Does lifestyle affect the incidence of medial meniscus posterior root tears?

(Risk factors associated with medial meniscus posterior root tears)

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Abstract

Background: Medial meniscus posterior root tear (MMPRT) have a different clinical impact than the other types of meniscal tears. They result in two separate pieces of menisci with attachment to the tibia at only one end. Asian people show a high incidence of MMPRT. The present study was designed to identify the risk factors for MMPRT and the reason why Asian people have a high incidence.

Methods: We performed an observational study of 476 consecutive patients undergoing an arthroscopic procedure on their medial meniscus from January 2010 and December 2010. One hundred and four were diagnosed as MMPRT (group 1), the others as other types of medial meniscus tear (group 2). Demographic (age, gender, BMI), anatomical (mechanical axis angle [MAA], tibia vara angle [TVA], tibial slope angle [TSA], Kellegren-Lawrence grade [KLG]), and environmental (occupation, trauma history, sport activity level, table use or not, bed use or not [we supposed that the last two indices were indicators of the frequency of lotus position and squatting in daily living]) factors were surveyed. We assessed the relation of these risk factors to the different groups of medial meniscus tear (group 1 or 2).

Results: There were 7 male and 97 female patients in group 1, and 136 male and 236 female patients in group 2 ($p<0.01$). The average age at the time of surgery was 58.2 years (range: 39 to 78 years) in group 1, and 54.3 years (range: 17 to 77 years) in group 2 ($p<0.01$). BMI was 26.7±3.4 in group 1, and 24.9±3.1 in group 2 ($p<0.01$). KLG was 1.4±0.8 in group 1, and 0.9±0.6 in group 2 ($p<0.01$). With regard to anatomical factors, only MAA showed significantly increased varus alignment in group 1 ($4.5^{o}\pm3.4^{o}$) than group 2 ($2.4^{o}\pm2.7^{o}$) ($p<0.01$). Environmental factors showed no differences in occupational, table use or not, and bed use or not, except sport activity level. There were 41 patients (42.7%) in group 1 and 77 patients (20.6%) in group 2, who did not participate in any recreational activity ($p<0.01$).

Logistic regression analysis showed that female gender was associated with a 5.9-fold increase in risk (95% CI; 2.138-16.575), a varus MAA with a 3.3-fold increase (95% CI; 1.492-7.153), a more than 30 kg/m^2 in BMI with a 4.9-fold increase (95% CI; 1.160-20.955).

Conclusion: This study showed that MMPRT had significant advancing age, female gender preference, high BMI, increased KLG, varus MAA, low sport activity level. The contributing risk factors were gender, BMI, and MAA. Interestingly, oriental specific lifestyles like lotus position and squatting showed no contribution to increased MMPRT. This suggests that intrinsic risk factors (similar to those that predispose to osteoarthritis) predispose to MMPRT.

Introduction

Radial tears of the posterior horn of the medial meniscus (MMPRT) have a different clinical impact than that of most other meniscal tears, which result in two separate pieces of menisci with attachment to the tibia at only one end. This permits meniscus to displace peripherally and to lose hoop stresses and leads to degenerative changes. These tears were more common than previously known with rate of 10.1% to 10.5% of the meniscus tear[1,2].

Several proposed risk factors for sustaining MMPRT are mentioned as age, BMI, gender, injury, and cultural environment. However, the relative importance of these risk factors has not been systematically investigated, although there are several previous reports that together present somewhat confusing evidence for apparent relationships between selected variables and MMPRT.

The purpose of this retrospective study was to contribute to the systematical understanding of variables (demographic, anatomical, and environmental factors) and their associations with MMPRT.

