

Original Research Article

Outside in and all inside approach for repair of meniscal tears: post-operative subjective evaluation: a retrospective study

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Received: 06 April 2024

Revised: 22 April 2024

Accepted: 23 April 2024

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ABSTRACT

Background: Assess clinical outcomes after using outside-in, all-inside or combination of both approaches for meniscal repair.

Methods: 86 patients with diagnosed meniscal tears, operated between January 2017 and January 2019 by one surgeon in Northway Clinic, Vilnius and Vilnius Clinical Hospital were surveyed. The meniscal repair techniques used included all-inside, outside-in, or a combination. Clinical outcomes were evaluated using the International Knee Documentation Committee Subjective Knee Evaluation Form, with meniscal retear indicating failure. Ethical approval was deemed unnecessary for this project. Descriptive statistical analyses were performed using IBM SPSS Statistics 29.01.

Results: Patients undergoing the outside-in approach scored 89.4 ± 12.5 on the IKDC questionnaire, compared to 88.5 ± 16.6 for all-inside and 82.8 ± 20.3 for both techniques combined ($p=0.194$). Kaplan–Meier analysis showed a 5.6-year survival rate of 80.9% with the all-inside approach. Subjective knee function assessment indicated scores of 8.50 ± 1.9 for outside-in, 8.49 ± 1.4 for all-inside, and 8.16 ± 1.95 for both techniques. Cox proportional hazards model analysis suggested that older age and higher BMI trended towards reduced reoperation risk (hazard ratio, 0.93 and 0.98; $p=0.246$ and $p=0.832$, respectively).

Conclusions: Self-reported outcomes in this study evaluated by IKDC questionnaire and subjective function assessment emphasize that both all-inside, outside-in or combination of the techniques provide similar results. All adverse outcomes defined as meniscal retears were observed using all-inside technique.

Keywords: Knee arthroscopy, Meniscus injury, Meniscus all-inside suturing, Meniscus inside-out suturing

INTRODUCTION

Menisci were called functionless remains of muscles stabilizing the knee as now there is a rise in recent many investigations that describe menisci as irreplaceable anatomical structure of the knee.¹ Menisci are susceptible to sports injury and age or disease-related degenerative breakdown. Over one million patients undergo surgical repair or meniscectomy annually in the U.S. alone.² Tears in the vascularized outer third region of meniscus can be surgically repaired by suturing torn parts. In contrast, tears

in the inner avascular region are hardly repaired due to poor intrinsic healing capacity and are frequently extended into the middle-third region, followed by meniscus deterioration.^{2,3} To alleviate symptoms caused by such irreparable meniscus injuries, partial or total meniscectomy is often performed. However, meniscectomy significantly increases the incidence of osteoarthritis.⁴ Biomechanical studies revealed that the decrease in intra-articular contact area followed by a meniscectomy causes elevation in the peak contact pressure and as a result the risk of osteoarthritis.^{5,6} The

objective of meniscal repair is to rebuild anatomy as closely as feasible to natural physiology in order to restore normal biomechanics. As the majority of adult menisci fibers are circumferential, the radial fibers are less frequent and are particularly prevalent on the meniscus' surface. For this reason, vertically placed sutures are held with the circumferential collagen fibers, while horizontally placed sutures are parallel to these fibers and therefore more easily pulled through the meniscus.⁷ However, the objective about which suture is more stable is controversial as horizontal and vertical stitches had the same resistance to tensile forces, and no significant difference was observed between these two kinds of suturing.⁸ Despite the anatomy of collagen fibers, the best method for treating a meniscal injury depends on the kind of tear, where it is located, the meniscal vascularity, and any co-existing injuries. It has been reported that 10%–20% of meniscal tears and 30% of longitudinal tears are suitable for repair. The optimal choice for meniscal healing is thought to be longitudinal vertical wounds in the periphery. Methods, such as “inside-out”, “outside in” and “all inside” are utilised for meniscal repairs.⁵

