ORIGINAL PAPER/PŮVODNÍ PRÁCE

There Is No Clinical and Radiological Difference between Suspensory and Cortical Button Fixation at the Treatment of Medial Meniscus Posterior Root Tear

Neexistuje žádný klinický ani radiologický rozdíl mezi závěsnou a kortikální knoflíkovou fixací při léčbě natržení zadního rohu mediálního menisku

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ABSTRACT

Purpose of the study

The purpose of this prospective study was to compare the two surgical techniques; (Transosseous Fixation with the Suspensory Fixation System technique and Pull Out Suture Repair) for clinical and radiologic scores and to investigate the effects on meniscal extrusion in Medial Meniscus Posterior Root Tear (MMPRT).

Material and Methods

This was a prospective single-center study. Patients undergoing MMPRT were divided into two groups. Group 1 patients were repaired with Transosseous Fixation with The Suspensory Fixation System technique while Group 2 patients were repaired with Pull Out Suture Repair with Cortical Button. Lysholm and Tegner Score, Visual Analog Scale (VAS), meniscus extrusion on magnetic resonance imaging (MRI) and K-L grade were recorded preop and postop at minimum one year follow-up.

Results

Meniscal extrusion on MRI increased in both groups at 12 months postoperatively compared to preoperative evaluation, but this increase was not statistically significant in both methods (Group 1: p=0.670, Group 2: p=0.211). There was no statistically significant difference in the pre-postoperative change in Lysholm knee score, Tegner activity score and meniscal extrusion on MRI in Group 1 compared to Group 2 (p=0.575, p=0.257 and, p=0.141 respectively). Both Lysholm Knee Score (Group 1: p=0.001, Group 2: p=0.001) and Tegner Activity Score (Group 1: p=0.008, Group 2: p < 0.001) increased statistically significantly at 12 months postoperatively compared to preoperative evaluation in Group 1 and Group 2. No patient in either group underwent total knee arthroplasty(TKA) at one-year follow-up.

Conclusions

The Suspensory Fixation System technique in MMPRT repair has been shown to be a feasible treatment method with similar functional and radiologic results compared to Pull Out Suture Repair with Cortical Button. At short-term follow-up, the addition of a suspensory device to the conventional transtibial pullout repair did not result in a statistical difference on meniscal extrusion on MRI.

Key words: transtibial pullout repair, meniscal root repair, meniscal extrusion, meniscus, posterior root tear.

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INTRODUCTION

Medial Meniscus Posterior Root Tear (MMPRT) is a degenerative tear that usually occurs in middle-aged people as a result of daily life activities such as descending stairs (11). MMPRT has been recognized as a "silent epidemic" in recent years and has received a lot of attention (8). MMPRT leads to pathologic meniscal extrusion and rapidly leads to increased arthrosis of the knee. Compared to root repair, nonoperative treatments and meniscectomy, it slows the progression to arthrosis and contributes to the return of the meniscus to its anatomical structure (1, 4). Although good clinical functional results have been reported with MMPRT repair, there are also studies showing that meniscal extrusion continues to increase (14).

Although the transtibial pullout method is the most commonly used method in MMPRT repair, there are some aspects that need to be improved (10, 19). Some of these are the difficulty of fixation of the MMPRT at the desired tension at the appropriate knee flexion angle, loosening of knot tension at the suture button-bone interface and persistence of meniscal extrusion on MRI. The previously published Transosseous Fixation with The technique aimed to prevent secondary loosening at the suture button-bone interface and may reduce meniscal extrusion (22).

This study is the first prospective follow-up clinical and radiologic comparison of Transosseous Fixation with The Suspensory Fixation System technique and Pull Out Suture Repair with Cortical Button technique. The purpose of this study was to compare these two methods in terms of clinical and radiologic scores in prospective follow-up and to examine their effects on meniscal extrusion on MRI.

MATERIAL AND METHODS

Our study was designed as a prospective Cohort study. Our study started after the decision of the Local Ethics Committee on 31. 03. 2022. Patients who underwent MMPRT repair from February 2022 to August 2022 were included and was registered prospectively at ClinicalTrials.gov (ID: NCT05370937).

