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Medial Abrasion Syndrome: A Neglected Cause of Knee Pain in Middle and Old Age

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Abstract: Knee pain is a prevailing health problem of middle and old age. Medial plica-related medial abrasion syndrome (MAS), although a well-known cause of knee pain in younger individuals, has rarely been investigated in older individuals. This prospective study was conducted to investigate the prevalence and clinical manifestations of this syndrome as a cause of knee pain in middle and old age. The outcomes of arthroscopic treatment for this syndrome were also evaluated.

A total of 232 knees of 169 patients >40 years of age (41–82, median: 63 years old) suffering from chronic knee pain were analyzed. The clinical diagnosis, predisposing factors, presenting symptoms, and physical signs were investigated. The sensitivity and specificity of each parameter of the clinical presentation for the diagnosis of MAS were evaluated after confirmation by arthroscopy. For patients with MAS, the roentgenographic and arthroscopic manifestations were investigated, and arthroscopic medial release (AMR) was performed. The outcomes were evaluated by the changes in the pain domain of the Knee Society scoring system and by patient satisfaction. The prevalence of medial plica was 95%, and osteoarthritis (OA) was the most common clinical diagnosis. Symptoms of pain and crepitus in motion and local tenderness during physical examination were the most sensitive parameters for the diagnosis. A history of a single knee injury combined with local tenderness and a palpable band found during physical examination were the most specific parameters for the diagnosis. The majority of patients suffering from this syndrome were successfully treated using AMR, yielding a satisfaction rate of 85.5% after a minimum of 3 years.

MAS is a common cause of knee pain in middle and old age and can be effectively treated by AMR. Its concomitance with OA warrants further investigation.

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Abbreviations: AMR = arthroscopic medial release, KSS = Knee Society scoring system, IL-1β = interleukin-1β, MAS = medial abrasion syndrome, MMP-3 = matrix metalloproteinase-3, OA = osteoarthritis.

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INTRODUCTION

Chronic knee pain is a prevalent health problem of middle and old age.[1] It has been found to be significantly associated with lower quality of life and is a major public health issue.[2–4] Effective prevention and early treatment of knee pain at these ages has a major influence on healthy aging in the population.[5] In the younger population, knee pain can have many possible causes, with medial plica syndrome always mentioned in the differential diagnosis[6]; in contrast, osteoarthritis (OA) is regarded as the most common cause of knee pain in middle-aged and older people in addition to trauma-related conditions, such as meniscus and/or ligament injury, crystal-induced inflammatory arthropathy, and rheumatoid arthritis.[7,8] Therefore, the issue of knee pain during middle and old age has always been intermingled with OA in the literature.[1–3,7,9,10]

Although OA is the most common concomitant diagnosis of the patients with knee pain in this age group, the etiology and mechanism of the pain have yet to be fully understood. Many studies have been conducted to investigate the origin of pain in the OA knee,[11–16] and they have reached the consensus that it is multifactorial, including psychosocial factors, mechanical factors (eg, misalignment, valgus-varus laxity, body mass index, and abnormal gait), subchondral bone abnormalities (eg, denuded subchondral bone and bone marrow lesions), and synovitis. Within these factors, synovitis has recently been increasingly recognized as an important feature of the pathophysiology of the OA knee.[17] It was not only proven to be strongly correlated with knee pain severity[18,19] but also considered a predictive factor of subsequent advanced chondropathy in the OA knee.[20] Therefore, synovitis treatment must be considered when treating OA knee pain.[21]

The mediopatellar plica is a fold in the synovium that represents an embryologic remnant in the development of the knee's synovial cavity.[22,23] Although the prevalence of medial plica ranges widely, from 22% to 95%,[24–26] it is generally agreed that this structure can produce knee pain and can be successfully treated by arthroscopic resection in the event that it becomes inflamed, thickened, and/or less elastic.[27–29] In a review of the literature, it appears to be only recognized as one of the main causes of knee pain in adolescents or young adults.[23,25–30] With the exception of a small number of case reports,[31] few studies have specified this well-known structure in their descriptions with regard to its presentation or clinical manifestation in older populations. Recent studies[32–36] that investigated the chronological evolution of medial plicae disclosed that medial plica was more commonly found in patients with OA knees and that the severity of the degeneration was positively correlated with the severity of the medial plica and the patient age. According to these studies, the abrasion from repeated friction between the medial plica and the facing medial femoral condyle during daily activities would increase the severity of the pathologic change in the medial plica and give rise to clinical symptoms such as synovitis and pain. Surgical eradication of this abrasion could cure most patients' pain and even decelerate or halt the

degenerative process in their knees.[37,38] However, there is no study in the literature that has focused on the clinical presentation of medial plicae in middle-aged and older individuals.

In this study, the prevalence and clinical manifestations of medial plica-related medial abrasion syndrome (MAS) in a population of middle-aged and older patients suffering from chronic knee pain were prospectively investigated. This syndrome was evaluated and defined by its clinical manifestations, including predisposing factors, symptoms, signs, radiographic manifestations, and arthroscopic findings. The clinical outcome of pain relief by arthroscopic medial release (AMR)[37] for this syndrome was also investigated. We postulated that this syndrome would be a common cause of knee pain in this age group and could be effectively treated using AMR.

MATERIALS AND METHODS

From March to August 2007, 176 consecutive patients >40 years, with a total of 243 knees that had received arthroscopic surgery at our institute by the first author, were included in this prospective study. All these patients were referred from other institutions with a given clinical diagnosis and had been treated conservatively, including physical therapy and medication, for >1 year. For the 67 bilateral cases, each knee was evaluated as an individual case.

