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ORIGINAL PAPER

Comparison of new and old all-inside suture devices in meniscal cyst formation rates after meniscal repair

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Abstract

Purpose We compared the magnetic resonance imaging (MRI)-confirmed cyst formation rate after meniscal tear repair using a new all-inside suture device (N group) versus the older all-inside suture device (O group).

Methods Between October 2008 and July 2017, 94 consecutive menisci of 89 patients were diagnosed with meniscal tears and underwent arthroscopic meniscal repair using the all-inside suture device. Five of these patients were lost to follow-up within 12 months and were excluded from the study. The remaining 89 menisci were followed up for at least 12 months and were included in this retrospective cohort study. Older all-inside suture devices (FasT-Fix, Ultra FasT-Fix) were used until December 2012, while the new all-inside suture device (FasT-Fix 360) was used from January 2013 onwards. Meniscal cysts were detected on T2-weighted fat-suppressed MRI at 12 months postoperatively. Multiple logistic regression analysis was used to identify demographic and clinical factors associated with the use of the new all-inside suture device and cyst formation.

Results In total, 36 and 53 menisci were included in the N and O groups, respectively. The incidence of meniscal cysts was significantly greater in the O group (14 out of 53, 26.4%) than in the N group (two out of 36, 5.56%) ($P=0.012$). Two patients in the O group had symptomatic cysts that required removal. Multivariate logistic analyses showed that the cyst formation risk significantly decreased after using the new all-inside suture device than the older all-inside suture devices (odds ratio = 0.139; $P=0.04$).

Conclusions The MRI-confirmed cyst formation rate after meniscal tear repair was significantly lower using the new than the older all-inside suture devices, indicating that the use of a low-profile device may decrease the cyst formation rate.

Keywords Meniscus · Meniscal cyst · FasT-Fix · Meniscal repair · All-inside suture device

Abbreviations

AI	All-inside
MRI	Magnetic resonance imaging
DLM	Discoid lateral meniscus
ACL	Anterior cruciate ligament
OR	Odds ratios
CI	Confidence intervals

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Introduction

The formation of meniscal cysts is related to meniscal mucoid degeneration, trauma, and meniscal tear and repair [1–5]. Meniscal cyst formation after meniscal repair is considered relatively rare. Although there are limited reported cases [2–8], the use of an all-inside (AI) device and medial meniscal tears are suggested to be risk factors for cyst formation after meniscal repair [2–6, 8, 9]. The AI device was designed to shorten the operative time and minimize the risk of neurovascular structure injury compared with the inside-out technique. Moreover, there were no significant differences in the clinical outcomes between all-inside meniscal repair using sutures and the AI device [10, 11]. However, the AI device was reportedly associated with complications, including cyst formation, implant breakage/migration, swelling, nerve irritation, and chondral damage [12, 13]. The FasT-Fix (Smith & Nephew, Endoscopy Division, Andover, MA) has been widely used as a meniscal repair device worldwide since its release in 2002 [14, 15]; then, the Ultra FasT-Fix was released in 2005, and the low-profile FasT-Fix 360 was released in 2013 in Japan. To the best of our knowledge, only limited data are available regarding the incidence rate of cyst formation after meniscal repair using the FasT-Fix 360 compared to those after using the older FasT-Fix devices (FasT-Fix and Ultra FasT-Fix).

We aimed to compare the magnetic resonance imaging (MRI)-confirmed cyst formation rate after meniscal repair using the new and older FasT-Fix devices. We hypothesized that the new FasT-Fix 360 would decrease the cyst formation rate compared with the older FasT-Fix devices.

Patients and methods

Consecutive patients who were diagnosed with meniscal tears and underwent arthroscopic meniscal repair with the AI technique between October 2008 and July 2017 by a single senior surgeon were retrospectively evaluated. The inclusion criteria were the diagnosis of meniscal tears, previous arthroscopic meniscal repair with the FasT-Fix, and previous MRI examination. The exclusion criteria were a prior meniscal surgery and a follow-up period < 12 months. Ninety-four consecutive menisci of 89 patients underwent arthroscopic meniscal repair with a FasT-Fix. Five of these patients were lost to follow-up within 12 months and were excluded from the study. The remaining 89 menisci were followed up for at least 12 months and were included in this retrospective cohort study. The indication for meniscal repair was a tear at the red-red or red-white zone of the posterior to middle portions of the medial or lateral meniscus. The FasT-Fix was used for meniscal tears less than 2 cm in length. If the tear was more than 2 cm, the menisci were repaired with an inside-out repair technique and the FasT-Fix was used for the lesion of the posterior horn. The older FasT-Fix devices were used until December 2012, while the new FasT-Fix 360 was used from January 2013.