Meniscal repair using inside-out sutures has been considered the ‘gold standard’ in terms of successful meniscal healing. The method can be technically demanding, more time consuming and has been described as sub-optimal for managing frequently encountered posterior horn tears. Inside-out technique has association with higher rates of injury to the saphenous nerve during medial meniscal repairs and the common peroneal nerve during lateral meniscal repairs. It demonstrated that the sutures tied on the posterior capsule were reported to lead to flexion contractures.⁹ The all-inside meniscal repair devices were introduced to spare the need for an additional incision and an assistant to tie knots on the capsule. With correct deployment of the anchors new generation devices do not cause the same degree of chronic chondral injury. It is suggested that all-inside repair is quicker to perform than inside-out and that there is almost no risk of nerve entrapment, which can occur during tying of the inside-out or outside-in meniscus sutures.¹⁰ Suturing methodologies applied in the management of meniscal tears Successful surgical meniscal repair despite surgical techniques depends on multiple factors, such as the healing process that is based on two basic principles: a solid primary fixation, and a biological process of cicatrization, which requires preceding abrasion.¹¹ Tears can be categorised into different categories based on healing probability and possible operative outcomes. Tears that can be grinded and left alone, tears that can be repaired, tears that can be repaired in specific conditions, and tears that should be resected and cannot be meniscus sparing. It is accepted that peripheral tears of 7 mm or less can heal without operative suturing treatment. Such tears should be probed to ensure less than 3 mm of displacement so that there is higher possibility of healing and during the procedure the meniscal synovium should be rasped to promote healing.¹¹

Inside out and outside in

Both inside-out and outside-in repair techniques involve passing a suture through the knee using an arthroscope, either from the inside or outside and tying it superiorly to the joint capsule through a small incision.^{11,14} These methods are especially valuable for addressing anterior and middle third tears that are less accessible through an all-inside approach. Nevertheless, it's crucial to exercise caution in protecting neurovascular structures, specifically the saphenous nerve on the inner side and the common peroneal nerve on the outer side, while creating the supplementary incisions.⁴

All-inside

Multiple techniques and implants are available for all-inside meniscal repair. Usually, the all-inside suturing technique is used for posterior tears and can be used for middle third tears. All-inside meniscal repair devices have allowed for all-inside arthroscopic meniscal repair techniques to evolve with the advantage of avoiding the need for accessory incisions.¹⁴ Suture based devices consisting of an anchor component and a sliding knot were the next generation to be developed to avoid the complications associated with rigid devices and to allow and more flexible fixation of the meniscal fragments. The all-inside technique has gained increased prominence compared to the inside-out or outside-in repair methods. This is primarily attributed to its shorter surgical duration, ability to mend meniscal tears without attaching to adjacent tissue, diminished potential for neurovascular and soft tissue harm, and the inherent restoration of contact area throughout a broader spectrum of knee movement.¹⁴

This study purpose is to assess clinical outcomes after using outside-in, all-inside or combination of both approaches for meniscal repair. Surgical outcomes refer to data regarding operation results, including information about patients' subjective satisfaction and International Knee Documentation Committee Subjective Knee Evaluation Form score. The hypothesis of this study was to determine that the outside in surgical approach leads to better outcomes than all-inside approach.

METHODS

86 patients with diagnosed meniscal tears, operated between January 2017 and January 2019 by one surgeon in Northway Clinic, Vilnius and Vilnius Clinical Hospital were surveyed. In this retrospective, single-center study patients operated by the same fellowship trained surgeon with documented meniscal tears, ≥18 years old, consented for research participation, and completed International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC) and subjective knee function evaluation were enrolled. Repair criteria comprised peripheral tear measuring 7 mm or smaller, with the repair method selected based on the tear's location: for anterior and middle thirds, an outside-in approach; for posterior

and middle thirds, an all-inside technique, with specific placement determined by the surgeon. Patients were categorized as having undergone all-inside repair if they had exclusively all-inside devices placed, and patients were categorized as having undergone outside-in repair if they either had only outside-in sutures placed or if they had combination of both all-inside outside-in suturing techniques. Exclusion criteria consisted of (1) less than 3 years of follow-up, (2) prior meniscal repair on the same side, (3) multiligament injuries, (4) concomitant periarticular fractures, (5) full-thickness (grade 4) osteochondral lesions by Outerbridge classification, (6) patients that were unable to complete questionnaires. A total of 146 patients were selected from January 2017 to January 2019. 146 selected patients were contacted via telephone out of whom 86 agreed to participate in this survey and answered the questionnaire or were mailed the online questionnaire. They also responded to additional questions regarding subjective knee function and the possibility of re-operation.