Preoperative Evaluation

The predisposing factors and presenting symptoms were questioned and recorded by a nursing specialist for each knee. The presenting physical signs of each knee were evaluated by the first author. During the history taking and physical examination, special attention was paid to the medial plica-related items that are described in the next subsections.

Predisposing Factors

Injuries

The presentation of a single episode of injury, such as knee buckling when it was suddenly bent, direct blunt injury over the anterior-medial aspect of the knee, or unexpected twisting of the knee (eg, change of position when kneeling).

Overuse

Having a history of repeated bending (such as squatting, kneeling, climbing stairs, hiking on slopes, climbing mountains, or bicycling) for either occupational or recreational reasons or of prolonged bending (such as driving or taking any transportation vehicle for a long distance) of the involved knee.

Symptoms

Pain

The pain was always described as a deep, throbbing, or sharp ache that would intensify when climbing stairs, sitting with the knees flexed for long periods of time, rising from a sitting position, or extending the knee against resistance. Night pain and difficulty finding a suitable sleep position were also common complaints. Some patients pointed to the anterior-medial aspect of the knee when providing the location of the pain.

Crepitus

A feeling or hearing of clicks or crepitus when the involved knee was flexed or extended after prolonged sitting, possibly accompanied by pain.

Snapping or Locking

A feeling of buckling or a sense of insecurity or pseudo-locking in a particular position, which mostly occurs when the knee is partially bent while bearing weight. Occasionally, locking occurs when a patient stands up to walk after sitting or lying down for a long period of time. The knee will unlock after standing for a few minutes.

Signs

Localized Tenderness

Precise tender area over the region between the inferior-medial margin of the lower pole of the patella and the ridge of the medial femoral condyle.

Palpable Band

A palpable band with snapping or crepitation over the tender area mentioned earlier.

Arthroscopic Surgery

All procedures were performed under either spinal or general anesthesia. During arthroscopic examination, special focus was placed on the presentation of the medial plica and the chondral lesions in the knee as clues for medial abrasion (see Supplemental Video, http://links.lww.com/MD/A247, which demonstrates the medial abrasion phenomenon). The size and appearance of the medial plicae and the location and severity of the cartilaginous degeneration over the medial femoral condyle facing the medial plica were inspected and recorded according to Lyu and Hsu classification.[34] The cartilaginous degeneration over the medial, lateral, and patellofemoral compartments was recorded based on the Outerbridge classification.[39] To investigate the relationship between the severity of the degeneration in different parts of the knee and that of the plical lesion, an arbitrary scoring system was defined to represent the severity of the cartilaginous degeneration on the medial femoral condyle facing the medial plica, medial compartment, lateral compartment, patellofemoral joint, and the whole knee, as shown in Table 1.

For patients with a medial plica, AMR[37] was performed to remove the tissue occupying the space over the inferomedial region of the patella, including the ligamentum mucosum, fibrotic or inflamed synovium, capsule, and distal part of the medial plica. The tight and obliterated medial facet of the patellofemoral joint (Fig. 1A) was released by medial retinaculotomy (Fig. 1B). The adequacy of the medial release was checked by pushing the tip of the scope under the patella and

TABLE 1. Degenerative Score of the Medial Femoral Condyle (Foci A and B) Facing the Medial Plica (S_{mfc}), Medial Compartment (S_{mc}), Lateral Compartment (S_{lc}), Patellofemoral Joint (S_{pf}), and the Whole Knee (S_{wk})

	Location					
	S_{mfc}					
Grade	A	B	S_{mc}	S_{lc}	S_{pf}	S_{wk}
I	10	10	10	10	5	25
II	20	20	20	20	10	50
III	30	30	30	30	15	75
IV	40	40	40	40	20	100
V	50	50				
Total	100		40	40	20	100