Surgical technique

General anaesthesia was administered to all patients. Tourniquet was only used for the posteromedial incision when using the inside-out technique. Diagnostic arthroscopy was performed via an anterolateral portal with 30° oblique arthroscope; a probe was introduced via an anteromedial portal to determine the meniscal tear's morphology. After confirmation of meniscal instability, defined as a longitudinal tear in the vascular area of the meniscus, the tear edge was freshened with a meniscus rasp and shaver to stimulate healing. Longitudinal tears with mild instability and horizontal tears with no peripheral tear were repaired with the AI technique only using the FasT-Fix. Longitudinal tears with instability and horizontal tears with a peripheral tear were repaired with the inside-out technique and with the AI technique using the FasT-Fix, if necessary (Fig. 1). When a FasT-Fix device was used for AI repair, the FasT-Fix device was used in accordance with the manufacturer's recommendations and previously described techniques [14, 16, 17].

Patients with a discoid lateral meniscus (DLM) first underwent saucerization that consisted of centrifugal resection to shape the meniscus until a residual peripheral rim of 6–8 mm was confirmed at the meniscal mid-body with a calibrated probe. All anterior cruciate ligament (ACL) injuries were reconstructed with double-bundle ACL reconstruction using the inside-out technique.

Post-operative rehabilitation protocol

The postoperative rehabilitation protocol was dictated by the presence of concurrent ACL injury. The knee was fixed with a brace for one week and, then, the range-of-motion training of the knee was initiated. Passive range of motion was restricted from 0° to 90° of flexion for one week, and then progressed to 120° of flexion for six weeks. Full squatting beyond 120° and bicycling were allowed after 12 weeks. A non-weight-bearing period of three weeks was imposed. Partial and full weight-bearing began at three and six weeks post-operatively, respectively. Jogging was permitted from three months after isolated meniscal repair and after meniscal repair with ACL reconstruction. Return to sports activity was allowed from six months after isolated meniscal repair and after meniscal repair with ACL reconstruction.

Clinical evaluation

The pre- and postoperative Lysholm scores and the preinjury Tegner activity scale were used as subjective and objective assessments of the clinical parameters. Side-to-side difference was calculated using the KT-2000 knee arthrometer (MEDmetric Corporation, San Diego, CA) in those who underwent ACL reconstruction. If a meniscal cyst was present, the presence of pain around the cyst was investigated. Data were collected preoperatively and at 12 months post-operatively.

Radiographic evaluation

Meniscal cysts were detected on T2-weighted fat-suppressed MRI at 12 months postoperatively (Fig. 2). MRI examinations were performed for all cases pre-operatively and at 12 months post-operatively with a 3.0-Tesla scanner (Achieva 3.0 T TX; Philips, Amsterdam, The Netherlands). Meniscal cysts were not detected on MRI pre-operatively. The sequences used for image interpretation were

