A commentary by Elizabeth Matzkin, MD, is linked to the online version of this article.

Ten-Year Outcomes of Second-Generation, All-Inside Meniscal Repair in the Setting of ACL Reconstruction

Rick W. Wright, MD, Laura J. Huston, MS, and Amanda K. Haas, MA

Investigation performed at Vanderbilt University Medical Center, Nashville, Tennessee

Background: Meniscal repair is the goal, whenever possible, for the treatment of meniscal injury. The purpose of this study was to evaluate the long-term clinical success of meniscal repair performed with a second-generation, all-inside repair device with a concomitant anterior cruciate ligament (ACL) reconstruction.

Methods: This was a retrospective review of prospectively collected patients who underwent meniscal repair by a single surgeon using the all-inside FAST-FIX Meniscal Repair System (Smith & Nephew) in conjunction with a concurrent ACL reconstruction. Eighty-one meniscal repairs (81 patients) were identified: 59 medial repairs and 22 lateral repairs. Clinical failure was defined as repeat surgical intervention involving resection or revision repair. Clinical outcomes were assessed with the Knee injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC) score, and Marx Activity Rating Scale score.

Results: Ten-year follow-up was obtained for 85% (69) of 81 patients. Nine patients (13% of 69) underwent a failed meniscal repair (6 medial, 3 lateral), corresponding to a failure rate of 12% (6 of 50) for medial repairs and 16% (3 of 19) for lateral repairs. The mean time to failure was 2.8 years (range, 1.2 to 5.6 years) for the medial repairs and 5.8 years (range, 4.2 to 7.0 years) for the lateral repairs ($p = 0.002$). There was no difference in mean patient age, sex, body mass index, graft type, or number of sutures utilized between successful repairs and failures. Postoperative KOOS and IKDC outcome scores significantly improved over baseline scores ($p < 0.001$). There was no significant difference in patient-reported outcomes at 10 years between the group with successful repairs and those who had a failed repair.

Conclusions: This report of long-term follow-up results of primary second-generation, all-inside meniscal repair demonstrates its relative success when it is performed with concurrent ACL reconstruction. After a minimum follow-up of 10 years, 84% to 88% of the patients continued to demonstrate successful repair. Failure of medial meniscal repairs occurred significantly earlier compared with lateral meniscal repairs.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

The medial and lateral menisci provide important protection for the chondral surfaces of the femur and tibia. Additionally, joint congruity, stability, and distribution of contact forces rely upon an intact meniscus to maximize the meniscal effect. Given the importance of the meniscus, repair with preservation of the uninjured portion of the meniscus when possible is preferred.

Early results of arthroscopic repair were reported by Charles Henning in the 1980s as an inside-out procedure[1,2]. Because of the neurovascular risk and the extra incision, surgeons continued to search for new methods. In the early 1990s, all-inside repair devices were developed. The early devices remained challenging to use and were frequently rigid devices that could cause harm to the chondral surface. Second-generation, all-inside repair devices were developed that mimicked the suture-based, inside-out process without requiring an additional incision. These gained wide acceptance and were the most common approach used for meniscal repair. Despite their popularity, few long-term 10-year results are available[3-7]. Although 10-year results are uncommon, a recent systematic review and meta-analysis utilizing random effects modeling of 5-year results demonstrated failures for inside-out (14.2%) and current-technique all-inside repairs (15.8%). Additionally, failure rates were similar ($p = 0.54$) between knees with an intact anterior cruciate ligament (ACL) (23.3%) and those requiring concomitant ACL reconstruction (21.2%)[8].

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/H491).

Surgeons have commonly believed that the inside-out repair method remains the standard with which other devices and methods should be compared. Second-generation devices were designed to more closely resemble inside-out suture techniques and to improve outcomes with less risk and fewer complications. The goal for meniscal repair is to create a biological environment for the meniscal tear surfaces to heal. This can be accomplished adequately by all-inside, suture-based repair techniques. In a meta-analysis of biomechanics of inside-out sutures and all-inside devices, Buckland et al. found that all-inside repairs can approximate the strength of inside-out sutures[9]. The purpose of this current study was to analyze minimum 10-year follow-up results of meniscal repair in the setting of concomitant ACL reconstruction. We hypothesized that all-inside repairs that have demonstrated good results at 5 years would maintain their reasonable outcomes beyond 10 years and remain equally successful compared with inside-out repairs.