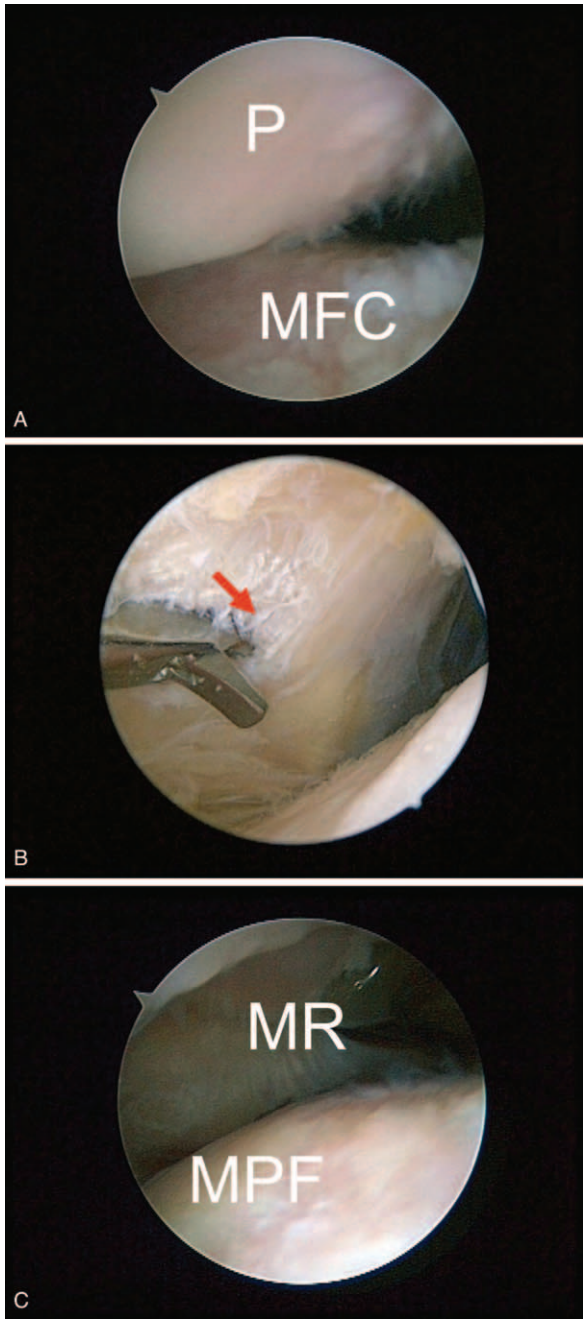

FIGURE 1. Arthroscopic medial release (AMR). (A) Before AMR, the space between the patella (P) and the medial femoral condyle (MFC) was tightly closed. (B) During AMR, the medial retinaculum including the fibrotic fascia of the pes anserinus (arrow) was severed to obtain adequate release. (C) After AMR, the medial facet of the patellofemoral joint was opened and the medial retinaculum (MR) became visible.

verifying if the previously tightly closed medial patellofemoral joint space could be easily opened and the medial retinaculum was clearly visible when the knee was fully extended (Fig. 1C). For patients with a meniscus tear, a partial meniscectomy was performed only when there was evidence of impingement. No reconstruction was performed for knees with ligament injury.

Postoperative Management

For patients who received AMR, suction drain was used for 24 hours. The involved limb was protected by an elastic bandage for 1 week. Full range of motion and free ambulation were allowed as tolerated. The patient was discharged the day after the operation. Home exercise programs, including active range of motion and quadriceps setting, were emphasized.

Follow-Up and Evaluation of Outcomes

Regular follow-up was undertaken monthly for 6 months. Thereafter, patients returned yearly for outcome evaluation. Of the 176 patients with 243 knees at the beginning of the study, 169 patients with 232 knees completed the 3-year follow-up study. The follow-up rates were 96% of the patients or 95.5% of the knees studied.

The pain domain of the Knee Society scoring system (KSS) was used to evaluate the pain preoperatively on the day before surgery and postoperatively on the last clinic visit. The score ranges from 0 to 50 points, with 50 points indicating no pain and 0 point indicating severe pain.[40] In addition, subjective satisfaction was assessed by asking patients using the criteria we developed for this study as follows: excellent, free of symptoms and no limitation in activities; good, greatly improved, occasional pain without pain medication, and normal activities; fair, same as preoperative condition and no improvement; and poor, has received or considered further operative treatment. The outcome was regarded as satisfactory if the subjective satisfaction was rated as ''excellent'' or ''good.'' The inquiry of subjective satisfaction ratings and evaluation of KSS scores were conducted by 2 different nursing specialists. In bilateral cases, each knee was evaluated separately.

This study was approved by the Research Ethics Committee of the Buddhist Dalin Tzu Chi General Hospital, which is certified by the Department of Health in Taiwan (IRB Approval Number: B09704022). Informed consent forms were obtained from all the patients who participated in this study.

Statistical Evaluation

The data and normality of data distribution were validated, and nonparametric analysis was used in this study. All values are presented as medians and ranges. Comparisons were made using the Kruskal–Wallis test to detect differences in the patients' age distribution and the type and severity of the medial plica in each grade of OA. Comparison of the preoperative and postoperative Knee Society pain scores was performed using the Wilcoxon signed-rank test. The difference between categorical variables was tested with Pearson χ^2 test. A P value less than 0.05 was considered to be statistically significant. SPSS version 15 (SPSS Inc., Chicago, IL) was used to analyze the data.

RESULTS

The median age of the patient cohort was 63 years (range, 41–82 years old). Of the 169 patients, 139 (82%) were female.

Clinical Manifestations

The age distribution and the prevalence of medial plica found in each subgroup of patients by diagnosis are shown in Table 2. OA was the most common clinical diagnosis (205/232, 88.4%). All the patients with the diagnosis of meniscus tear and ligament injury had received previous arthroscopic surgery at other hospitals. The prevalence of medial plica in the full study

TABLE 2. Age Distribution and Prevalence of Medial Plica by Diagnosis

Diagnosis	Number of Knee (Male/Female)	Number of Plica (Male/Female)	Mean Age (95% CI)	Prevalence (%) (Male/Female)
Osteoarthritis	205 (28/177)	197 (28/169)	64 (63–65)	96 (100/95)
Meniscus tear	11 (6/5)	11 (6/5)	47 (43–51)	100 (100/100)
Ligament injury	8 (6/2)	6 (4/2)	45 (41–48)	75 (67/100)
Gouty arthritis	4 (4/0)	2 (2/0)	51 (41–60)	50
Rheumatoid arthritis	4 (0/4)	4 (0/4)	55 (48–62)	100
Total	232 (44/188)	220 (40/180)	62 (61–63)	95 (91/96*)

CI = confidence interval.
* $P = 0.19$ (not statistically significant).

was 95%, and there was no significant difference between the genders.

The sensitivity and specificity of each parameter regarding the predisposing factors, symptoms, and signs for the diagnosis of medial plica-related MAS are shown in Table 3. Overuse, of some variety, was the most common response to inquiries regarding disease history. Nevertheless, having a history of knee injury was a more specific predisposing factor for MAS. The main complaint of the patients with MAS was pain localized over the anteromedial aspects of their knees. They would also describe episodes of crepitus, catching or snapping when performing specific activities when bending the knee was required. Although the sensitivity of pain and crepitus was high, the specificity of these symptoms was low and not reliable for the diagnosis of MAS. The most sensitive and specific test during the physical examination was the reproducible local tenderness over the inferior-medial margin of the lower pole of the patella and the ridge of the medial condyle. The finding of a palpable band, although not common, was another specific finding for the diagnosis of MAS. Although effusion occasionally occurred and represented acute inflammation, its sensitivity and specificity were also low.