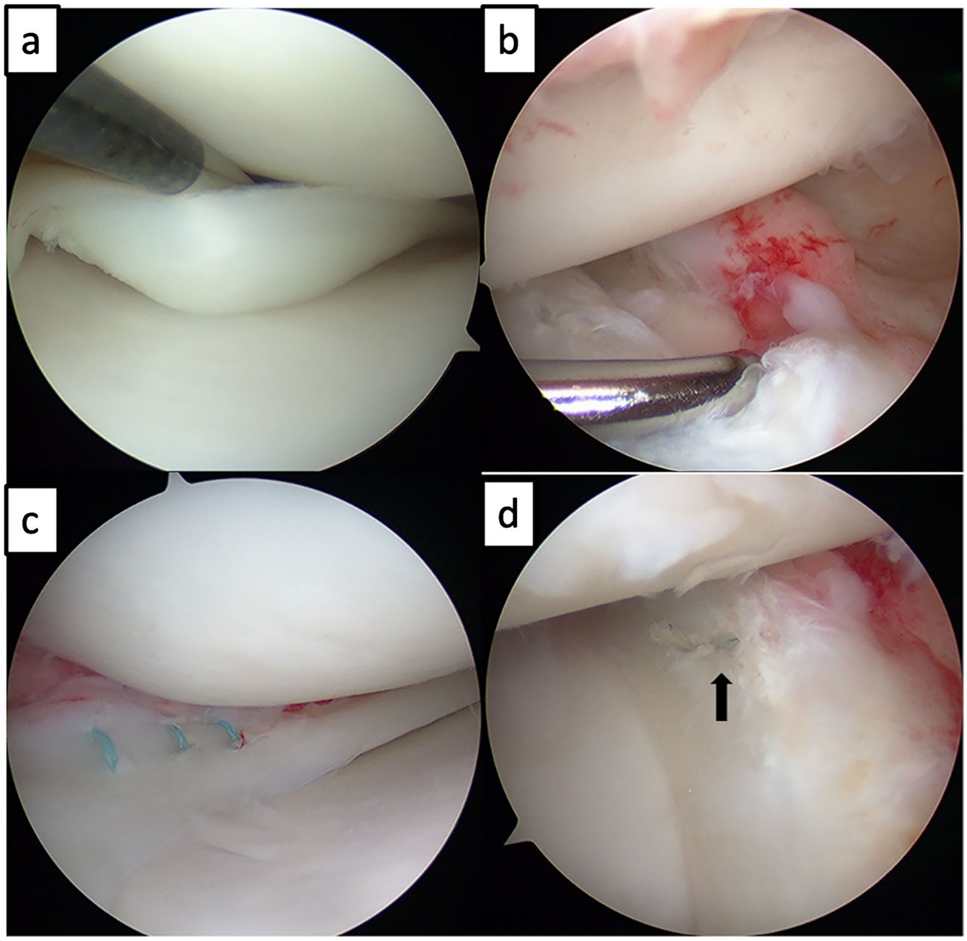

Fig. 1 The arthroscopic view of the longitudinal tear with instability of the medial meniscus in the left knee. **a**, **b** Pre-suture. **c**, **d** Post-suture. **a**, **c** The mid to posterior segment was repaired with inside-out sutures. **b**, **d** The posterior horn was repaired with one new FasT-Fix (arrow)

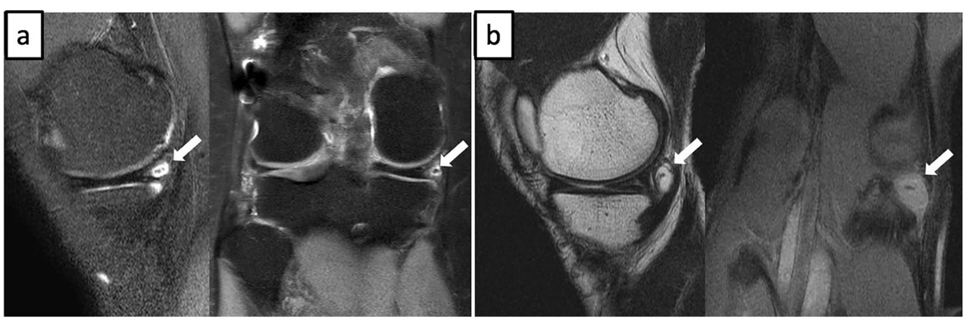

Fig. 2 Sagittal and coronal MRI images showing the "fish-eye" sign, which indicates the encasement of a suture anchor in a meniscal cyst (white arrow) [11, 13]. **a** A meniscal cyst case from the N group. **b** A meniscal cyst case from the O group. The meniscal cyst from the N group was smaller than the cyst from the O group. MRI, magnetic resonance imaging

coronal, sagittal, and axial proton density scans (TR/TE, 2117/10 ms; field of view, 16 cm; matrix, 256 9 256–192; slice thickness, 3.3 mm) and fat saturation scans (TR/TE, 3460/80 ms; field of view, 16 cm; matrix, 256 9 256–192; slice thickness, 3.3 mm). Two orthopaedic specialists who were blinded to the cases analyzed the MR images. Parameniscal cysts related to the FasT-Fix were defined as the presence of a mass more than 5 mm in size on sagittal and coronal images ("fish-eye" sign) in the area, in which the FasT-Fix was inserted (Fig. 2) [9, 13]. The fish-eye sign indicates a toggle anchor is observed in the cyst. The cyst size was measured on sagittal and coronal images, and the larger one was selected. Based on a previous study [18], meniscal healing was defined as a lower MRI signal intensity of the repaired portion of the meniscus than that of intra-articular fluid, while failure was defined as an equivalent MRI signal intensity to intra-articular fluid in the repaired portion.