Materials and Methods

Study Design

This was a retrospective review of prospectively collected data for patients who underwent meniscal repair with use of the all-inside FAST-FIX Meniscal Repair System (Smith & Nephew) in conjunction with a concurrent primary ACL reconstruction from January 2002 to December 2008. A previously established prospective database (Multicenter Orthopaedic Outcomes Network [MOON]) was analyzed to identify patients treated by the senior author (R.W.W.) with meniscal repair in conjunction with an ACL reconstruction. Patients who had previously undergone a repair of that meniscus were excluded. Patients who had undergone partial or full meniscal resection or had untreated meniscal tears were excluded. We analyzed patient data including demographics and intraoperative information. Tear location, morphology, and the number of sutures utilized for the repair were included in our data collection.

Clinical outcomes were assessed with the International Knee Documentation Committee (IKDC) score, Knee injury and Osteoarthritis Outcome Score (KOOS), and Marx Activity Rating Scale. These validated patient-reported outcome instruments were obtained both at the time of the index surgical procedure and at the 10-year follow-up.

Clinical failure was defined as repeat surgical intervention involving resection or revision repair of the involved meniscus.

Operative Technique

The surgeon (R.W.W.) assessed each tear for repairability. This was based on instability of the tear and a location in an area with adequate vascular supply for healing. All repaired tears in this series were bucket-handle or vertical longitudinal tears in the red-red or red-white vascular region. Radial tears were not included. All repairs were performed arthroscopically utilizing the FAST-FIX using manufacturer-described techniques. Sutures were placed until the desired stability was achieved. The ACL reconstruction technique was a bone-patellar tendon-bone (BTB) autograft reconstruction with metal interference screw fixation or a quadrupled hamstring autograft reconstruction with bio-interference screw fixation. All reconstructions were performed utilizing a 2-incision technique with a rear entry guide. The postoperative protocol for combined meniscal repair and ACL reconstruction was weight-bearing as tolerated without bracing. Jogging without cutting was allowed at 3 months and patients were allowed to begin to progress toward return to sports at 6 months.

Follow-up

Follow-up was managed centrally at a single site (Vanderbilt University Medical Center, Nashville, Tennessee). The questionnaire completed by subjects at the baseline ACL surgical procedure was readministered and completed by mail at the 10-year follow-up. All subjects were also contacted by phone by research coordinators to determine if they had undergone any knee reoperations since the time of the original ACL reconstruction. Research coordinators made every reasonable effort to obtain medical records for any reoperations not performed by the surgeon (R.W.W.).

Statistical Analysis

The description of categorical data (sex, ACL graft type, and meniscal repair location) for the cohort was performed using counts and percentages. The mean and the standard deviation were reported for age, body mass index (BMI), number of sutures, time to failure, and patient-reported outcome measures.

The comparison of categorical variables was performed with use of the Fisher exact test. The Wilcoxon test was used for the analysis of numerical data. Time to failure was defined as the time between the initial meniscal repair and the repeat meniscal repair or meniscectomy in the same compartment. SPSS Statistics version 27 (IBM) was used for survivorship analysis. Significance was defined as $p < 0.05$.

Source of Funding

There was no source of external funding for this study.

Results

Patient Characteristics

Eighty-one meniscal repairs, 59 medial and 22 lateral, were identified in 81 patients, 45 male and 36 female, with a mean age (and standard deviation) of 26.1 ± 10.4 years (range, 12 to 52 years) at the time of the index surgical procedure. The mean BMI at the time of the index surgical procedure was 26 ± 4.7 kg/m^2. Follow-up with regard to meniscal failure was obtained for 85% (69) of the 81 patients. The mean duration of follow-up was 10.5 ± 0.4 years (range, 10.0 to 12.5 years).

