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Clinical outcome and failure analysis of medial meniscus bucket-handle tear repair: a series of 96 patients with a minimum 2 year follow-up

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Abstract

Introduction The failure rate of meniscal repair remains significant, especially for bucket-handle tears. This study aimed to evaluate the clinical outcomes, failure rate and risk factors for failure of bucket-handle medial meniscal tear repairs performed during ACL reconstruction.

Materials and methods A retrospective analysis of prospectively collected data was performed on a consecutive series of 96 ACL reconstructions with meniscal arthroscopic suture of a bucket-handle tear of the medial meniscus with a minimum 2 year follow-up. Preoperative and postoperative evaluation at last follow-up included objective IKDC rating, instrumented differential laxity and Tegner activity level. Functional outcome was evaluated with Lysholm score at last follow-up. Failure rate, survival curves and risk factor analysis using Cox proportional hazard ratio models were performed to analyze suture repair failure.

Results At IKDC rating, all patients were C or D preoperatively, whereas they where all A or B at last follow-up. Instrumented differential laxity improved from 6.77 mm (1.57) to 1.02 mm (1.15) mm at last follow-up ($p = 1.9\ E^{-18}$). The mean Tegner score before injury was 6.79 (± 1.47) and 6.11 (± 1.75) at last follow-up ($p = 0.0011$). Mean Lyholm score at last follow-up was 91.53 (± 11.6). The average entire cohort failure rate was 19% at final follow-up of 35.2 ± 9.8 months. Kaplan–Meier survival analysis demonstrated that the probability of the absence of failure decreased constantly over time. No significant difference in the objective IKDC, Lysholm or Tegner scores was observed between the failure group and the success group. Multivariate analysis revealed that younger patients and a procedure of ACL revision are more at risk for suture repair failure. In the majority of cases, the meniscal lesion observed at revision was equivalent or less extensive than the initial lesion.

Conclusion Despite the fact that failure rate remains high for medial meniscus bucket-handle tears, suture repair of bucket-handle tears should be encouraged taking into account the long-term consequences of menisectomy.

Keywords Knee · Meniscus · Bucket-handle tear · Suture repair · Arthroscopic surgery

Introduction

Anterior cruciate ligament (ACL) tears are frequently associated with meniscal lesions. Preservation of meniscal tissue in a young and active population is critical to prevent degenerative change. Despite technical improvements, the failure rate of meniscal repair remains significant, especially for bucket-handle tears [1–3]. Bucket-handle meniscal tears account for approximately 10% of all meniscal lesions [2, 3]. These tears are usually vertical or oblique longitudinal tears beginning close to the posterior tibial insertion of the meniscus and extend to the middle third or even to the anterior horn, thus potentially resulting in its displacement into the intercondylar notch or around the femoral condyle [4, 5]. The aim of the current study was to evaluate the clinical outcomes, failure rate and risk factors for failure of bucket-handle meniscal tear repairs performed during ACL reconstruction. Study subjects had at least 2 years of follow-up.

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Materials and methods

Subjects

All patients who had concomitant ACL reconstruction and repair of a Bucket-Handle Medial Meniscal Tear (BHTMM) between January 2012 and June 2016 with a minimum 24 months of clinical follow-up were identified from a database of prospectively collected data. All surgeries were performed by one of three experienced knee surgeons, all of whom followed the same protocol and surgical technique. The repair was performed when tears were located in the red–red zone or in the red–white zone of the meniscus and when the bucket handle was reducible. All lesions were evaluated in terms of location and extension.

Patients with multi-ligament injuries, previous meniscectomy/meniscal repair, lateral meniscus lesions or with radiographic signs of osteoarthritis were excluded.

Surgical technique

The length of the lesion was noted at arthroscopy and recorded as one of the following three types:

- Limited to posterior horn (PH)
- Including posterior horn and mid body (PH–MB)
- Extending to anterior horn (PH–MB–AH)

Bucket-handle repairs were performed using different techniques depending on the portion of the medial meniscus which was torn.

Posterior horn tears

- Suture placed using a hook (Quick-Pass lasso Low profile, Arthrex FL) introduced through a posteromedial arthroscopic portal [6, 7] (Fig. 1a) [Suture Lasso (SL) group]

OR

- All-inside technique with suture anchor devices [8] (Fast-FixTM, Smith and Nephew MA) [FastFix (FF) group].