Statistical analysis

The *t* test was used for continuous variables (age, Lysholm score, Tegner activity scale, and number of sutures). The χ^2 test was used for categorical variables (sex, location of the meniscal tear, DLM, concomitant ACL tear, and cyst occurrence). Multivariable logistic regression was used to identify demographic and clinical factors associated with the use of new FasT-Fix and cyst formation. The odds ratios (OR) and 95% confidence intervals (CI) for cyst formation were determined among all patients. The significance level was set at $P < 0.05$. All hypotheses were tested assuming a 0.05 significance level and a two-sided alternative hypothesis. All statistical analyses were performed using SAS software, version 9.1 (SAS Institute Inc., Cary, NC). The reliability of measurements of the cyst was assessed using the interobserver and intraobserver intraclass correlation coefficient (ICC). The ICC was interpreted as poor, marginal, and good when it was < 0.4, ≧ 0.4 and < 0.75, and > 0.75, respectively.

Results

Pre- and intra-operative data

Demographic data are summarized in Table 1. Medial meniscal tears and concurrent ACL injury were significantly larger, and the follow-up duration was significantly longer in the O group than in the N group. The type of meniscal tear using FasT-Fix was as follows: N group: longitudinal, 35; bucket handle, seven; horizontal, six; flap, three; radial, two; O group: longitudinal, 23; bucket handle, one; horizontal, 11; flap, one.

Post-operative data

The post-operative data are summarized in Table 1. The incidence of meniscal cysts was significantly greater in the O group (14 out of 53, 26.4%) than in the N group (two out of 36, 5.56%) ($P = 0.012$). Meniscus tears were healed in more cases in the N group than in the O group. The data of the 16 patients with cyst formation are summarized in Table 2. The cyst size tended to be smaller in the N group than in the O group (Fig. 2). Two patients in the O group had a symptomatic cyst that required removal. In

Table 1 Demographic data

	Total ($n = 89$) No. or mean (% or SD)	N group ($n = 36$) No. or mean (% or SD)	O group ($n = 53$) No. or mean (% or SD)	*P*
Pre-operative and intra-operative data				
Age, year	24.1 (9.96)	21.9 (9.56)	25.5 (10.0)	0.091
Sex (male)	49 (55.1)	19 (52.3)	30 (56.6)	0.722
Medial meniscus/lateral meniscus	47/42	12/24	35/19	0.002
Height, cm	166 (8.89)	167 (8.92)	165 (8.82)	0.201
Weight, kg	65.5 (13.9)	66.9 (16.1)	64.6 (12.3)	0.457
BMI (kg/m^2)	23.7 (3.61)	23.8 (4.16)	23.7 (3.23)	0.97
Follow-up, year	3.03 (1.68)	2.3 (0.91)	3.6 (1.87)	< 0.001
Concurrent inside-out technique	20 (22.5)	5 (13.9)	15 (28.3)	0.11
Concurrent ACL injury	66 (74.2)	22 (61.1)	44 (83.0)	0.021
Discoid lateral meniscus	14 (15.7)	9 (25.0)	5 (9.4)	0.155
Pre-operative TAS	6.1 (1.46)	6.4 (1.42)	5.96 (1.48)	0.208
Pre-operative Lysholm score	65.6 (15.1)	68.3 (14.4)	63.6 (15.5)	0.163
Horizontal tear	20 (22.5)	11 (30.6)	9 (17)	0.132
Suture number of fast-Fix	2.32 (1.35)	2.2 (1.10)	2.4 (1.51)	0.545
Post-operative data				
Cyst formation	16 (18.0)	2 (5.56)	14 (26.4)	0.012
Meniscal healing	31 (34.8)	17 (47.2)	14 (26.9)	0.05
Side-to-side difference	1.18 (1.38)	1.26 (0.66)	1.14 (1.6)	0.754
Post-operative TAS	5.86 (1.50)	5.2 (1.72)	5.31 (1.65)	0.118
Post-operative Lysholm score	95.9 (6.19)	96.2 (5.11)	95.6 (6.90)	0.656

SD, standard deviation; *BMI*, body mass index; *ACL*, anterior cruciate ligament; *TAS*, Tegner activity scale