Successful Compared with Failed Repairs

Successful repair was defined as the patient not undergoing a subsequent surgical procedure related to the meniscus. Failed repair was defined as the patient requiring a subsequent surgical procedure for symptoms or the meniscus being noted to be torn at a subsequent surgical procedure for ACL revision reconstruction. At 10 years, 9 failed meniscal repairs (6 medial and 3 lateral) were identified among 69 patients, corresponding to an overall failure rate of 13% and failure rates of 12% (6 of

50) for medial repairs and 16% (3 of 19) for lateral repairs. The medial and lateral failure rates did not differ significantly (p = 0.70). Of the 9 failures, 1 medial repair and 2 lateral repair failures were identified in conjunction with a subsequent revision ACL reconstruction. All initial tears had involved at least a portion of the posterior horn, and all tears observed at reoperation involved at least a portion of the posterior horn. Thus, it is impossible to determine if these represented retears, new tears, or unhealed previous repairs.

There was no difference in patient age, sex, BMI, graft type, side of the repair (medial versus lateral), or number of sutures utilized between successful repairs and failures (Table I). Hamstring grafts had a nonsignificantly higher rate of repeat meniscal surgical procedures, for which there is no known

TABLE I Characteristics of Successful and Failed Meniscal Repairs

	Successful Repairs (N = 60)	Failed Repairs (N = 9)	P Value
Age *(yr)*			0.52
Mean*	26.5 ± 10.6	24.0 ± 11.2	
Median†	23.5 (13 to 52)	22.0 (12 to 43)	
Sex‡			1.00
Male	35 (58%)	5 (56%)	
Female	25 (42%)	4 (44%)	
BMI *(kg/m²)*			0.24
Mean*	26.0 ± 4.5	23.7 ± 4.3	
Median†	25.0 (18.6 to 40.2)	24.4 (18.3 to 32.1)	
ACL graft type‡			0.12
BTB autograft	57 (95%)	7 (78%)	
Hamstring autograft	3 (5%)	2 (22%)	
Meniscal repairs‡			0.70
Medial	44 (73%)	6 (67%)	
Lateral	16 (27%)	3 (33%)	
Location‡			
Anterior			
Central and/or middle third	0 (0%)	0 (0%)	
Peripheral thirds	1 (2%)	0 (0%)	
Posterior			
Central and/or middle third	11 (18%)	1 (11%)	
Peripheral thirds	32 (53%)	7 (78%)	
Not reported or blank	1 (2%)	0 (0%)	
Anterior and posterior			
Central and/or middle third	2 (3%)	1 (11%)	
Peripheral thirds	13 (22%)	0 (0%)	
Type of tear‡			0.10
Longitudinal	46 (77%)	8 (89%)	
Bucket-handle	13 (22%)	0 (0%)	
Posterior horn, other, or not reported	1 (2%)	1 (11%)	
No. of sutures			0.61
Medial			
Mean*	2.1 ± 1.1	2.0 ± 0.9	
Median†	2.0 (1 to 4)	2.0 (1 to 3)	
Lateral			
Mean*	1.7 ± 0.9	2.3 ± 1.2	
Median†	1.5 (1 to 4)	3.0 (1 to 3)	

*The values are given as the mean and the standard deviation. †The values are given as the median, with the range in parentheses. ‡The values are given as the number of patients, with the percentage in parentheses.