Radiographic Findings

Varying degrees of the roentgenographic manifestation of MAS, including joint space narrowing, spur formation, subchondral sclerosis, and cystic formation, were observed in the axial view (Merchant view) of the patellofemoral joint, as shown in Fig. 2. However, in the early stage of this syndrome, using this special view to make a diagnosis is difficult due to the commonly concurrent lateral deviation or compression of the patella.

Arthroscopic Findings

For the knees with a medial plica, the age distribution of the different types of medial plica for each grade of severity is summarized in Table 4. The median age of each type and each grade of medial plica were statisticlly different ($P < 0.001$) after comparing each group using the Kruskal–Wallis test.

For the patients who had received previous arthroscopic surgery for meniscus tear (N = 11) or ligament injury (N = 8), marked fibrotic change in the medial plica was common. No further operation was mandated for the menisci or ligaments of these patients.

Hidden Lesions

After adequate synovectomy and releasing of the inferomedial area of the patella and medial gutter, 2 distinct foci of cartilaginous lesions described by Lyu and Hsu[34] could be found on the edge and anterior part of the medial femoral condyle (Fig. 3). They were called ''hidden lesions'' because on most occasions, due to either synovitis or tightness of the joint

TABLE 3. Sensitivity and Specificity of Each Parameter Regarding Predisposing Factors, Symptoms, and Signs for the Diagnosis of the Presence of a Medial Plica

	Predisposing Factors			Symptoms			Signs	
Diagnosis	Injury	Overuse	Pain	Crepitus	Snapping	Local Tenderness	Palpable Band	Effusion
Osteoarthritis (197/8)†	20/0‡	97/6	197/8	165/8	77/4	196/0	84/0	55/2
Meniscus tear (11/0)	11/0	0/0	11/0	11/0	11/0	11/0	0/0	2/0
Ligament injury (6/2)	6/2	0/0	6/0	2/0	6/2	6/0	2/0	2/0
Gouty arthritis (2/2)	0/0	0/0	2/2	0/0	0/0	0/0	0/0	2/2
Rheumatoid arthritis (4/0)	0/0	0/0	4/0	2/0	0	4/0	0/0	4/0
Total (220/12)	37/2	97/6	220/10	180/8	94/6	217/0	86/0	65/4
Sensitivity/Specificity (%)	17/83*	40/50	100*/17	82*/33 2	43/50	99*/100*	39/100*	30/67

* > 80% of sensitivity or specificity.
† A/B A: number of knees having the structure of medial plica (group A); B: number of knees did not have the structure of medial plica (group B).
‡ C/D C: number of knees having the specified parameter in group A; D: number of knees having the specified parameter in group B.

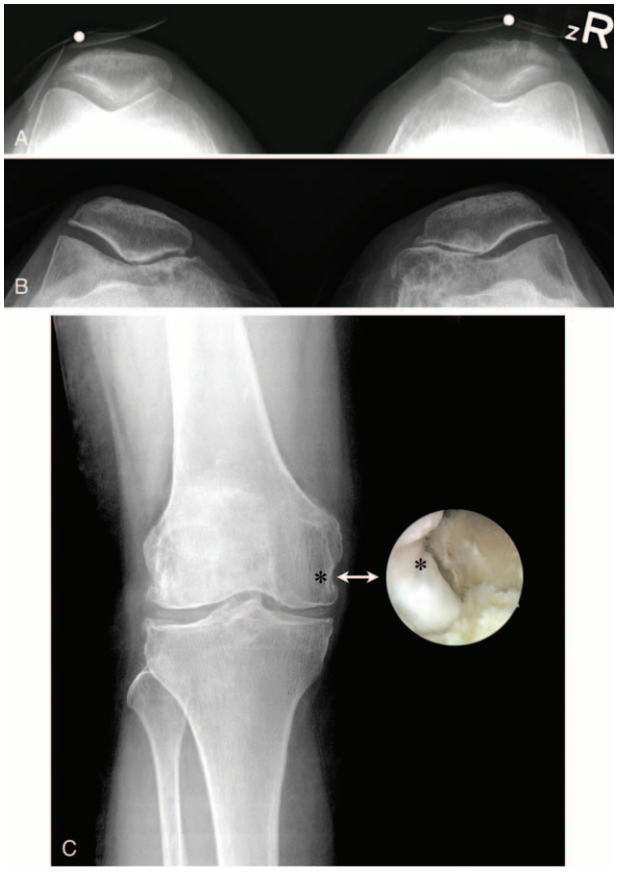

FIGURE 2. Radiographic findings of medial abrasion syndrome. (A) Narrowing of the medial patellofemoral joint space is demonstrated in this axial (Merchant) view. (B) Narrowing of the medial patellofemoral joint space with osteophyte formation, and subchondral cysts and hypersclerosis of the subchondral bone are obvious in this severe case. (C) A deep groove observed over the medial femoral condyle in this anterior–posterior view represents a Stage V hidden chondral lesion observed by arthroscopy (marked by ''∗'').