Materials and Method

Patients

We retrospectively reviewed the records of large group of patients 564 patients who underwent arthroscopic meniscectomy or meniscal repair for tears of the medial meniscus between January 2010 and December 2010, based on the exclusion criteria; patients with ligament laxity, lateral meniscal tear, systemic arthritis, osteonecrosis, or other combined ligament injury. There were 121 patients diagnosed as MMPRT and 443 patients as other typed medial meniscus tear. Of those patients, it was possible to review all pertinent information and get informed consent in 104 patients

(86%) of MMPRT (group 1), and 372 patient (84%) of other typed meniscus tear (group 2) by the medical records, phone, or clinic visit. Hospital Ethic Committee approval was obtained. The surgical indication was persistent medial joint area pain despite 3 months of conservative treatment.

Demographic factors include in this study are age, gender, BMI. Anatomical factors include mechanical axis angle (MAA), tibia vara angle (TVA), tibial slope angle (TSA), and Kellegren-Lawrence grade (KLG)[3]. Environmental factors include occupation, trauma history, sport activity level, table use or not, bed use or not.

Preoperatively, the standing hip-knee-ankle radiographs were taken and MAA was measured. MAA is the angle between a line from the center of the femoral head running distally to the mid-condylar point between the cruciate ligaments (femoral mechanical axis) and a line from the center of the tibial plateau extending distally to the center of the tibial plafond (tibial mechanical axis) in radiographs of the entire lower limb[4]. TVA is the angle between the tibial plateau tangent and the tibial mechanical axis (a line from the center of the tibial plateau extending distally to the center of the tibial plafond). On lateral radiographs, TSA was measured as the angle between the posterior tibial anatomical axis (a line from the center of cortex between 5 cm distal to the tibial tubercle and 15 cm distal to proximal joint facet) and the line tangential to the proximal joint facet of tibia[5]. Compartment specific KLG was measured at extension weight bearing views. Type of occupation was categorized as white/blue collar. Trauma history was categorized as none/memorial. Sport activity level was categorized as none/recreational. Variables about Table use or not and bed use or not are representative of oriental life style of lotus position (knees flexed and internally rotated) and squatting.

To access the reliability, each evaluation (KLG, MAA, TVA, and TSA) was measured by two experienced researchers, who were blinded to the information of the patients. The average of the two individual mean values was used.

SPSS (Statistical Package of the Social Science, v. 12.0, Chicago, IL) was used for statistical analyses. For the continuous data, a two sample's t-test was used to compare the two groups. A chi-square test was employed to compare the categorical ordinal data of the two groups. Multiple linear regression analysis was performed on variables thought to be associated with root tear according to the bivariate analyses (entry criterion $p<0.05$). Odds ratios (OR) and confidence intervals (CI) were reported for variables significantly associated with the outcome as defined by Wald's test. The interobserver reliability in measuring KLG, MAA, TVA, and tibial slop was evaluated using the intraclass correlation set at a 95% confidence interval. A level of significance was set at <0.05.

Funding Sources

There were no external funding sources for this study.

Result

Bivariate analyses of variables are provided in Table 1. With regard to demographic factors, there were 7 male and 97 female patients in group 1, and 136 male and 236 female patients in group 2 ($p<0.01$). The average age at the time of surgery was 58.2 years (range: 39 to 78 years) in group 1, and 54.3 years (range: 17 to 77 years) ($p<0.01$). BMI was 26.7±3.4 in group 1, and 24.9±3.1 in group 2 ($p<0.01$). KLG was 1.4±0.8 in group 1, and 0.9±0.6 in group 2 ($p<0.01$) (the intraclass correlation coefficient for inter-tester reliability were 0.854 and 0.867, respectively). With regard to anatomical factors, only MAA showed significantly increased varus alignment in group 1 ($4.5^{o}\pm3.4^{o}$) than group 2 ($2.4^{o}\pm2.7^{o}$) ($p<0.01$) (the intraclass correlation coefficient for inter-tester reliability were 0.826 and 0.833, respectively). Environmental factors showed no differences in occupational, trauma history, table use or not, and bed use or not, except sport activity level. There were 41 patients (42.7%) in group 1 and 77 patients (20.6%) in group 2, who don't have any recreational activity ($p<0.01$).