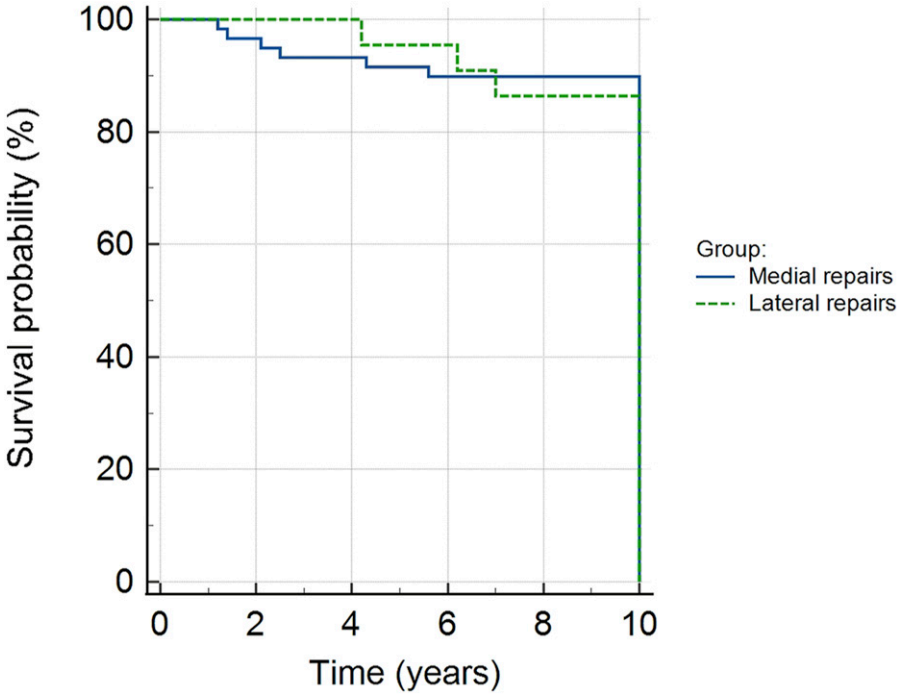

Fig. 1
Kaplan-Meier survival analysis for both medial and lateral meniscal repairs over the course of 10 years.

explanation. No other complications associated with meniscal repair were identified.

Time to Failure

The mean time to failure was 2.8 years (range, 1.2 to 5.6 years) for medial repairs and 5.8 years (range, 4.2 to 7.0 years) for lateral repairs; the difference was significant ($p = 0.002$). Figure 1 depicts the Kaplan-Meier survival analysis comparing the 2 repair groups.

Patient-Reported Outcome Scores

KOOS and IKDC outcome scores at 10 years were significantly better ($p < 0.001$) compared with baseline scores (Table II). Conversely, the Marx Activity Rating Scale score at 10 years was significantly lower (worse) ($p < 0.001$) compared with baseline (Table II).

There was no significant difference in patient-reported outcomes at either the time of the surgical procedure (Table III) or 10 years (Table IV) between the groups with successful and failed repairs.

Discussion

All-inside meniscal repair with a second-generation system is a reasonable approach with good long-term results. Our study demonstrates outcomes consistent with those of inside-out repairs at 10 years[10-12]. Surgeons do not rely on the suture to hold the repair for 10 years; rather, biological healing is intended

TABLE II Baseline and 10-Year IKDC, KOOS, and Marx Activity Rating Scale Results

	Baseline* (N = 81)	10-Year Follow-up* (N = 69)	P Value†
IKDC	55 ± 15	78 ± 20	**<0.001**
KOOS			
Symptoms	70 ± 20	84 ± 17	**<0.001**
Pain	77 ± 15	91 ± 14	**<0.001**
Activities of daily living	85 ± 14	94 ± 14	**<0.001**
Sport and recreation	57 ± 30	80 ± 25	**<0.001**
Quality of life	38 ± 21	76 ± 21	**<0.001**
Marx Activity Rating Scale	10.5 ± 6.1	5.4 ± 4.7	**<0.001**

*The values are given as the mean and the standard deviation. †Bold indicates a significant difference.

TABLE III Baseline IKDC, KOOS, and Marx Activity Rating Scale Results for Successful and Failed Meniscal Repairs

	Successful Repairs* (N = 60)	Failed Repairs* (N = 9)	P Value
IKDC	54 ± 15	62 ± 14	0.14
KOOS			
Symptoms	70 ± 20	72 ± 22	0.75
Pain	77 ± 15	80 ± 15	0.55
Activities of daily living	84 ± 15	91 ± 10	0.19
Sport and recreation	57 ± 30	52 ± 23	0.63
Quality of life	37 ± 20	47 ± 24	0.21
Marx Activity Rating Scale	10.4 ± 6.1	11.8 ± 5.8	0.52

*The values are given as the mean and the standard deviation.

to serve as the end point for the need of suture support. In our series, 84% to 88% of the patients had continued success at a minimum of 10 years after the repair. Success rates were not impacted by patient age, sex, or BMI, or by graft choice.

