meniscal position and FTA except subluxation of the midbody of the lateral meniscus (r=0.232,p=0.003),subluxation of the anterior horn of the medial meniscus (r=0.223,p=0.005), and subluxation of the midbody of the medial meniscus (r=0.257, p=0.001)

Discussion

The results of this study demonstrate that the majority of study patients had a completely macerated or destroyed meniscus with end stage lateral osteoarthritis of the knee; in contrast to our previous study [20] that showed that most cases with advanced medial osteoarthritis had a hypertrophied medial meniscus. These findings suggest that the degenerative changes of the lateral meniscus might progress to a meniscal tear, which can ultimately lead to complete destruction, unlike the medial meniscus. According to the modified WORMS classification, generally the predominant type of injured lateral meniscus in end stage lateral OA was grade 7 (complete maceration/destruction or complete resection) followed by grade 4 (displaced tear or partial resection).

In terms of the dimensional changes of the anterior horn of the lateral meniscus, the proportion of grade 4 and grade 7(Grade 3; 4; 5; 7 = 13.9%, 32.9%, 2.5%, 42.4%) was higher and grade 3 and grade 5 was lower , as compared to end staged isolated medial osteoarthritis (Grade 3; 4; 5; 7 = 20.4%; 15.6%; 30%; 0%). The tear of anterior horn of lateral meniscus were a very common finding (82.9%, 131/158 cases) in lateral compartment osteoarthritis, unlike anterior horn of medial meniscus in end staged isolated medial osteoarthritis [20], which showed incidence of 47.9%(80/167 cases). Regarding the mid-body of the lateral meniscus, the proportion of grade 7 (53.8%) was much higher than (7.2%) for end stage medial osteoarthritis. The overall incidence of midbody tears of lateral meniscus was 94.3%(149/158 cases) in comparison to 95.7(160/167 cases) of medial meniscus mid-body of end staged medial osteoarthritis [20].

For the posterior horn, the proportion of grade 6 (1.3%) was low and grade 7 (53.9%) was much higher, compared to end stage medial osteoarthritis (Grade 6, 7 = 83.8%; 0.5%). The overall incidence of post horn damage of lateral meniscus was 94.9%(150/158 cases) in comparison to 98.8%(165/167 cases) of medial meniscus posterior horn of end staged osteoarthritis[20]. These findings indicate that most lateral menisci in persons with end-staqe lateral OA are predominantly macerated. However, all parts of the meniscus were not completely macerated; 57.6% (91/158 cases), 46.2% (63/158 cases) and 47.5% (75/158 cases) of each portion of the lateral meniscus was not macerated.

Therefore, although the existing dogma appears to be correct in suggesting that in the vast majority of persons with end-stage OA the meniscus is destroyed/ macerated, it is important to consider that the entire lateral meniscus was not affected by the same mechanism. In addition, various factors influencing the mechanisms associated with lateral osteoarthritis remain unknown.

Limb alignment had a significant association with meniscal morphology of midbody of lateral meniscus, which was high valgus alignment of 17.7 ± 3.7° in grade 5, relative to other grades. These findings are different from those of end stage medial osteoarthritis in previous published our study, which limb alignment was not associated with meniscal morphology[20]. However, as the number of cases of grade 5 was small, further study with larger number of cases might be needed to conclude whether there are definite differences between FTA and meniscal morphology or not. In terms of meniscal position, both non-macerated and macerated lateral menisci were accompanied by the subluxation of the medial meniscus of the same knee. In detail, the anterior horn and midbody of medial meniscus in cases with non-macerated lateral meniscus showed subluxation of 1.30±1.72 mm and 2.44±2.14 mm, respectively. For case of the macerated lateral meniscus, those are 2.77 ± 2.55 mm and 2.26 ± 1.98 mm. This finding indicates that the lateral TF osteoarthritis can affect the medial compartment.

In terms of meniscal height, lateral meniscus with non-macerated morphology (anterior horn=5.41±1.98 mm, midbody=6.03±1.88 mm) showed smaller height than medial meniscus of same cases (anterior horn=6.35±1.71 mm, midbody 7.05 ±1.83 mm). These finding may be due to the fact that lateral TF osteoarthritis did not have many case of grade 5 and grade 6 than the medial TF osteoarthritis. But this was the case in anterior horn and midbody, not in posterior horn.(Posterior horn of lateral meniscus = 5.66±1.63, Posterior horn of medial meniscus = 5.89±0.92)