Table 2 List of cyst formation cases

								Cyst size	Post-operative	Meniscus	
Case	Group	Age	Sex	BMI	Tear side	Type	FasT-Fix	mm	Lysholm score	Healing	Main symptom/additional surgery
1	N	16	Male	23.6	Medial	Longitudinal	1	5	100	Failure	None
2	N	19	Male	23.2	Medial	Longitudinal	4	8	100	Healing	None
3	O	27	Female	20.2	Medial	Longitudinal	2	18	95	Failure	Pain at cyst during activities/cyst removal via open excision
4	O	16	Male	22.5	Medial	Longitudinal	2	7	100	Healing	None
5	O	16	Female	26.4	Medial	Longitudinal	4	8	95	Failure	None
6	O	15	Female	18.7	Lateral	Flap	2	30	100	Healing	Feeling knee stiffness during long walk/None
7	O	27	Male	20.3	Medial	Longitudinal	2	7	99	Failure	None
8	O	17	Male	20.1	Medial	Longitudinal	3	11	95	Failure	None
9	O	21	Male	22.8	Medial	Longitudinal	5	13	95	Failure	None
10	O	12	Male	19.9	Lateral	Longitudinal	4	8	100	Healing	None
11	O	13	Male	26.7	Medial	Bucket handle, horizontal	6	8	100	Failure	None
12	O	21	Male	25.6	Medial	Longitudinal	6	11	100	Healing	None
13	O	20	Male	24.7	Medial	Longitudinal	4	10	95	Failure	Tenderness at the joint space and pain during long walks/cyst removal via open excision
14	O	16	Male	21.4	Medial	Longitudinal	3	11	90	Failure	Pain at the cyst while cross-legged/None
15	O	21	Female	22.5	Medial	Longitudinal	3	8	-	Healing	None
16	O	22	Female	28	Medial	Longitudinal	4	16	100	Failure	None

these patients, arthroscopy revealed that the meniscus was completely healed and, therefore, the cyst was removed via open excision. The cyst was found to be continuous with the anchors.

The mean Lysholm score significantly improved from preoperatively to post-operatively in the N and O groups (both $P < 0.001$). The mean post-operative Lysholm score did not differ significantly between the two groups ($P = 0.485$).

The interobserver ICC was 0.761 indicating a high agreement between evaluators. The intraobserver ICC was 0.907 indicating high agreement.

Table 3 Logistic regression analyses of relative contribution of variables to use of new FasT-Fix

Characteristic	Adjusted OR (95% CI)	*P*
Age, year (per 1 year)	0.955 (0.09–1.003)	0.067
Cyst formation	0.187 (0.034–1.025)	0.053
Meniscal healing	2.094 (0.783–5.602)	0.141
Concurrent ACL injury	0.972 (0.262–3.61)	0.966
Medial meniscal tear	0.381 (0.116–1.26)	0.113

OR, odds ratio; *CI*, confidence interval; *ACL*, anterior cruciate ligament. ORs were adjusted for age (per 1 year), cyst formation, meniscal healing, concurrent ACL injury, and medial meniscal tear

Logistic regression analyses of relative contribution of variables to use of new FasT-Fix

Table 3 shows demographic and clinical factors associated with use of new FasT-Fix according to multivariate logistic regression analyses. Multivariate logistic analyses showed that the risk of meniscal cyst formation decreased using the new FasT-Fix 360 (OR = 0.187; $P = 0.053$).

Comparison of cases with versus without meniscal cysts

Table 4 shows comparison of cases with versus without meniscal cysts. There were significantly more cyst cases in younger patients, male individuals, use of older more FasT-Fix devices, concurrent ACL injury, and increased use of FasT-Fix.