The diagnosis of MMPRT was established preoperatively through a combination of clinical suspicion and MRI imaging (5, 18). Diagnosis was confirmed intraoperatively through arthroscopic visualization.

Criteria for inclusion in the study: Patients older than 18 years of age, MRI results showing MMPRT, patients with varus alignment of less than 5 degrees, and Kellgren and Lawrence (K-L) grade 0-2 arthrosis of the knee on anteroposterior radiograph. Exlusion criterias for MMPRT repair are diffuse grade 3 or 4 chondromalacia, substantial osteoarthritic changes (Kellgren-Lawrence grade 3 or 4) and misalignment > 5 (28).

Thirty-five patients who met the inclusion criteria were included in the study group. However, five patients (3 patients from Group 1, 2 patients from Group 2) were excluded from the study due to failure to complete the one-year follow-up period. Patients were divided into two groups preoperatively. Age, gender, and preoperative K-L stage were taken into consideration while dividing the patients into groups.

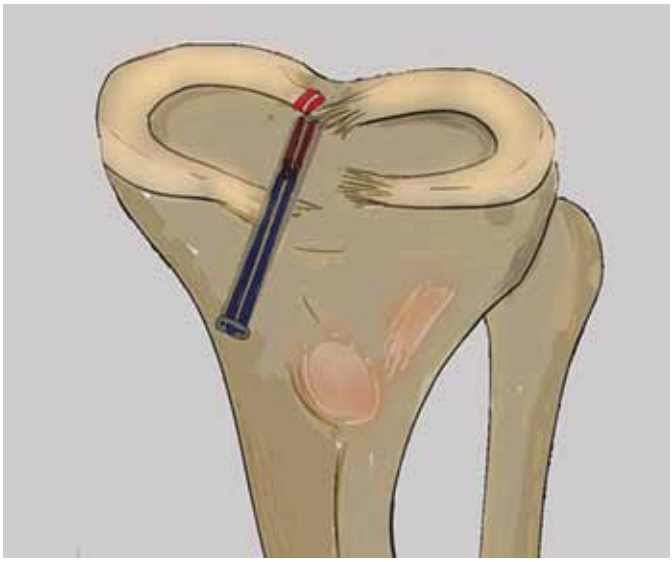

Fig. 1. **Schematic drawing of MMPRT Repair with The Suspensory Fixation System technique.**

Patients who underwent repair with Transosseous Fixation with Suspensory Fixation were referred to as Group 1. Patients who underwent Pull Out Suture Repair with Cortical Button were classified as Group 2.

Preoperative radiographic evaluations, which included weight-bearing anteroposterior radiographs and MRI images, repeated end of the one year following. Original criteria of Kellgren and Lawrence for osteoarthritis degrees were used (16). All patients underwent preoperative MRI evaluation with a 1.5-T scanner (Siemens, Munich, Germany) and Follow-up MRI scans were 12th months after surgery. All meniscus extrusion values were noted(used the apex of the medial tibial spine) and calculated separately by two expert surgeons and the average values were taken(13).

Transosseous Fixation with Suspensory Fixation (Group 1) and Pull Out Suture Repair with Cortical Button (Group 2) were compared. Clinical results, both preoperatively and at final follow-up, were evaluated by use of Lysholm knee score, Tegner activitiy score and Visiual Analog Scale (23, 25).

Transosseous fixation with suspensory fixation system on medial meniscus root tears

The Suspensory Fixation System technique has been described in depth previously (22). Inbrief, standard arthroscopy portals are used. After the meniscus root is revived with by

the punch, loop stitches are tied to the meniscus root with 2 nonabsorbable sutures (Fiber wire-Arhrex-Naples,USA) using the Firstpass Mini self-retrieving device (Smith&Nephew-Germany). Attachment area is prepared than tibial tunnel is created from the tibia over the guide. The Suspensory Fixation System is installed. No:1 PDS (Polydioxanone Suture) is connected to the lifted system by using it as a carrier suture and sent to the joint. When the loop of the Suspensory Fixation System comes out of the tunnel, the carrier thread is cut. Loop stitches is tied with 4 arthroscopic knots into the suspensory system. The desired tension in the meniscus root is adjusted using Suspensory Fixation System, while the knee is in 45° of flexion. Afterward, 4 knots are tied on the suture button with Suspensory Fixation System threads. Schematic Drawing of MMPRT Repair with Suspension Fixation System Technique is shown in Figure 1.