The limitations of this study include the following. First, the cohort size (158 knees) was relatively small and different results might have been obtained with a larger study sample. However, based on the low prevalence of lateral osteoarthritis, which is one-tenth that of medial osteoarthritis [26], the results suggest the need for additional research. Second,our study finding can not be generalized to all lateral OA because this study is highly selected sample of severe symptomatic lateral OA scheduled for TKA with no trauma background which is likely not representative for lateral knee OA at large. Third, there is the possibility that the menisci in the subjects might continue to change and become completely destroyed or macerated, which would affect the findings and interpretation of outcomes. Forth, it is unclear whether the hypertrophied lateral menisci in this series (13 cases at the anterior horn, 11 cases at the mid-body, 5 cases at the posterior horn) were truly hypertrophied or alternatively the result of destroyed discoid lateral menisci, a common finding in Korea [27-28]. This would depend on the enrollment of patients with a discoid meniscus in the study, which is unknown and would likely lead to different results. Fifth, as histologic analysis were not done in this series, we cannot definitely conclude that lateral compartment osteoarthritis has various grades of meniscal morphology but we believe that our classification based on previous reports [20] can contribute to understanding different mechanisms of medial and lateral osteoarthritis.

Based on the high prevalence of a hypertrophied medial meniscus in patients with end stage medial osteoarthritis, and the high prevalence of a macerated lateral meniscus in patients with end stage lateral osteoarthritis, other factors such as local biomechanical dynamics and the different surrounding structures for each compartment should be considered and investigated to better understand the development and progression of medial and lateral osteoarthritis. Since the macerated meniscus is the final form of lateral OA, the morphological changes of the meniscus in prior grades of end stage lateral OA should be further studied. Based on the results of this study, the final meniscus abnormality of end stage lateral OA appears to be complete maceration.

Author contributions

All authors made substantial contributions to all of thefollowing: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Conflict of interest

The authors have declared no conflicts of interest.

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Legends

Fig. 1 A, B. The modification of the WORMS assessment method[24]. Schematic drawing (a) and MRI findings (b) are representative of the global meniscus scoring system.

0= intact,

1= minor radial tear or parrot-beak tear

2= nondisplaced tear

3= displaced but no tear

4= displaced tear or partial resection

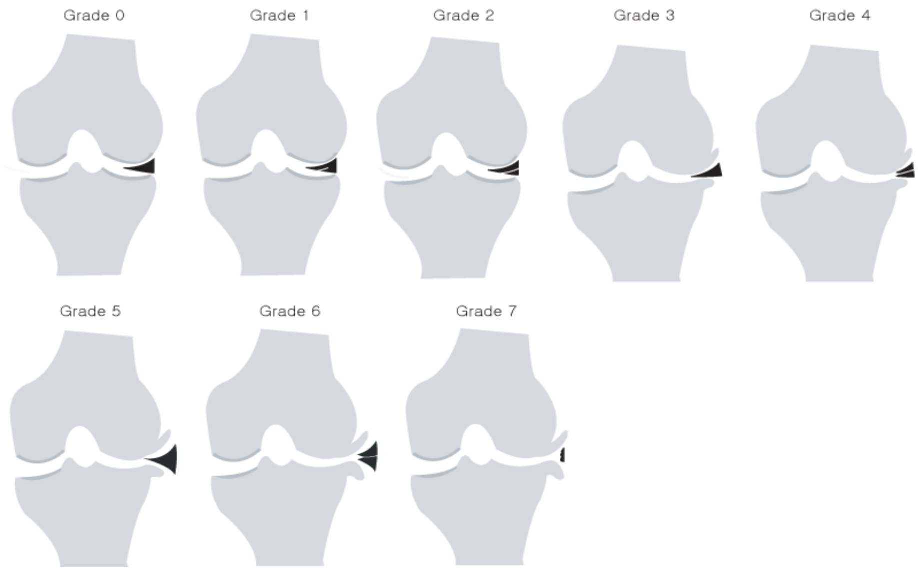
5= hypertrophied displaced

6= hypertrophied displaced tear

7=complete maceration/destruction or complete resection

"Hypertrophy" > 2 mm larger than MM

A)



B)