Anterior horn or mid-body tears

- An outside–in technique (thread placed through spinal needle) (Fig. 1b).

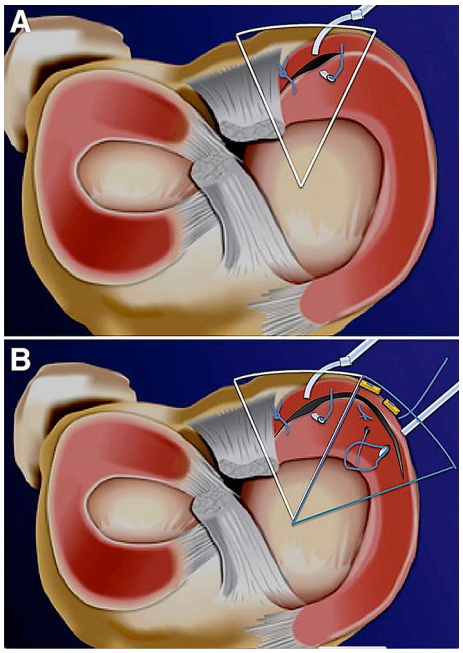

Fig. 1 **a** Suture placed with a hook through posteromedial portal for posterior horn area. **b** Outside in suture placed through a spinal needle in the mid-body area

Combined ACL and ALL reconstruction was performed in young and active patients practicing a pivoting sport and for revision procedures. Isolated ACL reconstruction with a hamstring graft was performed for less active patients.

After surgery, a standardized rehabilitation protocol of ACL reconstruction was implemented. This was comprised of brace-free mobilization, weight-bearing as tolerated and a restricted range of motion from 0° to 90° for the first 4 weeks postoperatively.

Clinical assessment

Patients were examined by the team who performed the surgery. The need for revision surgery was determined when the patient presented with return of clinical symptoms in addition to a re-tear of the repaired meniscus in the area of the initial surgical repair as confirmed by MRI. Objective IKDC rating [9] and instrumented differential laxity measured by Rolimeter® knee tester (Aircast®, Europe) were performed for all patients before surgery and at last follow-up.

Patients were evaluated by the Tegner activity level [10] score which related to their sports activity, before injury and after surgery. At last follow-up, patient-reported outcomes were assessed with Lysholm score [11]. All these scores have been validated for use in cases of meniscal injury [12, 13].

Statistical analysis

Statistical analysis was performed using a t test with significance when $p < 0.05$. The χ^2 test was used to compare qualitative data if the expected counts were greater than five; otherwise, the Fischer exact test was used. Survival curves were estimated using Kaplan–Meier estimates and compared using a log-rank test. To identify factors which influence time to reintervention, variable selection was performed. All variables with an effect corresponding to a p value < 0.2 upon univariate analysis were analyzed in a multivariate model using Cox proportional hazard models. All calculations were performed using R version 3.4.0 (2017-04 21).

Results

Ninety-six patients were available for clinical assessment at an average of 34.6 ± 9.3 months (range 24–59) post-surgery. Patients' characteristics are given in Table 1.

Preoperatively, 51% of the patient were C and 49% D at IKDC rating. The score improved postoperatively with 59% of A and 41% of B. The mean instrumented differential laxity measured by Rolimeter® improved from 6.77 (1.57) to 1.02 (1.15) mm at last follow-up ($p = 1.9\ E^{-18}$). The mean Tegner score before injury was 6.79 (± 1.47) and 6.11 (± 1.75) at last follow-up ($p = 0.0011$). Mean Lyholm score at last follow-up was 91.53 (± 11.6).

Out of 96, 18 required a revision operation at 19.7 (± 10) months after the initial repair for bucket-handle suture repair failure, leading to an overall 19% failure rate.

Kaplan–Meier survival analysis demonstrated that the probability of the absence of failure decreased constantly over time (Fig. 2).