Risk factors contributing to cyst formation

Table 5 shows demographic and clinical factors associated with meniscal cyst formation according to multivariate logistic regression analyses. Multivariate logistic analyses showed that the meniscal cyst formation risk significantly decreased with the new FasT-Fix 360 (OR = 0.139; $P = 0.04$), and older age (OR = 0.850; $P = 0.012$), and significantly increased with a higher suture number of FasT-Fix

Table 4 Comparison of cases with versus without meniscal cysts

	Cyst + ($n = 16$) No. or mean (% or SD)	Cyst − ($n = 73$) No. or mean (% or SD)	*P*
Pre-operative and intraoperative data			
Age, year	18.7 (4.39)	25.2 (10.5)	0.016
Sex (male)	11 (68.8)	29 (39.7)	0.035
Use of new Fast-Fix	2 (12.5)	34 (46.6)	0.019
Medial meniscus/lateral meniscus	14/2	33/40	0.002
BMI (kg/m^2)	22.9 (2.77)	23.9 (3.76)	0.31
Follow-up, year	3.48 (1.59)	2.93 (1.69)	0.239
Concurrent inside-out technique	3 (18.8)	17 (23.3)	0.694
Concurrent ACL injury	16 (100)	50 (68.5)	0.009
Discoid lateral meniscus	0 (0)	16 (21.9)	0.065
Pre-operative TAS	6.56 (1.36)	6.03 (1.47)	0.186
Pre-operative Lysholm score	67.9 (11.4)	65.1 (15.9)	0.528
Horizontal tear	1 (6.25)	19 (26)	0.107
Suture number of fast-Fix	3.19 (1.33)	2.15 (1.27)	0.007
Post-operative data			
Meniscal healing	3 (18.8)	28 (38.4)	0.127
Side-to-side difference	1.57 (1.49)	1.04 (1.33)	0.204
Post-operative TAS	5.63 (1.67)	5.51 (1.60)	0.792
Post-operative Lysholm score	97.6 (3.16)	95.5 (6.65)	0.232

SD, standard deviation; *BMI*, body mass index; *ACL*, anterior cruciate ligament; *TAS*, Tegner activity scale

Table 5 Logistic regression analyses of relative contribution of variables to meniscal cyst formation

Characteristic	Adjusted OR (95% CI)	*P*
Age, year (per 1 year)	0.850 (0.749–0.965)	0.012
Male	3.39 (0.71–16.24)	0.126
Use of new fast-Fix	0.139 (0.021–0.913)	0.04
Suture number of fast-Fix (per 1 suture)	1.73 (1.02–2.93)	0.042
Medial meniscal tear	17.2 (2.34–125)	0.005

OR, odds ratio; *CI*, confidence interval. ORs were adjusted for age (per 1 year), sex, use of new FasT-Fix, suture number of FasT-Fix (per 1 suture), and medial meniscal tear

(OR = 1.73; $P = 0.042$), and the presence of a medial meniscal tear (OR = 17.2; $P = 0.005$).

Discussion

The most important finding of this study was that the incidence of meniscal cysts was significantly lower in the new all-inside suture device group than in the older all-inside suture device group. Moreover, the use of the new FasT-Fix 360 significantly decreased the cyst formation risk compared with that after using older FasT-Fix devices. These results were consistent with our hypothesis.

Six previous case reports have described meniscal cyst formation after AI meniscal repair. Of these six cases, three underwent removal of the cyst and anchors via open excision and one underwent arthroscopic partial cystectomy, and in two cases the symptoms resolved without additional surgery [2, 5, 6, 8, 19]. Some authors have recommended arthroscopic partial meniscectomy and cyst decompression for unrepaired meniscal cysts [1, 20]. In this study, two patients underwent removal of the cyst and anchors via open excision, as arthroscopic decompression was considered insufficient because the non-absorbable anchors and sutures may have contributed to cyst formation. Intra-operatively, it was found that the anchors were located in the cyst in these cases.

A previous study reported that meniscal cysts occur after arthroscopic meniscal repair in 1.7–40.0% of cases and suggested that the risk factors for cyst formation are medial meniscal tears and the AI device use [9]. Other studies have also reported meniscal cyst formation after medial meniscal repair [2, 4, 6–8, 19, 21]. In this study, multivariate logistic analyses showed that the cyst formation risk significantly increased in patients with a medial meniscal tear compared with those with a lateral meniscal tear (OR = 17.2; $P = 0.005$). Possible reasons for cysts being more likely to occur in the medial meniscus have previously been reported [9, 13] and state the translation of the medial meniscus is smaller than that of the lateral meniscus, and the load is concentrated on the posterior segment of the medial meniscus during deep flexion [22–24].