Outside-in technique

Outside-in methods, used specifically in this research paper entail two injection needles percutaneously threading sutures through spinal needles positioned at the joint line across the tear. One needle is used as a loop (mostly used PDS No.0 thread) to retrieve intraarticular thread end of No.0 or No. 2/0 Fiberwice (or other braided) thread. After penetrating the meniscus in the right position through a small skin incision, the intraarticular end was retrieved outside through the Polydioxanone loop. Then, using the polydioxanone loop both thread ends are delivered outside the capsule. Afterwards, the thread ends were tightened and bonded together using 4-5 knots in arthroscopic control. Suture choice was dependent on rupture pattern.^{11,15}

All-inside technique

All-inside repair was also performed in a vertical mattress or horizontal configuration and in accordance with the

guidelines for the all-inside device used. All all-inside repairs utilized anchors.

Clinical evaluation

Scores according to IKDC and subjective knee function satisfaction of the all-inside, outside-in or both techniques combined were assessed.

Survival analysis

For survival analysis, failure was defined as meniscal re-tear.

Statistical analysis

Post-operative results were compared using different statistical criteria using IBM SPSS Statistics software, Version 29.01. Descriptive statistic measures were conducted to calculate the mean, range, and standard deviation as well as percentages. A p value ≤ 0.05 signified a significant difference.

RESULTS

Sociodemographic data of patients who received IKDC questionnaire

In total 86 patients’ questionnaires’ results were included. 14 (16.3%) of patients had their surgery done in 2017, 29 (33.7%) in 2018 and 43 (50.0%) in 2019. IKDC Subjective Short Form and additional questions of re-operation, weight and height were administered to 25 female (29.1%) and 61 (70.9%) male patients. There was a statistically significant difference between IKDC score and gender ($p=0.043$), males scored higher on the IKDC questionnaire 89.8 ± 15.0 than females 81.1 ± 21.0 . The average age of females was 39 ± 10.0 years and 37 ± 11.2 for the males, while the oldest patient was 79 and the youngest was 21. Weak but statistically significant correlation was observed between age and IKDC scores ($r=-0.28$; $p=0.007$) - as the age of the individuals in the sample increases, their test scores tend to decrease (Figure 1).

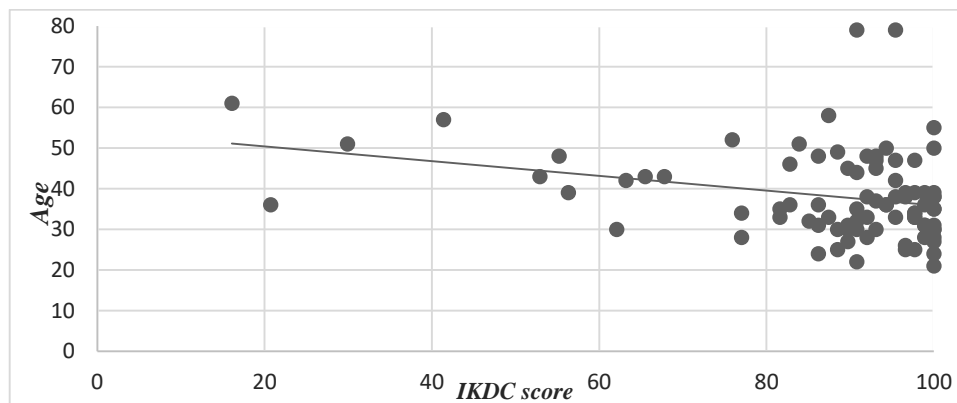


Figure 1: Scatter plot demonstrating patient age and IKDC score correlation. A simple linear regression line of best fit is shown ($R^2=0.083$).