There are previous reports in the literature of minimum 10-year follow-up of meniscal repairs[3,4,7,10-13] and all-inside repairs[3-5,7]. Most 10-year studies are reports of early open techniques[14,15] or inside-out techniques[10-12]. In general, these minimum 10-year studies have demonstrated good results, with success rates ranging from 58% to 91% as determined by a variety of parameters.

Several studies have shown the minimum 5-year results of all-inside repair[6,15-22]. Alvarez-Diaz et al. reported on 29 soccer players with a minimum follow-up of 5 years[16]. Utilizing the FAST-FIX device, 6.7% required a repeat arthroscopy with a partial meniscectomy prior to returning to soccer. Bogunovic et al. reported on the results at a minimum 5-year follow-up of 75 repairs utilizing the FAST-FIX device, which showed failure rates of 12% for isolated meniscal repair and 18% for meniscal repair with ACL reconstruction[17]. The difference between these rates was not significant. Additionally, they assessed the KOOS and reported the subscale results for stiffness (84.0), pain (91.3), activities of daily living (90.9), sport and recreation (63.6), and quality of life (76.2). The subjective IKDC score was 80.9. Pujol et al. evaluated FAST-FIX repairs in 27 patients at a median follow-up of 9.5 years[6]; they noted a 14.8% failure rate (4 repairs) requiring a repeat surgical procedure. In a series of meniscal repairs, utilizing a variety of devices, in the MOON cohort evaluated at 6 years, Westermann et al. demonstrated a failure rate of 14.9% (31 of 208) for all-inside repairs[19].

Solheim et al. reported results at a median follow-up of 10 years (range, 7 to 12 years) following all-inside repair using an alternative device (RapidLoc; DePuy Mitek) not utilized in our study[4]. At the time of follow-up, 39 (48%) of 82 patients had undergone a further surgical procedure due to failure of the meniscal repair, and 26 of the 39 failures occurred within 2 years. Solheim et al. were unable to detect a significant difference in failure rate based on sex, age, medial compared with lateral repair, or intact compared with reconstructed ACLs. Based on the high failure rate, Solheim et al. questioned the utility of this device in meniscal repair.

Zimmerer et al. reported on their use of the FAST-FIX system for meniscal repair at a minimum follow-up of 12 years[3]. A total of 325 patients underwent all-inside meniscal repair, but the authors were only able to obtain follow-up on 63

TABLE IV Ten-Year IKDC, KOOS, and Marx Activity Rating Scale Results for Successful and Failed Meniscal Repairs

	Successful Repairs* (N = 60)	Failed Repairs* (N = 9)	P Value
IKDC	80 ± 20	72 ± 17	0.31
KOOS			
Symptoms	84 ± 18	80 ± 14	0.52
Pain	91 ± 14	91 ± 12	0.97
Activities of daily living	94 ± 14	94 ± 11	0.97
Sport and recreation	81 ±24	71 ± 28	0.26
Quality of life	78 ± 21	65 ± 19	0.07
Marx Activity Rating Scale	5.3 ± 4.6	6.0 ± 5.0	0.67

*The values are given as the mean and the standard deviation.

patients (19%). Seventeen (27%) of the 63 patients required a further surgical procedure for the repaired meniscus. Eight of the 17 failures occurred in the first 2 years, which is an earlier time frame than most of the unhealed repairs or retears identified in our study. Zimmerer et al. obtained KOOS subscale scores at follow-up for pain (91.3), stiffness (86.6), activities of daily living (94.6), sport and recreation (80.3), and quality of life (77.3). Unlike our study, they found a failure rate of 48% in female patients that was significantly higher than the 15% in male patients ($p = 0.005$). Similar to our study, patient age, height, and weight demonstrated no significant differences, but both studies may be underpowered. Zimmerer et al. included both patients with an intact ACL and those with a reconstructed ACL but could not detect a difference in the failure rates between these 2 groups.