Pull out suture repair with cortical button

Pull Out Suture Repair with Cortical Button Technique has been described in depth previously (17, 20). No. 2 (Fiberwire-Arhrex-Naples,USA) nonabsorbable sutures are passed using the Firstpass Mini self-retrieving device (Smith&Nephew-Germany) direction through the substance of the meniscal root, shuttled down the transtibial tunnel, and secured over the anteromedial tibial cortex with cortical button.

Postoperative management

Unrestricted range of motion exercises were started immediately after the surgery. Patients are walked non-weightbearing for 6 weeks after surgery. Deep squatting (> 90) was allowed after 6 months. The patients achieved full activity after 6 months.

Statistical analyses

With reference to a study by Okazaki et al. (18), it was calculated with the G*POWER 3.1.9.4 program (Germany) that in order for the difference in Lysholm score between preop and postoperative sixth month to be statistically significant 33 ± 10 units in the first group and 20 ± 14 units between preop and postoperative sixth month in the second group, 15 patients from each group and 30 patients in total should be included at 80% power and 95% confidence level.

Categorical descriptive data were expressed as frequency and percentage, while continuous variables were expressed as mean and standard deviation or median and maximum/minimum values. Wilcoxon signed-rank test were used to compare repeated measures of Visual Analogue Scale, Lysholm knee score, meniscal extrusion on MRI and Tegner Score in independent groups. McNemar's test was used to compare repeated checks of Kellgren and Lawrence. Statistical analyses were performed using SPSS Statistics 25.0 (IBM Corp, Armork, NY).

Table 1. **Comparison of group 1 with group 2 in terms of demographic characteristics and preoperative scoring systems**

	GROUP 1	GROUP 2	P*
Age, mean ± SD	48.53 ± 8.39	53.60 ± 9.44	0.174
Gender, n (%)			0.500
Male	4(26.7)	3(20.0)	
Female	11(73.3)	12(80.0)	
Involved knee, n (%)			0.273
Right	6(40.0)	9(60.0)	
Left	9(60.0)	6(40.0)	
Preoperative Outer Bridge Staging, n (%)			0.456
Grade 1	7(46.7)	5(33.3)	
Grade 2	8(53.3)	10(66.7)	
Preoperative Kelegren Lawrence, n (%)			0.659
Grade 1	11(73.3)	11(73.3)	
Grade 2	4(26.7)	4(26.7)	

* Mann-Whitney U Test and Chi-square test

RESULTS

The mean age of the patients included in the study was 51.06 ± 9.14 years and 23 (76.7%) were female. The comparison of the patients with these two methods in terms of demographic characteristics, involved knee, preoperative Outer Bridge and Kelegren Lawrence staging is evaluated in Table 1. There was no significant difference between the two methods in terms of demographic characteristics, side of the involved knee, Outer Bridge Staging and Kellgren and Lawrence scores evaluated intraoperatively.

The post-operative 12th month changes of the two methods in terms of Visual Analog Scale, Lysholm knee score, meniscal extrusion on MRI and Tegner Score are presented in Table 2. In both methods, the Visual Analog Scale pain score decreased statistically significantly at 12 months postoperatively compared to the preoperative evaluation. In both Group 1 and Group 2, both Lysholm Knee Score and Tegner Activity Score increased statistically significantly at 12 months postoperatively compared to preoperative evaluation. Meniscal extrusion on MRI increased in both Groups at 12 months post operatively compared to preoperative evaluation, but this increase was not statistically significant in both methods (Table 2).