The multiple logistic regression model provided estimates of the magnitude of association for risk factors of interest (Table 2). Female gender was associated with a 5.9-fold increase in risk (95% CI; 2.138-16.575), a varus MAA with a 3.3-fold increase (95% CI; 1.492-7.153), a more than 30 kg/m^2 in BMI with a 4.9-fold increase (95% CI; 1.160-20.955). However, advancing age was not associated any increase in risk between MMPRT and other typed medial meniscus tear.

Discussion

MMPRT have attracted renewed attention over recent years, mainly because of concerns of significant loss of primary biomechanical meniscus functions in preventing extrusion of the medial meniscus and preserving normal medial meniscal position and function, leading to a condition biomechanically similar to a total meniscectomy. However, studies of clinical features, characteristics, and risk factors have not been systematically investigated, although there are several previous reports focusing on surgical technique and clinical outcome.

This study was conducted to investigate the epidemiologic characteristics of MMPRT and relevant risk factors. The incidence of MMPRT has not been thoroughly investigated. Several studies have suggested that up to 27.8% of all medial meniscal tears are MMPRT[1,2]. Our series showed that 21.5% (121/564) of the patients who were treated for medial meniscus tear was diagnosed as MMPRT.

Bin et al.[1] reported that, among MMPRT, 81 of 96 (84.4%) patients were female, 75 of 96 (78.1%) patients were older than 50 years. Ozkoc et al.[2] reported that 47 of 67 (70.1%) patients were female, 54 of 67 (80.6%) patients were older than 50 years, 54 of 67 (80.6%) of patients were obese (more than 30 kg/m^2 in BMI). Especially, they postulated that lifestyle of lotus position and squatting was responsible for the high incidence of MMPRT, and explained that these lifestyle lead to high incidence of MMPRT in Asian people.

In this study, we confirmed that female gender is of the utmost important risk factors in MMPRT. In addition, certain demographic factor (higher BMI), anatomical factors (varus MAA, increased KLG), and environmental factor (decreased sport activity level) contributed as risk factors for MMPRT. Anatomical factors representing regional knee geometry such as TVA, TSA revealed no differences between two groups. However, overall lower limb geometry such as MAA contributed to the development of MMPRT.

We may postulate from these findings (MMPRT were common in those of elderly age, increased KLG and BMI.) that MMPRT has a location in the spectrum of degenerative joint disease. Generally, degenerative meniscal changes are thought to predispose the meniscus to the development of symptomatic meniscal tears. The posterior horn of the medial meniscus endures most of the stress applied to the medial compartment. The posterior horn region has little mobility due to its strong attachment to the tibia at the meniscal root. Hence, the medial meniscus posterior horn is particularly vulnerable to injury including micro-injury, which can lead to degeneration and tearing[6,7]. Ford et al.[8] demonstrated a significant associations between increasing BMI and meniscal tears leading to surgery. Moreover, our study demonstrated that MMPRT was more positively associated with high BMI than other typed medial meniscus tear. Also, increased KLG and varus MAA have a same effect on MMPRT as high BMI.

Inconsistent with other reports, we found that advancing age and oriental lifestyle of lotus position and squatting (not using a bed or a table) showed no differences between two groups. Bivariate analysis showed that 96/104 (92.3%) patient in group 1 and 271/372 (72.9%) patients in group 2 were older than 50 years old ($p<0.01$). However, advancing age does not have a weighted effect on MMPRT compared to other typed medial meniscus tear. We thought that age factor have an even effect on medial meniscus tears regardless of location of tear.

Interestingly, lifestyle showed no differences between two groups. Bin et al.[1] said that oriental lifestyle might lead to impingement of the posterior meniscal segment more often, and eventually the resultant degenerated posterior horn would be prone to tear, based on the kinematic analysis shown that menisci are dynamic structures that move anterior with extension and posterior with flexion[9]. We thought that Asian people need lotus position and squatting in activities of daily living from young children, which made knee structures (including musculature and ligament structure) adapt to these circumstances.