Our 10-year results of second-generation, all-inside repair were better than those of first-generation implants and equivalent to those seen with the other common techniques[10-15]. In a systematic review and meta-analysis evaluating the 5-year results of meniscal repairs performed with a variety of techniques, the combined failure rate of first-generation, all-inside repair was 24%, whereas the authors found pooled failure rates of 22.2% for inside-out meniscal repairs, 23.9% for outside-in meniscal repairs, and 23.1% for open meniscal repairs[23]. This analysis was recently updated with the inclusion of more recent studies and modern repair techniques[8]. Failure rates were analyzed by technique. Similar to the current study, all-inside failure rates were good overall and essentially equal to those of inside-out suturing. The failure rates were 23.7% for open repairs, 21.7% for outside-in repairs, 14.2% for inside-out repairs, and 15.8% for modern all-inside devices. Our failure rate of 13% in a setting of concomitant ACL reconstruction compares favorably with those results. The meta-analysis also compared medial with lateral tears and found a medial meniscal failure rate of 23.9% that was significantly higher ($p = 0.04$) than the lateral meniscal failure rate of 12.6%. This is in contradistinction to our study, which showed a failure rate of 16% for lateral tear repairs that was higher than the rate of 12% for medial tear repairs, but not significantly so ($p = 0.70$). We do not have an explanation or hypothesis for why medial repairs would fail sooner than lateral repairs. In the meta-analysis by Nepple et al.[8], failure rates at 10 years did not differ between repairs with concomitant ACL reconstruction (21.2%) and repairs in knees with an intact ACL (23.3%, $p = 0.54$). Additionally, there was no difference in failure rates between meniscal repairs with concomitant ACL reconstruction and repairs in knees with an intact ACL in the individual studies that contained both.

The Marx Activity Rating Scale scores in the current study were worse after 10 years, which is consistent with the decreased activity over time demonstrated by a previous analysis of the MOON cohort[24]. The Marx Activity Rating Scale scores in our study were similar to the MOON Group's scores at 10 years, with a median score of 6 in their study compared with 5.4 in our study. Scores in both groups had decreased from a baseline of 10. We believe the reason that patient-reported outcome measures were similar for patients who required or did not require a repeat surgical procedure is that, even at a 10-year follow-up, patient-reported outcome measures may not be negatively impacted until articular cartilage damage resulting from meniscectomy has developed to a level that affects the patient and his or her impression of the status and function of the knee.

The strengths of our study include the duration of follow-up and utilization of validated patient-based outcome measures. An additional strength is the 85% follow-up rate, which limited attrition bias. The follow-up rate was only 19% in the only other study with minimum 10-year follow-up after use of the FASTFIX[3]. In our study, meniscal repair failure was noted to occur as late as 7 years postoperatively, with the typical time to failure being 3 years for medial repairs and 6 years for lateral repairs. Thus, long-term follow-up is necessary to adequately assess meniscal repair.

This study had several limitations. First, it was a retrospective review of prospectively enrolled patients and was vulnerable to the bias associated with such reviews. Second, it was a single-surgeon, single-center study, with the same surgeon determining the repairability of all tears. Thus, external validity may have been limited. Third, meniscal repair failure was defined as the need for a repeat surgical procedure involving revision repair or partial meniscectomy. This may underestimate failure, but it represents the currently accepted definition of failure[25,26]. It remains possible that there are undetected tears or partially healed repairs in patients without symptoms. We are also unable to ascertain if the tears seen at reoperations for meniscus-related symptoms or for revision ACL reconstruction represented new tears or unhealed repairs. A meniscal tear rate of approximately 50% has been found to be associated with ACL primary and graft ruptures; thus, even normal menisci have torn in this setting[27,28], which may have resulted in an overestimation of the tear rate in ACL reconstruction. However, the failure rate may have been underestimated because second-look arthroscopy was not performed routinely to assess the healing of the meniscus. Finally, the small number of retears may result in the underpowering of some comparisons.