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Table 2. **Pre-Operative and post-operative 12. month change in Visual Analog Scale, Lysholm knee score, MRI extrusion amount and Tegner score of the two methods**

		PRE-OPERATIVE	POST-OPERATIVE 12 MONTHS	P*
MRI-Extrusion, mean ± SD (mm)	Group 1	4.63 ± 0.52	4.73 ± 0.54	0.670
	Group 2	4.65 ± 0.37	4.74 ± 0.57	0.211
LysholmScores, mean ± SD	Group 1	49.40 ± 9.33	71.80 ± 10.47	0.001
	Group 2	36.20 ± 14.18	64.20 ± 14.21	0.001
TegnerActivity, mean ± SD	Group 1	3.13 ± 0.51	3.80 ± 0.67	0.008
	Group 2	2.46 ± 0.74	3.40 ± 0.73	< 0.001
VisualAnalogue Scale pain score,mean ± SD	Group 1	6.73 ± 0.96	4.70 ± 1.52	0.006
	Group 2	7.93 ± 0.59	4.20±0.84	0.001

*p values were derived using Wilcoxon signed-rank test

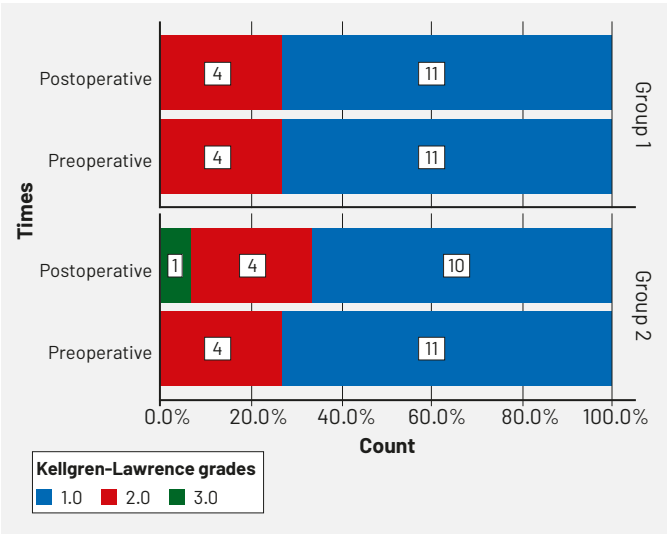

Fig. 2. **Pre-postoperative 12th month K-L change in the two groups.**

The comparison of preoperative and postoperative changes in Visual Analog Scale (VAS), Lysholm knee score, Meniscal extrusion on MRI and Tegner Score between Group 1 and Group 2 is shown in Table 3. VAS values decreased statistically significantly more in Group 2 compared to Group 1 postoperatively (p = 0.006). There was no statistically significant difference in the pre-post operative change in Lysholm knee score, Tegner activity score and meniscal extrusion on MRI in Group 1 compared to Group 2 (p = 0.575, p = 0.257, p = 0.141 respectively).

The preoperative and postoperative changes of the two methods in terms of Kellgren and Lawrence stage are presented in Figure 2. Mcnemar Test was used for this purpose. In Group 1.o postoperative change was detected compared to the preoperative value. In Group 2, one patient's stage changed from stage 1 preoperative to stage 2 postoperative, and another's changed from stage 2 preoperative to stage 3 postoperative. This change was not statistically significant (p = 0.157) (Fig. 2)

One patient in Group 1 had skin infection at the tunnel site in the first postoperative month and was treated with IV antibiotics and dressing. In the 2nd group, loosening of the cortical button implant was observed in two patients at the sixth month follow-up, and the patients who had an increase in clinical scores compared to the preoperative period did not accept surgery. No patient in either group required TKA during at one-year follow-up period.

DISCUSSION

The most important findings of the presented study were that the postoperative clinical scores and radiologic values of two different MMPRT arthroscopic repair methods were comparable. There was an increase in postoperative clinical scores compared to preoperative in both groups. No significant difference was observed between the two groups in terms of clinical scores, radiologic progression and conversion to TKA.

In a retrospective study by Moon et al. 51 MMPRT patients were repaired with Pull Out Suture Repair with cortical button and it was observed that the VAS value decreased after 33 months of follow-up (19). In our study, VAS values decreased statistically significantly more postoperatively in Group 2 compared to Group 1. We may think that the higher preop mean VAS values of the patients in Group 2 contributed to this result.