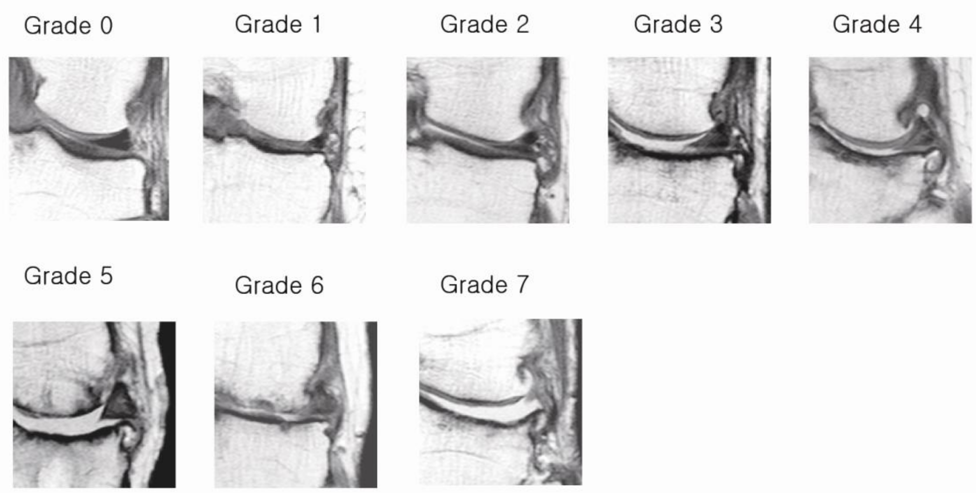

Grade 0
Grade 1
Grade 2
Grade 3
Grade 4
Grade 5
Grade 6
Grade 7

Fig. 2 A, B. Meniscal position was assessed by measuring meniscal subluxation and height for each knee. To determine the meniscal height, the anterior and posterior horns of the menisci were measured in the sagittal plane, which allowed for the best visualization of the greatest meniscal size. The mid-body height was measured in the coronal plane, where the medial and lateral tibial spine volume was maximal. (a) The meniscal height was measured at the most peripheral edge of each meniscus, regardless of whether the meniscus was ‘‘in-place’’, subluxed or extruded. To determine the meniscal subluxation, the anterior subluxation of the anterior horn of the medial and lateral meniscus was assessed in the area where the subluxation was most prominent, based on multiple sagittal slices.(b) Lateral subluxation of the mid-body of the lateral and medial subluxation of the medial meniscus was measured where the volume of the medial and lateral tibial spine was greatest.* Posterior subluxation of the posterior horn was not measured, because this could not be performed accurately in the sagittal plane. For the menisci that were completely macerated or destroyed, meniscal subluxation and meniscal height could not be measured.

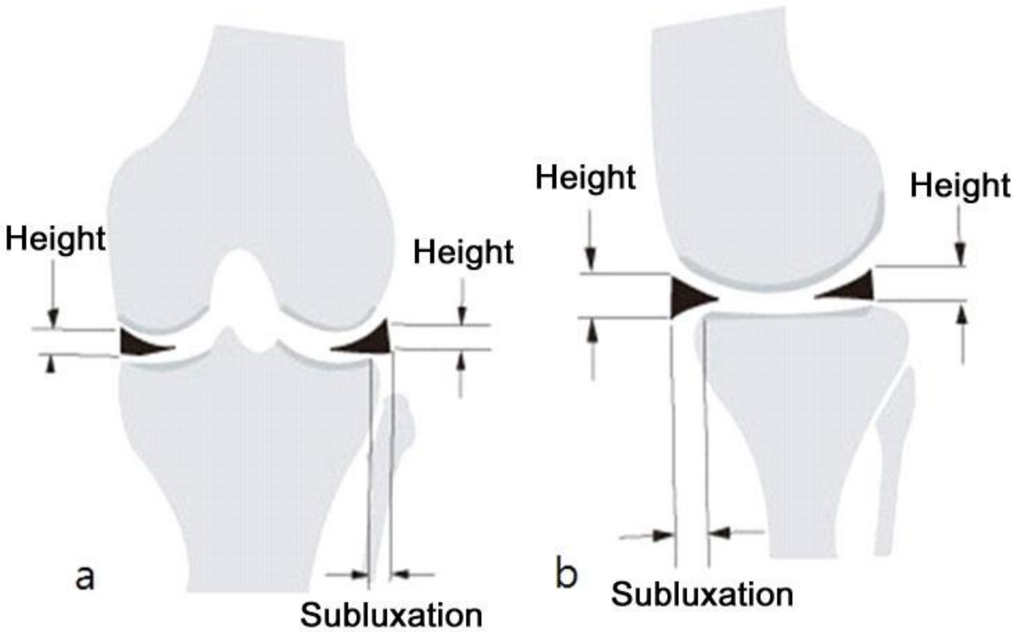

Height
Height
Subluxation
a
Height
Height
b
Subluxation

Table 1. Meniscal morphology at each portion of the lateral meniscus assessed by a modified WORMS method

	Grade 0(%)	Grade 1(%)	Grade 2(%)	Grade 3(%)	Grade 4(%)	Grade 5(%)	Grade 6(%)	Grade 7(%)	Total (%)
Ant. Horn of LM	**1(0.6)**	**0**	**3(1.9)**	**22(13.9)**	**52(32.9)**	**4(2.5)**	**9(5.7)**	**67(42.4)***	**158(100)**
Mid-body of LM	**1(0.6)**	**1(0.6)**	**6(3.8)**	**4(2.5)**	**50(31.6)**	**4(2.5)**	**7(4.4)**	**85(53.8)***	**158(100)**
Post. Horn of LM	**1(0.6)**	**0**	**1(0.6)**	**5(3.2)**	**63(39.9)**	**2(1.3)**	**3(1.9)**	**83(52.5)***	**158(100)**