In conclusion, this study of long-term follow-up results of primary, second-generation, all-inside meniscal repair demonstrates its effectiveness when it is performed with concurrent ACL reconstruction. After a minimum follow-up of 10 years, 84% to 88% of the patients continued to demonstrate successful repair. Failures occurred significantly earlier after medial meniscal repairs compared with lateral meniscal repairs. ■

Rick W. Wright, MD[1]
Laura J. Huston, MS[1]
Amanda K. Haas, MA[2]

[1]Department of Orthopaedic Surgery, Vanderbilt University Medical Center, Nashville, Tennessee

[2]Department of Orthopaedic Surgery, Washington University in St. Louis, St. Louis, Missouri

Email for corresponding author: rick.w.wright@vumc.org

References

1. Henning CE. Arthroscopic repair of meniscus tears. Orthopedics. 1983 Sep 1; 6(9):1130-2.
2. Henning CE, Clark JR, Lynch MA, Stallbaumer R, Yearout KM, Vequist SW. Arthroscopic meniscus repair with a posterior incision. Instr Course Lect. 1988;37: 209-21.
3. Zimmerer A, Sobau C, Nietschke R, Schneider M, Ellermann A. Long-term outcome after all inside meniscal repair using the FasT-Fix system. J Orthop. 2018 May 8;15(2):602-5.
4. Solheim E, Hegna J, Inderhaug E. Long-term outcome after all-inside meniscal repair using the RapidLoc system. Knee Surg Sports Traumatol Arthrosc. 2016 May; 24(5):1495-500.
5. Ronnblad E, Barenius B, Engstrom B, Eriksson K. Predictive factors for failure of meniscal repair: a retrospective dual-center analysis of 918 consecutive cases. Orthop J Sports Med. 2020 Mar 27;8(3):2325967120905529.
6. Pujol N, Tardy N, Boisrenoult P, Beaufils P. Long-term outcomes of all-inside meniscal repair. Knee Surg Sports Traumatol Arthrosc. 2015 Jan;23(1):219-24.
7. Tagliero AJ, Desai VS, Kennedy NI, Camp CL, Stuart MJ, Levy BA, Dahm DL, Krych AJ. Seventeen-year follow-up after meniscal repair with concomitant anterior cruciate ligament reconstruction in a pediatric and adolescent population. Am J Sports Med. 2018 Dec;46(14):3361-7.
8. Nepple JJ, Block AM, Eisenberg MT, Palumbo NE, Wright RW. Meniscal repair outcomes at greater than 5 years: a systematic review and meta-analysis. J Bone Joint Surg Am. 2022 Jul 20;104(14):1311-20.
9. Buckland DM, Sadoghi P, Wimmer MD, Vavken P, Pagenstert GI, Valderrabano V, Rosso C. Meta-analysis on biomechanical properties of meniscus repairs: are devices better than sutures? Knee Surg Sports Traumatol Arthrosc. 2015 Jan;23(1):83-9.
10. Johnson MJ, Lucas GL, Dusek JK, Henning CE. Isolated arthroscopic meniscal repair: a long-term outcome study (more than 10 years). Am J Sports Med. 1999 Jan-Feb;27(1):44-9.
11. Kimura M, Shirakura K, Higuchi H, Kobayashi Y, Takagishi K. Eight- to 14-year followup of arthroscopic meniscal repair. Clin Orthop Relat Res. 2004 Apr;(421): 175-80.
12. Melton JT, Murray JR, Karim A, Pandit H, Wandless F, Thomas NP. Meniscal repair in anterior cruciate ligament reconstruction: a long-term outcome study. Knee Surg Sports Traumatol Arthrosc. 2011 Oct;19(10):1729-34.
13. Abdelkafy A, Aigner N, Zada M, Elghoul Y, Abdelsadek H, Landsiedl F. Two to nineteen years follow-up of arthroscopic meniscal repair using the outside-in technique: a retrospective study. Arch Orthop Trauma Surg. 2007 May;127(4):245-52.