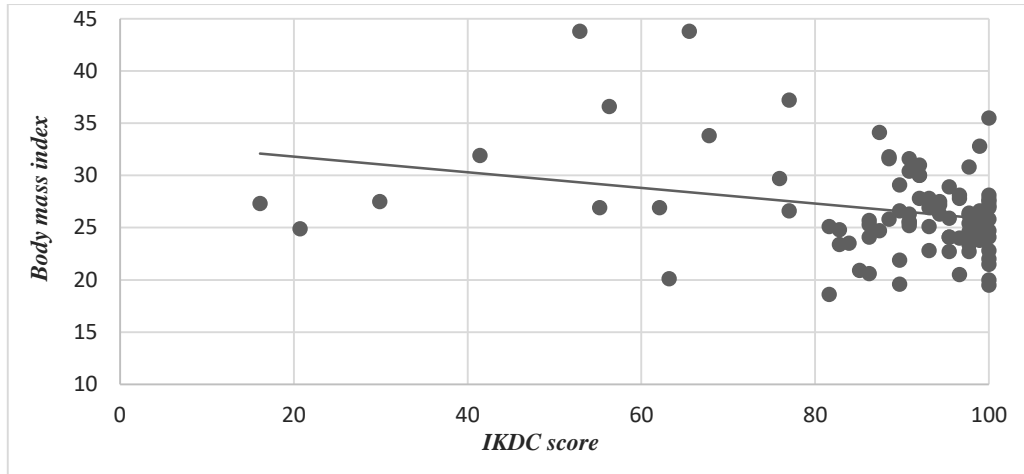


Figure 2. Scatter plot demonstrating patient body mass index and IKDC score correlation. A simple linear regression line of best fit is shown (R²=0.078).

Biometric measurements

Out of the total patient population, 30 individuals with a normal BMI accounted for 34.9%. The majority of patients, comprising 39 individuals (45.3%), fell into the overweight category, while 17 patients (19.8%) exhibited first-degree obesity. In our medical research, the analysis of correlations revealed a statistically significant but weak negative association between BMI and IKDC scores, as evidenced by a Pearson correlation coefficient of -0.28 (p=0.009). This finding indicates that higher BMI values were linked to lower IKDC scores, implying that an increase in BMI was associated with a decrease in knee-

related health and functionality as measured by the IKDC scoring system (Figure 2).

All-inside meniscal repair technique, outside-in and combination of both approaches according to patients' subjective assessment on their knee function and IKDC score.

Among the patient cohort, a majority of 63 individuals (77.3%) exclusively underwent the all-inside repair technique, while 4 patients (4.7%) exclusively received an outside-in repair. Additionally, 19 patients (22.1%) underwent a combination of both techniques (Table 1).

Table 1. Patient demographics and suturing techniques.

	Only outside-in	Only all-inside	Both techniques
Patients	4	63	19
Percentage, %	4.7	73.3	22.1
Average IKDC	89.4±12.5	88.5±16.6	82.8±20.3
Age (years)	34.8±12.9	38.5±9.6	37.7±14.5
Gender			
Female	2	17	6
Male	2	46	13
Knee			
Right	3	37	8
Left	1	26	11
Meniscus			
Lateral		13	3
Medial	4	49	16
Both		1	

Table 2: Patient demographics and IKDC scoring in outside-in vertical, horizontal, or both suturing approaches.

Only outside-in suturing techniques		
Variables	Outside-in vertical	Outside-in in horizontal and vertical
Patients	2	2
Percentage, %	50.0	50.0
Average IKDC	87.9±17.0	90.8±13.0

Continued.

Only outside-in suturing techniques		
Variables	Outside-in vertical	Outside-in in horizontal and vertical
Age (years)	41.5±14.9	28.0±9.9
Gender		
Female	2	
Male		2
Knee		
Right	2	1
Left		1
Meniscus		
Lateral		
Medial	2	2
Both		

Table 3: Patient demographics and IKDC scoring in both outside-in and all-inside vertical, horizontal or both suturing approaches.