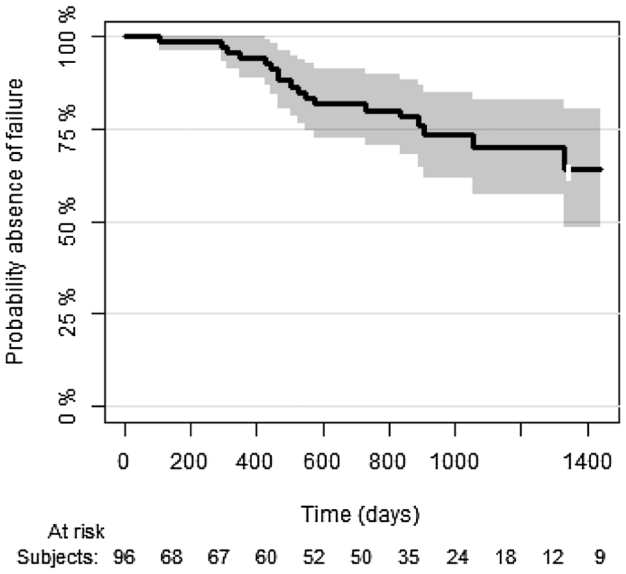

Fig. 2 Kaplan–Meier estimation of probability of absence of failure, with 95% confidence limits. Failure is defined as the need for revision surgery of the initial bucket-handle meniscal repair. Index time was the date of the initial bucket-handle meniscal repair

Table 1 Patients' characteristics

Variable	Level	Success ($n = 78$)	Failure ($n = 18$)	Total ($n = 96$)
Age	Mean (sd)	28.1 (9)	24 (6.7)	27.3 (8.7)
Sex	F (%)	19 (24.4)	7 (38.9)	26 (27.1%)
	M (%)	59 (75.6)	11 (61.1)	70 (72.9%)
BMI	Mean (sd)	24.7 (3.8)	25.1 (2.2)	24.8 (3.6)
Revision ACL	Nb (%)	6 (7.7)	5 (27.8)	11 (11.5)
Acute/chronic	A (%)	45 (73.8)	11 (68.8)	56 (72.7)
	C (%)	16 (26.2)	5 (31.2)	21 (27.3)
Length lesion	CM and CP (%)	37 (55.2)	12 (66.7)	49 (57.6)
	CP (%)	9 (13.4)	4 (22.2)	13 (15.3)
	CM, CP and CA (%)	21 (31.3)	2 (11.1)	23 (27.1)
Laxity preop	Mean (sd)	6.9 (1.7)	6.3 (1)	6.8 (1.6)
Tegner pre injury	Mean (sd)	6.7 (1.5)	7.1 (1.5)	6.8 (1.5)
Objective IKDC preop	A (%)	0 (0)	0 (0)	0 (0.0)
	B (%)	0 (0)	0 (0)	0 (0.0)
	C (%)	24 (55.8)	8 (66.7)	28 (50.9)
	D (%)	19 (44.2)	8 (66.7)	27 (49.1)
Graft source	Hamstring (%)	62 (79.5)	16 (88.9)	78 (81.2)
	B-PT-B (%)	16 (20.5)	2 (11.1)	18 (18.8)
Lateral tenodesis	ALL R (%)	29 (37.2)	8 (44.4)	37 (38.5%)

Risk factor analysis

Estimated hazard ratio (HR) was calculated for each variable (univariate Cox proportional model). Variables with p values below 0.2 were included in the multivariate analysis. The variables' age and revision ACL were selected on the final model as relevant factors (Table 2).

Multivariate analysis demonstrated that older patients were found to have a significantly lower risk of failure, $p = 0.0315$. A procedure of ACL revision was found to increase the probability of failure (0.0210). All patients with suture repair failure of the bucket-handle tear underwent menisectomy at revision surgery. This menisectomy was limited to the posterior horn in seven patients (39%) who had presented with an initial lesion running from posterior horn to the midbody (Fig. 3).

In two cases (11%), the lesion at revision was more extensive than at the index procedure, and in nine cases (50%), the lesion at revision was equivalent to the initial bucket-handle tear. There were no significant differences with regard to the time between injury and surgery, injury or outcome patterns between male and female patients, pre-operative laxity or significant associations with whether patients underwent a concomitant ALL reconstruction or not.