14. Brucker PU, von Campe A, Meyer DC, Arbab D, Stanek L, Koch PP. Clinical and radiological results 21 years following successful, isolated, open meniscal repair in stable knee joints. Knee. 2011 Dec;18(6):396-401.
15. DeHaven KE, Lohrer WA, Lovelock JE. Long-term results of open meniscal repair. Am J Sports Med. 1995 Sep-Oct;23(5):524-30.
16. Alvarez-Diaz P, Alentorn-Geli E, Llobet F, Granados N, Steinbacher G, Cugat R. Return to play after all-inside meniscal repair in competitive football players: a minimum 5-year follow-up. Knee Surg Sports Traumatol Arthrosc. 2016 Jun;24(6):1997-2001.
17. Bogunovic L, Kruse LM, Haas AK, Huston LJ, Wright RW. Outcome of all-inside second-generation meniscal repair: minimum five-year follow-up. J Bone Joint Surg Am. 2014 Aug 6;96(15):1303-7.
18. Tengrootenhuysen M, Meermans G, Pittoors K, van Riet R, Victor J. Long-term outcome after meniscal repair. Knee Surg Sports Traumatol Arthrosc. 2011 Feb; 19(2):236-41.
19. Westermann RW, Wright RW, Spindler KP, Huston LJ, Wolf BR; MOON Knee Group. Meniscal repair with concurrent anterior cruciate ligament reconstruction: operative success and patient outcomes at 6-year follow-up. Am J Sports Med. 2014 Sep;42(9):2184-92.
20. Lee GP, Diduch DR. Deteriorating outcomes after meniscal repair using the Meniscus Arrow in knees undergoing concurrent anterior cruciate ligament reconstruction: increased failure rate with long-term follow-up. Am J Sports Med. 2005 Aug;33(8):1138-41.
21. Siebold R, Dehler C, Boes L, Ellermann A. Arthroscopic all-inside repair using the Meniscus Arrow: long-term clinical follow-up of 113 patients. Arthroscopy. 2007 Apr; 23(4):394-9.
22. Steenbrugge F, Verdonk R, Hürel C, Verstraete K. Arthroscopic meniscus repair: inside-out technique vs. Biofix meniscus arrow. Knee Surg Sports Traumatol Arthrosc. 2004 Jan;12(1):43-9.
23. Nepple JJ, Dunn WR, Wright RW. Meniscal repair outcomes at greater than five years: a systematic literature review and meta-analysis. J Bone Joint Surg Am. 2012 Dec 19;94(24):2222-7.
24. Spindler KP, Huston LJ, Chagin KM, Kattan MW, Reinke EK, Amendola A, Andrish JT, Brophy RH, Cox CL, Dunn WR, Flanigan DC, Jones MH, Kaeding CC, Magnussen RA, Marx RG, Matava MJ, McCarty EC, Parker RD, Pedroza AD, Vidal AF, Wolcott ML, Wolf BR, Wright RW; MOON Knee Group. Ten-year outcomes and risk factors after anterior cruciate ligament reconstruction: a MOON longitudinal prospective cohort study. Am J Sports Med. 2018 Mar;46(4):815-25.
25. Lozano J, Ma CB, Cannon WD. All-inside meniscus repair: a systematic review. Clin Orthop Relat Res. 2007 Feb;455(455):134-41.
26. Schweizer C, Hanreich C, Tscholl PM, Ristl R, Apprich S, Windhager R, Waldstein W. Nineteen percent of meniscus repairs are being revised and failures frequently occur after the second postoperative year: a systematic review and meta-analysis with a minimum follow-up of 5 years. Knee Surg Sports Traumatol Arthrosc. 2022 Jul; 30(7):2267-76.
27. Spindler KP, Warren TA, Callison JC Jr, Secic M, Fleisch SB, Wright RW. Clinical outcome at a minimum of five years after reconstruction of the anterior cruciate ligament. J Bone Joint Surg Am. 2005 Aug;87(8):1673-9.
28. MARS Group. Meniscal and articular cartilage predictors of clinical outcome after revision anterior cruciate ligament reconstruction. Am J Sports Med. 2016 Jul; 44(7):1671-9.