Grade 0 = intact, 1 = minor radial tear or parrot-beak tear, 2 = nondisplaced tear, 3 = displaced but no tear, 4 = displaced tear or partial resection, 5 = hypertrophied displaced 6 = hypertrophied displaced tear, 7 = complete maceration/destruction or complete resection

*Predominant type in each portion

Table 2. Meniscal position and Meniscal Height for each region of the meniscus, as determined by MR imaging.
MM= Medial meniscus, LM= Lateral meniscus   Mean BMI : 25.8 +_ 3.36(Range:17.92 to 32.39)

		No. of knees (n, total n = 158)	Subluxation of LM	Suluxation of MM	Height of LM	Height of MM
Macerated LM (Grade 7)	Ant. horn	67	Not measured	2.77±2.55 mm (0 to 12.31)§	Not measured	5.38 ± 1.10 mm (3.44 to 8.50)
	Midbody	85	Not measured	2.26±1.98 mm (0.0 to 7.91)	Not measured	5.92 ± 1.60 mm (2.93 to 9.67)
	Post. Horn	83	Not measured	Not measured	Not measured	5.56 ± 1.40 mm (2.5 to 8.9)
Non-macerated LM (remainder)	Ant. horn	91	6.45 ± 3.11 mm* (0 to 12.01)	1.30±1.72mm (0 to 6.74)	5.41 ± 1.98 mm (2.03 to 11.15)	6.35 ± 1.71 mm** (3.01 to 7.91)
	Midbody	73	5.27 ±3.37 mm* (0 to 14.94)	2.44±2.14mm (0 to 7.32)	6.03 ± 1.88 mm (0.25 to 11.70)	7.05 ± 1.83 mm**,§§ (3.14 to 12.89)
	Post. Horn	75	Not measured	Not measured	5.66 ± 1.63 mm (3.01 to 9.08)	5.89 ± 0.92 mm (4.1 to 7.62)

MM medial meniscus, LM lateral meniscus, n total number of knee,

* Statistically significant difference between LM subluxation and MM subluxation for the cases with non-macerated LM, using independent T-test at the anterior horn and midbody (p=0.001).

** Statistically significant difference between LM height and MM height for the cases with non-macerated LM, using independent T-test at the anterior horn and midbody (p=0.001).

§ Statistically significant difference in MM subluxation between cases with macerated LM and non-macerated LM, using independent T-test at the anterior horn (p=0.0001).

§§ Statistically significant difference in MM height between cases with macerated LM and non-macerated LM, using independent T-test at the anterior horn and midbody (p=0.003, p=0.002).

Table 3.Association between FTA and each meniscal morphology

	Anterior horn of lateral meniscus *		Midbody of lateral meniscus **		Posterior horn of lateral meniscus ***	
Meniscus morphology	No.of knee	FTA mean± SD	No.of knee	FTA mean±SD	No.of knee	FTA mean±SD
0	1	8.15	1	0.5	1	0.5
1	0	-	1	2.8	0	-
2	3	11.8±6.4	6	7.2±2.6	1	2.8
3	22	8.2±4.5	4	13.0±4.5	5	13.1±5.8
4	52	8.0±4.6	49	8.4±4.5	62	8.8±5.7
5	4	13.0±9.8	4	17.7±3.7	2	16.3±1.3
6	9	9.1±7.0	7	7.0±3.9	3	6.3±0.9
7	66	10.6±5.8	86	10.0±5.9	84	9.7±5.3
Total	158	9.4±5.5	158	9.4±5.5	158	9.4±5.5

* anteror horn : P-value (oneway ANOVA test): 0.067

** midbody: P-value (oneway ANOVA test): 0.007, grade 5 Vs grade 2 (P=0.030), grade 5 Vs grade 4 (p=0.012). grade 5 Vs grade 6 (p=0.018) in Post-hoc test(Tukey test)

*** posterior horn : P-value (oneway ANOVA test): 0.113

Table 4 Association between sex and meniscal subluxation ,FTA

	Sex	No. of Knees	Mean ± SD	P value
FTA	F	126	9.15±5.36	0.267
	M	32	10.35±5.89	
Subluxation of LM (ant horn)	F	126	3.56±3.93	0.335
	M	32	4.32±4.12	
Subluxation of LM (midbody)	F	126	2.44±3.61	0.180
	M	32	3.40±3.54	
Subluxation of MM (ant horn)	F	126	1.85±2.19	0.460
	M	32	2.18±2.37	
Subluxation of MM (midbody)	F	126	2.51±2.03	0.042
	M	32	1.68±2.01	