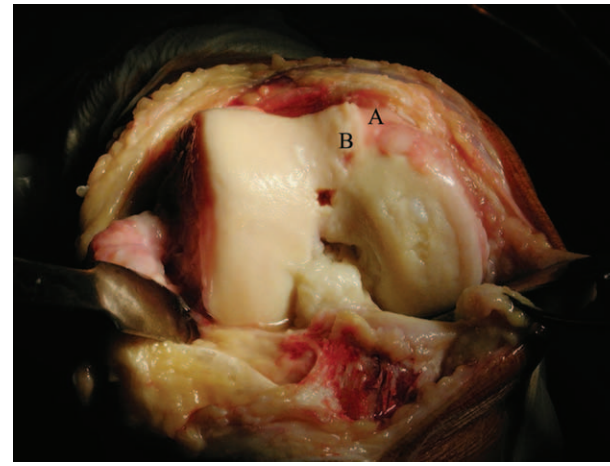

FIGURE 3. Cartilaginous lesions associated with medial abrasion syndrome (MAS). Two distinct foci (A and B) of cartilaginous lesions on the edge and anterior part of the medial femoral condyle caused by MAS are demonstrated in this knee, which is receiving arthroplasty.

space, these lesions were easily overlooked during routine arthroscopic examination. Only after adequate medial release did they become visible (Fig. 4). The appearance of these focal cartilaginous lesions was unique and different from what has been described in the classical arthroscopic classification of cartilaginous lesions. These lesions could be classified into 5 stages by Lyu and Hsu as shown in Fig. 5.[34] The severity of cartilaginous degeneration in individual locations represented by the arbitrary scoring system shown in Table 1 is summarized in Table 5. We found that the severity of degeneration in each individual location and in the whole knee were negatively correlated with the size and positively correlated with the severity of the medial plica.

Clinical Outcome

As shown in Tables 6 and 7, the subjective satisfaction rating of the patients suffering from MAS who received AMR was 85.5%, and their Knee Society pain scores improved from 8 (range, 4–28) to 50 (range, 30–50). After comparing their

TABLE 4. Distribution of Median (Range) Ages and Number of Knees for Each Type of Plica in Relation to Each Grade of Severity

	I	II	III	IV	V	Total
A	0	2[†]	2	6	34	44
	—	55 (55–55)[‡]	59 (59–59)	63 (63–63)	69 (58–80)	67.5 (55–80)[*]
B	0	15	4	31	118	168
	—	48 (41–61)	56 (56–56)	64 (50–73)	63 (41–82)	62 (41–82)
C	0	2	0	1	5	8
	—	61 (61–61)	—	50 (50–50)	48 (47–61)	55.5 (47–61)
Total	0	19	6	38	157	220
	—	52 (41–61)	56 (56–59)	63 (50–73)	65 (41–82)[*]	63 (41–82)

[*] Statistically significant using the Kruskal–Wallis test ($P < 0.001$).
[†] Number of knees.
[‡] Median (range) of ages.

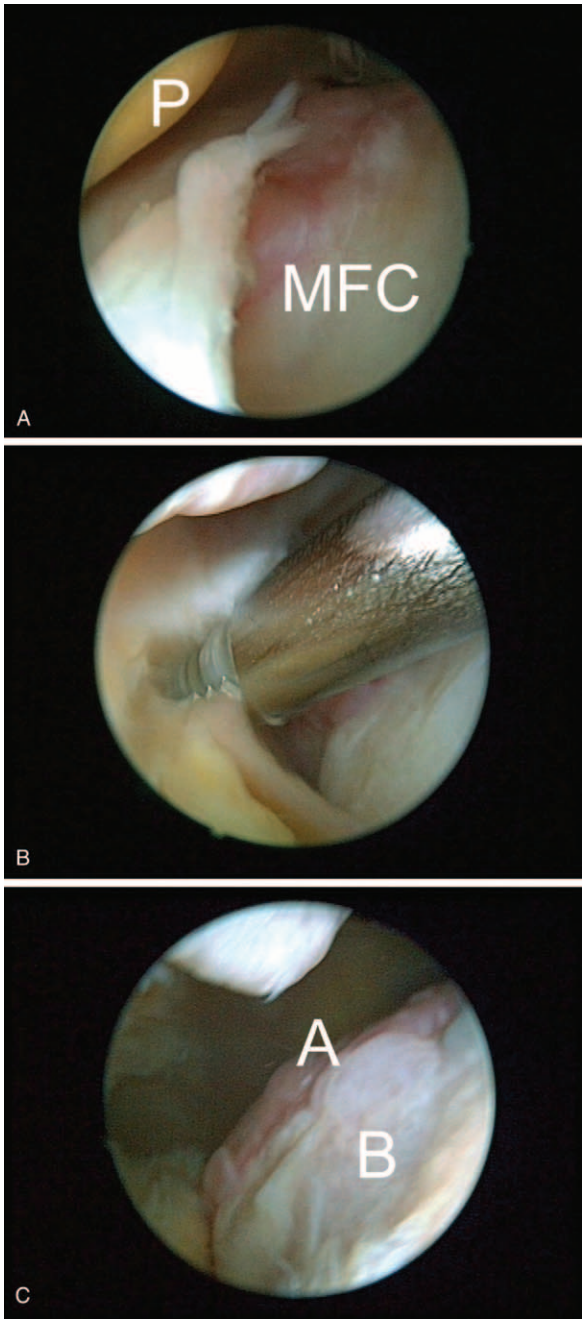

FIGURE 4. Hidden lesions. (A) Before AMR, the space between the patella (P) and the medial femoral condyle (MFC) was obliterated by inflamed medial plica. (B) AMR was undertaken. (C) After AMR, the hidden lesions on the medial femoral condyle (A and B) became clearly visible.

satisfaction rates, we found no significant difference between male (85%) and female (85.6%) patients ($P = 0.928$) (Tables 8 and 9). The improvement in the scores was significant for all grades of plica lesions and for each category of diagnosis. Satisfactory outcomes were obtained for all patients with the diagnosis of ''meniscus tear or ligament injury, received previous arthroscopic surgery.''