Both Outside-in and all-inside suturing techniques						
Variables	Outside-in Horizontal	Outside-in Vertical	Outside-in in Horizontal and Vertical	All-inside horizontal	All-inside vertical	All-inside in combination
Patients	1	12	6	8	10	1
Percentage, %	5.3	63.2	31.6	42.1	52.6	5.3
Average IKDC		81.9±21.9	89.5±13.8	74.3±28.7	89.6±8.2	
Age (years)		37.4±12.2	37.3±20.8	35.1±12.3	38.9±17.1	
Gender						
Female		6		2	4	
Male	1	6	6	6	6	1
Knee						
Right	1	3	4	4	4	
Left		9	2	4	6	1
Meniscus						
Lateral		2	1	1	2	
Medial	1	10	5	7	8	1
Both						

Patients who had an explicitly outside-in approach, assessed the status of current knee function as 8.5±1.9, compared to all-inside 8.5±1.4 or both techniques 8.2±1.9 accordingly. Superior outcomes were achieved when evaluating the suturing techniques using the IKDC questionnaire. Patients who had outside-in assessed by IKDC questionnaire scored 89.4±12.5, compared to all-inside that scored 88.5 ± 16.6 or both techniques 82.8±20.3 accordingly. However, no statistically significant difference was found between different suturing techniques and IKDC or subjective knee assessment scores using Kruskal-Wallis test (p=0.194, 0.860).

In outside-in only consisting of 4 (4.7%) individuals group: 2 patients (50%) had vertical and 2 (50%) horizontal and vertical suturing approaches (Table 2).

In explicitly all-inside 63 (77.3%) group: 58 (92.1%) patients had horizontal with average IKDC 88.7±16.7 and mean age of 38.9±9.6, 4 (6.3%) vertical with average IKDC of 88.7±16.7 and mean age 35.5±9.7 and 1 (1.6%) combination of vertical and horizontal with IKDC of 92 and age of 28. When considering a group of 19 (22.1%) patients who had all-inside and outside-in approaches

combined, the majority had vertical instead of horizontal suturing approaches (Table 3).

However, no statistically significant differences were found between horizontal of vertical suturing approaches in each (all-inside, outside-in or combined) groups and demographic parameters, IKDC or subjective knee assessment scores.

Survival free of clinical retears

There is a total of 6 failures in the all-inside only group and 0 failures in the outside-in only or combined group. In the all-inside group (n=6), the majority of reoperations were observed in male patients (83.3%), and the right side of the injury was predominantly affected (83.3%). The average age of individuals who experienced meniscal retear was 33.3±8.5 years and the mean BMI 25.9±2.9.

Kaplan–Meier survival analysis demonstrated a survival rate of 80.9% at 5.6 years using all-inside approach with meniscal retear defined as failure and no significant difference in reoperation rates between the outside-in, all-inside only or combined groups (p=0.402) (Figure 3).

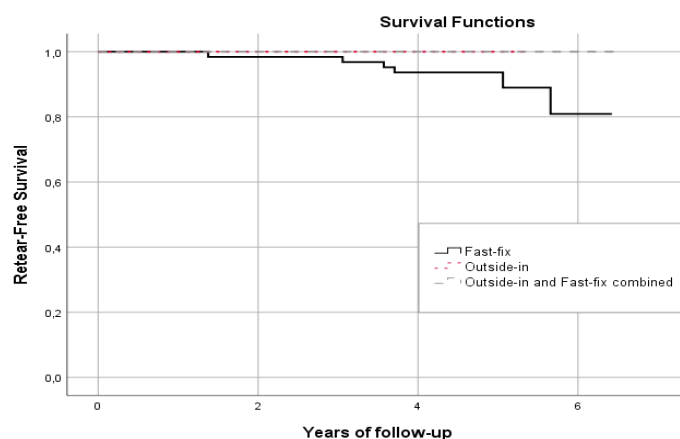


Figure 3: Kaplan-Meier survivorship curve demonstrating the overall proportion of patients free from reoperations at given time points for the outside-in and all-inside groups.