Group 1 has lower portion of high performance athletes than group 2. We might assume from these findings that inadequate quadriceps muscle strength is prone to cause MMPRT. Baker et al.[10] reported that lower extremity muscle weakness may play an important role in degenerative joint disease.

MMPRT showed little correlation with traumatic injury. Actually, none of the patients had a history of major knee trauma. However, mechanical meniscal symptoms such as pain on climbing, stairs, squatting, getting up and down were more common in MMPRT (30/104 [29.2%] patients in group 1, 60/372 [16.2%] patients in group 2 ($p<0.01$)).

We acknowledge that the present study had some limitations. First, enrolled patients in this study underwent arthroscopic procedure, which impose selection bias. Therefore, it may be improper to translate the present findings into an asymptomatic or conservatively managed meniscal tears, also into an end staged osteoarthritis patients associated with meniscal tears. Second, we did not subdivide the type of meniscal tear. MMPRT is defined as location (posterior horn) and type (radial tear) of medial meniscus tear. In this study, we just focused on the location, not on tear type. Interestingly, MMPRT is caused by degenerative process, though the tear type of MMPRT is radial tear (Commonly, most of radial tear of body and posterior horn is caused by trauma). Third, this study included 84.4% of all included patients. However, we thought that the number of eligible patients (476 patients) could weaken this limitation.

Conclusion

This study showed that MMPRT had significant advancing age, female gender preference, high BMI, increased KLG, varus MAA, low sport activity level. The contributing risk factors were gender, BMI, and MAA. Interestingly, oriental specific lifestyles like the cross legged position and kneeling showed no contribution to increased MMPRT. This suggests that intrinsic risk factors (similar to those that predispose to osteoarthritis) predispose to MMPRT.

Table 1. Demographics

	Group I (N=104)	Group II (N=372)	p-value
Age (years)	58.2 (39 to 78)	54.3 (17 to 77)	<0.01
Sex (M/F)	7/97	136/236	<0.01
BMI* (kg/m2)	26.7 ± 3.4	24.9 ± 3.1	<0.01
KLG†	1.4 ± 0.8	0.9 ± 0.6	<0.01
TVA‡ (degrees)	4.9 ± 2.3	4.2 ± 2.5	0.07
TSA※ (degrees)	10.4 ± 3.0	9.8 ± 3.7	0.25
Bed use	34/62 (55%)	25/43 (58%)	0.74
Table use	41/96 (42.7%)	32/68 (47.1%)	0.43
Occupation (blue-collar/total)	33/96 (34.4%)	17/69 (25%)	0.87
Sport activity(recreational/total)	41/96 (42.7%)	14/68 (20.6%)	<0.01

*BMI, body mass index
†KLG, Kellegren-Lawrence grade
‡TVA, tibia vara angle
※TSA, tibial slope angle
BMIGroup I: medial meniscus posterior root tear, Group II: other typed medial meniscus tear

Table 2. Logistic regression model of the potential risk factors for medial meniscus posterior root tear.

	Adjusted odds ratio	Lower 95% CI	Upper 95% CI*	p-value
Age (years)				
<50	Reference			0.429
50 to 60	2.172	0.688	6.849	0.186
60 to 70	2.767	0.821	9.321	0.101
>=70	1.818	0.381	8.681	0.454
Female gender	5.953	2.138	16.575	0.001
BMI† (kg/m2)				
<25	Reference			0.067
25 to 30	1.746	0.821	3.713	0.148
>=30	4.929	1.160	20.955	0.031
MAA‡				
Nertral (0 to 2)	Reference			0.012
Varus (<0)	3.267	1.492	7.153	0.003
Valgus (>=2)	2.174	0.445	10.615	0.337

*CI, confidence interval
†BMI, body mass index
‡MAA, mechanical axis angle
Group I: medial meniscus posterior root tear, Group II: other typed medial meniscus tear

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