The incidence of cyst formation detected on follow-up MRI after meniscal repair with AI devices is reportedly 8.0–40.0% [9, 10, 13, 25]. These cases are mostly asymptomatic or involve mild pain/effusion. Tschirch et al. [26] also reported that meniscal cysts might be present in asymptomatic knees. Cyst excision is reportedly only needed in 0–14.2% of patients with meniscal cysts because of pain and tenderness along the joint line [2, 5, 6, 8–10, 13, 25]. In this study, as in previous reports, cyst formation was mostly asymptomatic or involved mild symptoms, and only two patients in the O group needed cyst excision because of pain during activity (Table 1). The incidence rates of cyst formation were 26.4% and 5.56% in the O and N groups, respectively. The use of the new FasT-Fix 360 resulted in a lower incidence rate of meniscal cyst formation than that reported in previous studies, which used the old FasT-Fix [9, 10, 13, 25].

The proposed causes of meniscal cyst formation include direct contact between the meniscal cyst and an adjacent meniscal horizontal tear [27], extrusion of synovial fluid through an adjacent meniscal tear [28–31], and the pumping action of joint motion [6]. In this study, there were significantly more cyst cases in young patients. Younger patients may have higher activity levels, which may have contributed to the increased incidence of cysts. On the other hand, contrary to the previous report [27], in this study, there was no significant difference in horizontal tears between cases with and those without meniscal cysts.

Sutures and AI devices are considered to affect cyst formation [4, 7, 9, 13, 21]. Moreover, meniscal cysts after surgery using bioabsorbable implants reportedly resolve within 18 weeks [19]. Terai et al. [13] suggested that the hole created by the needle of the AI device could promote cyst formation. The new FasT-Fix 360 includes a 17-gauge needle, no. 2–0 braided polyester, and lower profile implants with diameters of 1 and 1.5 mm. However, older FasT-Fix devices include a 17-gauge needle, the suture material is no. 0 non-absorbable braided polyester, and the implant diameter is 2 mm. The size of the hole created by the use of implant is considered to be primarily affected by the implant diameter and, therefore, the implant size may affect cyst formation. In this study, the cyst formation rate was low, and the cyst size tended to be smaller in the N than in the O group. Previous case reports have described the presence of large cysts (15–30 mm) with older type implants [2, 5, 6, 8, 19], which could be attributed to the fact that the use of low-profile devices has resulted in a decreased rate of cyst formation and smaller cyst size. Moreover, the suture number of FasT-Fix was larger in cases with cysts than in those without cysts. It is considered that a larger number of used sutures may increase the chance for cyst formation with that mechanism. The other proposed causes of meniscal cyst formation after meniscal repair include soft tissue irritation with repetitive trauma by non-absorbable suture materials [3] and degeneration of the unhealed meniscus [4, 7]. In this study, there was no significant difference in meniscal healing between cases with and those without meniscal cysts.

The present study had some limitations. First, it was a retrospective cohort study; thus, it was vulnerable to bias associated with the patient background characteristics. For example, as medial meniscal repair using an AI device was found to be a risk factor for meniscal cyst formation, over time, the surgeon tended to refrain from using AI devices in such cases. Moreover, a surgeon's skill may improve annually with experience and it could be a confounder for lower meniscal cyst formation in the N group. Second, the number of patients was relatively small. A power analysis revealed that 50 cases in each group were the minimum required sample to detect a difference of cyst formation between the N and O groups. Third, the follow-up period might have been too short to detect meniscal cyst formation. However, Terai et al. [13] reported that 15 cyst formations were observed in 12 menisci within one year post-operatively and in three menisci at two years post-operatively, suggesting that meniscal cysts are likely to occur within 1 year postoperatively. Fourth, the follow-up period was significantly shorter in the N group than in the O group because the two groups were divided by the time period. Fifth, meniscal healing was assessed using MRI rather than arthroscopy.

Conclusion

The MRI-confirmed cyst formation rate after meniscal repair was significantly lower using the new FasT-Fix 360 device rather than the older FasT-Fix devices, suggesting that use of a low-profile device may decrease the cyst formation rate.

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Author contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Takuya Kinoshita, Yusuke Hashimoto, Kazuya Nishino, Yohei Nishida, Shinji Takahashi, and Hiroaki Nakamura. The first draft of the manuscript was written by Takuya Kinoshita and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Availability of data and materials The data and materials of the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval This study was approved by the hospital ethics committee and the internal review board of our institution (3071).

Consent to participate Informed consent was obtained from all participants included in the study.

Consent for publication Patients signed informed consent regarding publishing their data and photographs.

Conflict of interest The authors declare no competing interests.

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