DISCUSSION

The most important finding of this study was the discovery of a high prevalence (95%) of medial plica in a cohort of middle-aged and older individuals who suffered from chronic knee pain. OA was the most common concomitant clinical diagnosis. Medial plica-related MAS, which affected most of these patients, was found to have characteristic clinical manifestations. Symptoms of pain and crepitus in motion and local tenderness found during physical examination were the most sensitive parameters for the diagnosis. History of a single knee injury, local tenderness, and a palpable band as identified during physical examination were the most specific parameters for the diagnosis. Various degrees of distinctive radiographic and arthroscopic findings associated with this syndrome were also elucidated. Most of the patients with this syndrome could be successfully treated using AMR, yielding a satisfaction rate of 85.5% after a 3-year follow-up.

In a nationally representative cross-sectional survey in the United States, 18.1% of men and 23.5% of women aged $\geq$60 years reported knee pain.[2] The prevalence of knee pain among South Koreans >50 years was reported to be 46.2%.[41] In another study investigating chronic knee pain in 892 participants >40 years of age, OA was found to be the most common diagnosis (85%).[6] Our study also found OA to be the most common diagnosis (88.4%) in knees that had received arthroscopy for debilitating pain in the same age group.

Because knee pain is the most disturbing symptom of the OA knee, it has been scrupulously investigated. Nonetheless, the origin and mechanism of the pain have not yet been definitively clarified. Many studies[12,42–45] have been conducted that focused on the relationship between radiographic manifestations and OA knee pain in which the pain was found to be associated with bone marrow lesions, effusion, and synovitis, suggesting that these features may indicate the origin of the knee pain. The relationship between specific tissue lesions and pain severity in persons with OA knees has also been investigated. One of the sources of OA knee pain is believed to be local chronic inflammation of the knee joints, which involves the production of various inflammatory cytokines in the synovial membrane.[46,47] In recent studies, synovitis has been noted to be an important factor in OA knee pain.[13,16,21,48,49] Our findings and the favorable AMR outcomes verified that the repeated friction or impingement between the tight, fibrotic, and hypertrophied medial plica and the adjacent medial femoral condyle in patients with MAS could have given rise to chronic synovitis in the anteromedial compartment and thus might explain the characteristic presentation of the chronic knee pain in these patients.

The prevalence of medial plica is quite variable[23–26] according to the literature and was recently reported to be higher in OA knees.[34,36] In this cohort of middle-aged and older individuals who were predominantly affected by OA knee pain, we also found a high prevalence (95%) of medial plica. To the best of our knowledge, no previous studies have been conducted that demonstrate medial plica-related MAS in this age group. Our patients' clinical manifestations, including predisposing factors, symptoms, and signs, were similar to those reported by others in younger populations.[23,27,30,50] Our description of the radiographic manifestations of MAS in the present study is the first in the literature. However, because of the intermingling of the commonly concurrent lateral deviation or compression of the patella, early detection of MAS