Table 2 Multivariate Cox model of time to failure

Variable	Hazard ratio	CI 95	p value
Age	0.92	[0.86; 0.99]	0.0315
Revision ACL	4.09	[1.24; 13.55]	0.0210

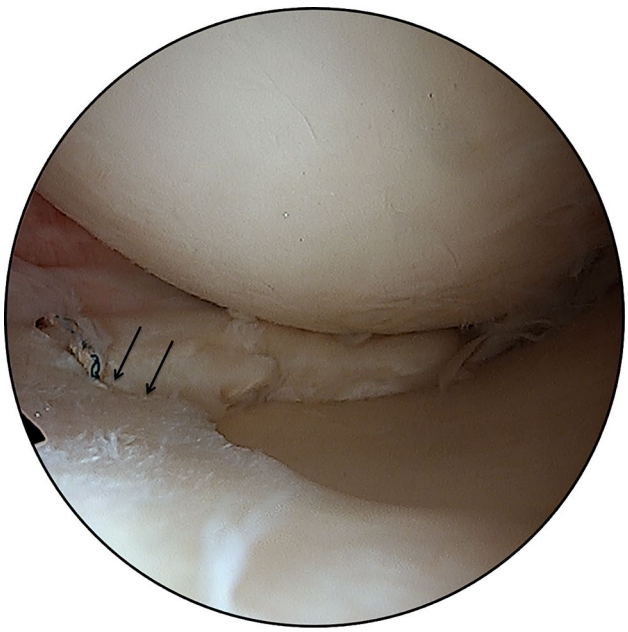

Fig. 3 Revision surgery for BHTMM suture failure. The posterior horn area demonstrates a new tear at the level of the suture thread of the FF device (black arrow). Healing of meniscal tissue can be observed in the mid-body portion

Discussion

In the current study, the meniscal repair failure rate of bucket handle (19%) was comparable to failure rate reported in the literature [14–18], with a similar follow-up duration.

The failure rate of bucket-handle meniscal tears can be influenced by several factors. Repairs associated with ACL injuries are associated with better outcomes than those with no ACL injuries [17, 19]. It is postulated that this is due to bleeding from the ACL tunnels. In the current study, a procedure of ACL revision was found to increase the probability of failure; it was also shown that older patients had a significantly lower repair failure rate than younger patients. Younger age has already been reported as a significant factors affecting healing of meniscus bucket-handle tear [20]. This finding has also been reported recently by other investigators [21] and may reflect the high demand placed on the repair by younger patients in a similar way that these young patients demonstrate higher ACL graft re-rupture [22]. Thus, age is an important factor to consider when performing ACL reconstruction and BHMMT repair. It has also been recently reported that adding an anterolateral ligament repair during ACL reconstruction would have a protective effect on medial meniscus suture repair [23]. In the current series of BHMMT, the addition of an ALL reconstruction did not demonstrate any beneficial effect on bucket-handle suture repair. In fact, the failure rate was superior in the ACL + ALL group though this difference was not statistically significant. Furthermore, patients with a combined ACL and ALL reconstruction are younger and more active than those patients undergoing isolated ACL reconstruction.

In 2003, the symposium of the French Arthroscopy Society (SFA) [24] reported that 25% of meniscal repairs underwent subsequent secondary meniscectomy. The revision procedures were typically performed in the first 2 years following the index procedure. In the current study, the authors noted that the probability of an absence of failure continued to decrease after 2 years and all along the study period. Thus, stabilization of failure rates, after the 2 year post-op period did not occur. One hypothesis is that efficient and complete healing of the medial meniscus bucket-handle repair is more challenging to achieve than for other more limited meniscal tear patterns. In the current study, subsequent menisectomy after repair failure continued to occur after 2 years. This menisectomy was more limited than the initial lesion length in 39% of the cases, equivalent to the initial lesion length in 50% of cases and longer than the initial lesion length in 11% of cases. Considering these observations, the limited

consequences of a failure should be considered when deciding upon surgery.

The current study has certain limitations. It is a retrospective study with a relatively small number of patients, thus limiting the statistical power, and there is limited follow-up.

Conclusion

The failure rate remains high for medial meniscus bucket-handle tears concomitant to ACL reconstruction. A procedure of ACL revision was found to increase the probability of failure and younger patients are more at risk than older patients for suture repair failure. In most cases of failure, the meniscal lesion observed at revision was equivalent or less extensive than the initial lesion. Based on these observations and taking into account the long-term consequences of menisectomy, suture repair of bucket-handle tears should be encouraged.

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Compliance with ethical standards

Conflict of interest Mathieu Thaunat, and Bertrand Sonnery-Cottet are consultant for Arthrex company; Jean-Marie Fayard is consultant for Arthrex and New Clip Technics.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee of Ramsay Générale de Santé n° IRB COS-RGDS-2019-05-006-THAUNAT-M and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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