Table 3. **Comparison of the preoperative and postoperative changes in Visual Analog Scale, Lysholm knee score, Meniscal extrusion on MRI and Tegner Score between group 1 and group 2**

PRE-POST OPERATIVE CHANGE MEAN ± SD	GROUP 1	GROUP 2	P
Visual Analog Scale	2.03 ± 1.99	3.73 ± 0.96	0.006
Lysholm Knee Score	17.86 ± 17.34	26.13 ± 17.84	0.575
Meniscal Extrusion on MRI	−0.10 ± 0.61	0.30 ± 0.52	0.141
Tegner Score	1.31 ± 0.71	2.48 ± 0.88	0.257

In a systematic review by Chang et al., it was observed that the Tegner Activity Score and Lysholm Score increased at the end of follow-up compared to the preoperative period in patients diagnosed with MMPRT and followed up for an average of four years after arthroscopic repair (4). Consistent with the literature, both scores increased in Group 1 and Group 2 at the end of 12 months follow-up and were found to be statistically significant. In a study conducted by Briggs et al. in 488 healthy knees, Lysholm and Tegner scores were measured and the mean Lysholm score was 94 and Tegner activity score was 5.7. In our results, while preoperative clinical scores were well below normal, postoperative scores approached normal (2).

Although there are studies showing a decrease in meniscal extrusion after MMPRT repair, most studies have shown that extrusion continues to increase postoperatively (14, 29). A biomechanical study showed that the most common loosening in MMPRT repair with Pull Out Suture Repair with Cortical Button method was at the meniscus-suture interface (3). However, as in biomechanical studies, it is not always possible to ideally obtain the desired fixation tension at the suture button-bone interface, since fixation is not performed on a bone model without soft tissue.These laxities at the suture button-bone interface may be a reason for increased meniscal extrusion postoperatively.

The method of measuring meniscal extrusion on MRI in coronal section MRI is accepted as the most accurate measurement in the literature and was measured with this method in our study (13). There was an increase in meniscal extrusion on MRI at the end of 12 months follow-up in Group 1 and Group 2, but the difference was not statistically significant. In Group 1, tight dynamic fixation by preventing looseness at the suture button-bone interface during surgery was found to be similarly effective in reducing meniscal extrusion on MRI in the long term compared to classical pullout.

A meta-analysis by Chung et al. showed that the Kellgren and Lawrence (K-L) arthrosis stage did not decrease after MMPRT repair(6). In a retrospective study by Chung et al. comparing patients under and over 60 years of age who underwent MMPRT repair, a statistically significant increase in K-L stage was observed in both groups (7).In a retrospective study by Yanagisiwa et al. patients underwent repair with Pull Out Suture Repair with Cortical Button method. The patients were followed up for 12 months and it was found that Kellgren and Lawrence (K-L) stage increased in the group in which meniscal extrusion increased postoperatively, whereas no significant K-L stage change was found in the group in which extrusion decreased (29). In our study, although meniscal extrusion increased in both groups at the end of one-year follow-up, there was no change in the pre-postoperative K-L stage in Group 1, while arthrosis progressed in two patients in Group 2without any statistical significance. Strauss et al. reported that anatomical fixation in MMPRT should be performed with the knee in 30 degrees of flexion (24).

The main advantage of The Suspensory Fixation System technique is that the fixation tension can be advanced as desired during surgery while the knee is in the desired flexion angle. This ease of application distinguishes it from all other MMPRT repair methods. This study is the first prospective study comparing the results of prospective follow-up of The Suspensory Fixation System technique with Pull Out Suture Repair with Cortical Button. And the study showed that the Suspensory Fixation System technique in MMPRT repair has been shown to be a feasible treatment method with similar functional and radiologic results compared to Pull Out Suture Repair with Cortical Button.

First limitation of the study is that, fifteen patients from each group caused the sample to be small. Another limitation is that the follow-up period was limited to twelve months. Studies with longer follow-up are needed to compare the relationship between arthrosis progression and conversion to TKA. Another limitation is that there is a learning process involved in tying the loop stitches into the suspensory system.

CONCLUSIONS

The Suspensory Fixation System technique in MMPRT repair has been shown to be a feasible treatment method with similar functional and radiologic results compared to Pull Out Suture Repair with Cortical Button. At short-term follow-up, the addition of suspensory device to the conventional transtibial pullout repair did not result in a statistical difference on meniscal extrusion on MRI. ■

List of abbreviations
Medial Meniscus Posterior Root Tear: MMPRT
Visual Analog Scale: VAS
Kellgren and Lawrence: K-L
Total Knee Arthroplasty: TKA
Magnetic Resonance Imaging: MRI

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