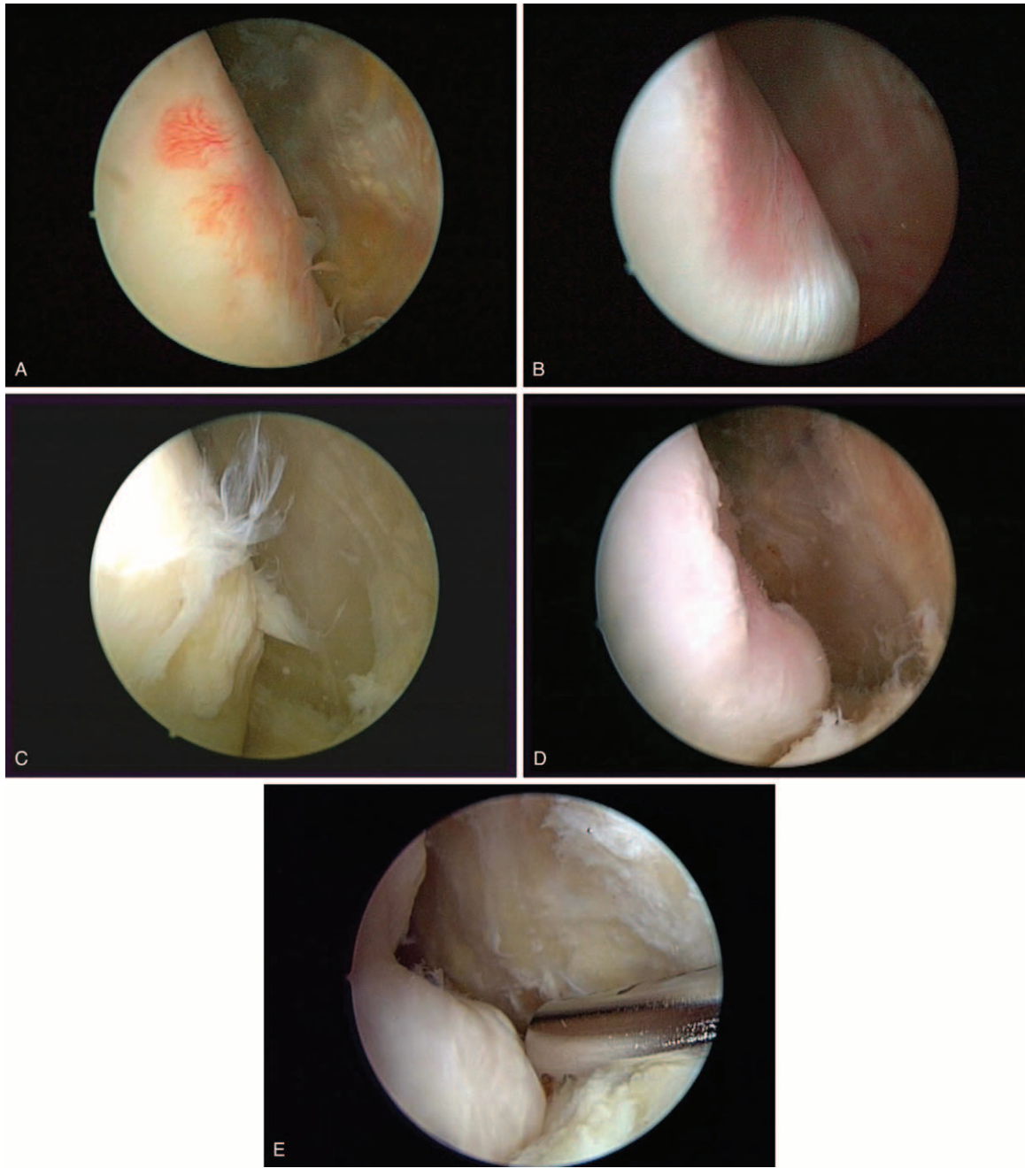

FIGURE 5. Arthroscopic staging of the hidden lesion on the medial femoral condyle. (A) Stage I: neovascularization and pannus formation are found over the margin of the lesion. (B) Stage II: in addition to the findings of the Stage I lesion, flattening and indentation of the cartilage is identified. (C) Stage III: partial thickness cartilaginous damage with fissuring and fibrillation. (D) Stage IV: a shallow gutter is identified, representing the imprint of the abrasion. (E) Stage V: the imprint of the abrasion becomes a deep gutter.

is difficult by conventional radiographic evaluation, including the axial view. Further investigation using a more precise modality, such as magnetic resonance imaging, might be valuable for the early detection of this syndrome. The findings of our arthroscopic evaluations were consistent with those of the previous studies[34,51] and provided more insight into the chronological evolution of the medial plica. We propose that the repeated abrasion between the medial plica and the facing medial femoral condyle in daily activities will increase the severity of the pathologic changes in the medial plica and simultaneously decrease its size due to wear. Meanwhile, degenerative cartilaginous lesions on the facing medial femoral condyle will also increase in severity. These findings suggest that MAS might play a role in the pathogenesis of medial compartment OA of the knee, a possibility that warrants further investigation.

TABLE 5. Distribution of Median (Range) Scores for Each Type and Grade of Medial Plica with regard to Different Locations of the Knee

	S_A	S_B	S_{mfc}	S_{mc}	S_{lc}	S_{pf}	S_{wk}
Plica type							
A	40 (20–50)	30 (20–40)	70 (40–90)	30 (20–40)	20 (10–30)	15 (5–15)	65 (35–85)
B	40 (10–50)	30 (10–50)	70 (20–90)	30 (10–40)	20 (10–40)	10 (5–30)	60 (25–90)
C	30 (20–30)	30 (20–30)	60 (40–60)	20 (20–30)	10 (10–20)	7.5 (5–10)	37.5 (35–60)
P value*	0.001	0.004	<0.001	<0.001	0.785	<0.001	<0.001
Plica grade							
II	20 (10–30)	20 (10–30)	40 (20–60)	20 (10–20)	10 (10–40)	5 (5–15)	35 (25–75)
III	30 (20–40)	30 (20–30)	60 (40–70)	20 (20–20)	10 (10–10)	5 (5–5)	35 (35–35)
IV	40 (30–50)	30 (30–50)	70 (60–90)	30 (20–40)	20 (10–40)	10 (5–20)	60 (35–85)
V	40 (20–50)	30 (20–40)	70 (40–90)	30 (20–40)	20 (10–40)	10 (5–30)	60 (35–90)
P value*	0.008	0.055	0.005	0.006	0.650	0.037	0.011

Degenerative score of foci A (S_A) and B (S_B) on the medial femoral condyle facing the medial plica (S_{mfc}), medial compartment (S_{mc}), lateral compartment (S_{lc}), patellofemoral joint (S_{pf}), and the whole knee (S_{wk}).
* Statistically significant using the Kruskal–Wallis test.

TABLE 6. Distribution of Subjective Outcome for Knees (%) and the Median (Range) of Knee Society Score for Pain Preoperatively and Postoperatively Relative to the Medial Plica Severity Grading

	Subjective Outcome					Knee Society Score for Pain		
Grade	**Excellent**	**Good**	**Fair**	**Poor**	**Satisfied (%)**	**Preoperatively**	**Postoperatively**	***P* Value***
II	16 (84.2)	1 (5.3)	2 (10.5)	0	89.5	22 (18–28)	50 (31–50)	<0.0001
III	4 (66.7)	1 (16.7)	1 (16.7)	0	83.4	21 (16–22)	50 (36–50)	<0.0001
IV	21 (55.3)	12 (31.6)	5 (13.1)	0	86.9	13 (4–18)	47.5 (31–50)	<0.0001
V	94 (59.9)	39 (24.8)	24 (15.2)	0	84.7	8 (4–28)	49 (30–50)	<0.0001
All grades	135 (61.4)	53 (24.1)	32 (14.5)	0	85.5	8 (4–28)	50 (30–50)	<0.0001

* Wilcoxon signed-rank test.