Because the outside-in and combined groups were free of the reoperations and Hazard Ratio for the different techniques would be undefined or not interpretable, a Cox proportional hazards model with covariates instead of regular Cox proportional hazards analysis was conducted. In the study of 86 patients with meniscal repair 6 demographic predictors on disease recurrence were assessed. Cumulative incidence values for failure were determined along with their 95% CIs. Cox proportional hazards model with covariates analysis suggested that increased patients' age, body mass index trended toward a decreasing risk of reoperations (hazard ratio, 0.93 and 0.98; $p=0.246$ and 0.832 accordingly). Hazard Ratio according to the side on injury was approximately 0.203, meaning that medial side of injury may be associated with a reduced hazard of meniscal reoperation compared to lateral side of injury, but the difference is not statistically significant ($p=0.074$). No single variable was found to predict increased failure incidence over time.

DISCUSSION

IKDC questionnaire and subjective function assessment scores were similar when using all-inside, outside-in or combination of both techniques for meniscal repair. While extensive research has been conducted comparing the all-inside and inside-out approaches, there remains a notable gap in the literature when it comes to comparing the all-inside and outside-in ones. The selection of the surgical approach continues to be a contentious issue within the field, primarily due to the limited availability of high-level evidence that can effectively differentiate between them.¹⁶

The outside-in repair method has established itself as a pivotal procedure for addressing meniscal tears. Its use of small incisions and impressive success rate have made it a dependable approach, especially for tears located in the front two-thirds of the meniscus.¹⁷

A notable clinical efficacy in the current study is comparable with those reported in similar studies, outside-

in repair technique showcased favourable outcomes in terms of relieving pain, addressing problems such as joint immobility and swelling, and leading to enhanced International Knee Documentation Committee scores.¹⁸

It was observed that the selected patient population exhibited similarities in demographic characteristics of those concerning meniscal tear repair. Primarily, male patients with medial meniscal injuries continue to be a population of concern.

The implementation of all-inside meniscal repair systems has offered two main advantages: reduction of severe neurovascular complications and shortening the operative duration.^{9,19} Currently, there is an abundance of available devices designed for all-inside meniscal repair, exhibiting success rates that fall within the range of 75% to 90%.²⁰ The all-inside technique offers the benefit of meniscus repair without tethering it to adjacent soft tissues, enabling independent mobility from structures like the MCL, capsule recesses, or muscles. This autonomy facilitates healing even when early passive range of motion is introduced. Additionally, it prevents excessive medial meniscus hyperstability, which could otherwise result in acute suture breakage or re-tearing.²¹

Nonetheless, when examining additional factors such as failure rates, the existing body of literature generally aligns with our study's findings by revealing that meniscal tears repaired using the all-inside technique exhibited considerably higher failure rates compared to alternative methods, including our focus on the outside-in approach. It's important to be mindful of potential biases and limitations in the current research when analysing survival curves. This study was conducted during a 5-year period and the patients distribution in groups divided by suturing techniques were unequal. Further research with a bigger sample size of outside-in approach should be conducted. In the outside-in group no relapses were observed, and the interpretation of the data should be made cautiously due to lack of observed events for comparison.

Limitations

The study's retrospective, non-randomized design presented a potential for selection bias and should be considered in the evaluation of the research findings. Additional limitations include single surgeon study susceptible to confounding factors related to the surgeon's individual characteristics, skill level, and experience.

CONCLUSIONS

Self – reported outcomes in this study evaluated by IKDC questionnaire and subjective function assessment emphasize that both all-inside, outside-in or combination of them provide similar results. All adverse outcomes defined as meniscal retears were observed using all-inside technique and highlights the importance of considering factors beyond subjective outcomes alone.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Dauderytė B, Lukoševičiūtė G, Bliznikas K. Outside in and all inside approach for repair of meniscal tears: post-operative subjective evaluation: retrospective study. *Int J Res Orthop* 2024;10:507-13.