Although it is agreed that medial plica syndrome can be successfully treated by arthroscopic resection,[27–29] the success rates vary.[23] Concerns have been proposed about the more disabling and painful arthroscopic resection scar and about less-successful results in older patients.[50] In middle and old age, the chronological evolution of the medial plica could make it difficult to view during arthroscopic examinations. In addition, the related pathologic condition of the medial capsule might become unmanageable by simple resection of the medial plica. To our understanding, there was no literature that focused on this issue except for one study that investigated the promising outcomes of performing AMR for medial plica-related medial abrasion in OA knee patients.[37] The main rationale for this AMR was to eradicate the friction or impingement between

TABLE 7. Distribution of Subjective Outcome for Knees (%) and the Median (Range) of Knee Society Score for Pain Preoperatively and Postoperatively Relative to the Diagnosis

	Subjective Outcome					Knee Society Score for Pain		
	Excellent	**Good**	**Fair**	**Poor**	**Satisfied (%)**	**Preoperatively**	**Postoperatively**	***P* Value***
OA	113 (57.4)	52 (26.4)	32 (16.2)	0	83.8	8 (4–26)	49 (30–50)	<0.001
MT	11 (100)	0	0	0	100	20 (6–28)	50 (44–50)	0.003
LI	5 (83.3)	1 (16.7)	0	0	100	19 (4–24)	50 (42–50)	0.027
GA	2 (100)	0	0	0	100	9 (8–10)	50 (50–50)	0.180
RA	4 (100)	0	0	0	100	8 (4–12)	50 (50–50)	0.066

GA = gouty arthritis, LI = ligament injury, MT = meniscus tear, OA = osteoarthritis, RA = rheumatoid arthritis.
* Wilcoxon signed-rank test.

TABLE 8. Distribution of Subjective Outcome for Knees (%) With Relation to the Medial Plica Severity Grading in Male and Female Patients

	Male					Female				
Grade	Excellent N (%)	Good N (%)	Fair N (%)	Poor N (%)	Satisfied N (%)	Excellent N (%)	Good N (%)	Fair N (%)	Poor N (%)	Satisfied N (%)
II	10 (100)	—	—	—	10 (100)	6 (66.7)	1 (11.1)	2 (22.2)	—	7 (77.8)
III	1 (50)	—	1 (50)	—	1 (50)	3 (75)	1 (25)	—	—	4 (100)
IV	7 (70)	2 (20)	1 (10)	—	9 (90)	14 (50)	10 (35.7)	4 (14.3)	—	24 (85.7)
V	11 (61.1)	3 (16.7)	4 (22.2)	—	14 (77.8)	83 (59.7)	36 (25.9)	20 (14.4)	—	119 (85.6)
All grades	29 (72.5)	5 (12.5)	6 (15)	—	34 (85)*	106 (58.9)	48 (26.7)	26 (14.4)	—	154 (85.6)*

* P value = 0.928 (Pearson χ^2 test); N = number.

TABLE 9. Distribution of Subjective Outcome for Knees (%) With Relation to the Diagnosis in Male and Female Patients

	Male					Female				
Diagnosis	Excellent N (%)	Good N (%)	Fair N (%)	Poor N (%)	Satisfied N (%)	Excellent N (%)	Good N (%)	Fair N (%)	Poor N (%)	Satisfied N (%)
OA	17 (60.7)	5 (17.9)	6 (21.4)	—	22 (78.6)	96 (56.8)	47 (27.8)	26 (15.4)	—	143 (84.6)
MT	6 (100)	—	—	—	6 (100)	5 (100)	—	—	—	5 (100)
LI	4 (100)	—	—	—	4 (100)	1 (50)	1 (50)	—	—	2 (100)
GA	2 (100)	—	—	—	2 (100)	—	—	—	—	—
RA	—	—	—	—	—	4 (100)	—	—	—	4 (100)
Total	29 (72.5)	5 (12.5)	6 (15)		34 (85)*	106 (58.9)	48 (26.7)	26 (14.4)		154 (85.6)*

GA = gouty arthritis, LI = ligament injury, MT = meniscus tear, OA = osteoarthritis, RA = rheumatoid arthritis.
* P value = 0.928 (Pearson χ^2 test); N = number.

the pathologic medial plica and the adjacent medial femoral condyle[32–34] by resecting the plica and releasing the fibrotic medial joint capsule and retinaculum. The beneficial effect of releasing retinaculum bands has also been verified and reported by Yilmaz et al.[52] The effect of AMR was validated by a recent study[35] that investigated interleukin-1β (IL-1β) mRNA and matrix metalloproteinase-3 (MMP-3) mRNA expressions in the medial plica isolated from patients with different stages of medial compartment OA of the knee. According to this study, the repeated abrasions of the medial plica triggered IL-1β production and enhanced the expression of MMP-3. Therefore, removal of a pathologic medial plica and its related inflamed structures by AMR can effectively relieve symptoms[37] or even modify the disease process of OA in the knee, according to a recent study.[38] Our outcomes also indicated that AMR is a useful modality for treating MAS in middle-aged and older patients. It reduced their pain and satisfied the majority of them.

There were some limitations of this study. Although a high prevalence of MAS was found in this cohort, because of the limited number of patients, statistically valuable information about the prevalence of MAS in each subgroup of patients with different diagnoses could not be obtained. Moreover, because OA was the main diagnosis of patients with knee pain in this study and AMR for their MAS satisfied most of them, further study with a sufficient number of patients in 2 different groups—those with and without knee OA—is warranted to clarify whether to consider MAS the main cause of OA knee pain. Furthermore, radiographic evaluation, such as magnetic resonance imaging, might be helpful for acquiring additional information about this syndrome for its early diagnosis. More precise radiographic outcome evaluation is also mandatory, especially in the case of OA knees. These shortcomings in our investigation warrant further studies.

In conclusion, we found that medial plica-related MAS in middle and old age was a common clinical condition. We defined this syndrome by investigating its clinical presentations, including predisposing factors, symptoms, signs, radiographic manifestations, and arthroscopic findings, and determined that it was a common cause of knee pain in this age group; we recommend that MAS be taken into consideration during the differential diagnosis and postulate that MAS can be effectively treated using AMR. In addition, our findings of the coincidence of knee OA and MAS and the encouraging outcomes by treating them using AMR might assist in identifying a target for treatment of this common disease.

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