Knee Surg Sports Traumatol Arthrosc (2016) 24:1427–1431
DOI 10.1007/s00167-015-3590-z

KNEE

Which patients are less likely to improve during the first year after arthroscopic partial meniscectomy? A multivariate analysis of 201 patients with prospective follow-up

Barak Haviv[1,2] · Shlomo Bronak[1] · Yona Kosashvili[2,3] · Rafael Thein[1,2]

Received: 8 August 2014 / Accepted: 27 March 2015 / Published online: 5 April 2015

Abstract
Purpose To determine which specific factors influence the improvements in function and pain at the first year following arthroscopic partial meniscectomy.
Methods Between 2012 and 2013, patients who had arthroscopic partial meniscectomy were included ($n = 201$) and followed prospectively before surgery and at 12 months. Multivariable stepwise analysis included preoperative variables (age, gender, limb side, height, weight, body mass index, comorbidities, smoking, Tegner activity scale, Lysholm knee score, preceding injury and duration of preoperative symptoms) and arthroscopic findings (degree of cartilage lesions, medial or lateral meniscus involvement, type of meniscal tear and concomitant cruciate tear). The Lysholm clinical score at the last follow-up and the time interval for substantial pain relief was modelled as a function of the above predictor variables.
Results At the last follow-up, the mean Lysholm score improved by 14.6 points (95 % CI 10.4–18.8, $P < 0.001$), from 68.0 ± 16.1 to 82.6 ± 19.6 points and 153 (76 %) patients declared they were satisfied to have had the operation. The mean time interval for substantial pain relief was 3.5 ± 1.5 months. Females and patients with lower preoperative Lysholm score were correlated with lower post-operative Lysholm score, while females and patients with lateral meniscal tears (compared to medial meniscal tears) were correlated with longer recovery.
Conclusions Arthroscopic partial meniscectomy improved pain and function at the first year post-operatively. Female gender, lateral meniscal tear and less favourable preoperative function were relatively correlated to worse post-operative function and longer rehabilitation time.
Level of evidence IV.

Keywords Knee · Arthroscopy · Meniscectomy · Factors · Outcome

Introduction

Arthroscopic partial meniscectomy (APM) is considered the standard of care for torn menisci in appropriate selective indications [6]. Determining which patients will do well following partial meniscectomy is a challenging task and multiple factors need to be considered. Currently, the evidence in the literature on factors that may predict success of APM is focused on medium-to-long-term results. Although at 5–15 years, APM was found generally successful, the correlation with preoperative (e.g. age, sex, activity level, etc.) and intra-operative (e.g. tear type, chondral damage, etc.) factors was not entirely consistent [5, 14, 18]. Examples of factors that correlated with worse results were older age [17], obesity [4], female gender [17], extensive meniscal resection [4, 9] and advanced chondral damage at surgery [15].

As part of the modern hectic lifestyle, people are concerned with fast solutions and quick recovery for medical ailments. Specifically, patients with meniscal tears that are

✉ Barak Haviv
barak_haviv69@hotmail.com

[1] Arthroscopy and Sports Injuries Unit, Hasharon Hospital, Rabin Medical Center, 7 Keren Kayemet St, 49372 Petach Tikva, Israel

[2] Orthopedic Department, Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel

[3] Orthopedic Department, Beilinson Hospital, Rabin Medical Center, Petach Tikva, Israel

candidates for arthroscopy often inquire on their short-term return to normal function.

The factors that have been shown to predict long-term outcome may not necessarily affect the short-term outcome. Therefore, it is essential to investigate the impact of demographic and surgical variables associated with patient rate of recovery at the first year after APM. The information in the literature on first-year results and its correlation to various factors is scarce. A short-term follow-up by Kobayashi et al. [12] concluded that cartilage damage predicts clinical results after APM for horizontal degenerative tear of medial meniscus. Fabricant et al. [7] have found that female gender and osteoarthritis were associated with slower recovery from APM at the first year after surgery. The aim of this study was to determine which specific factors influence the improvements in function and pain at the first year following APM. A secondary objective was to assess the clinical improvement at the first year following APM.

Materials and methods

Between 2012 and 2013, 445 patients had knee arthroscopic procedures in a regional referral centre for arthroscopic surgery, Rabin Medical Center, Petach-Tikva, Israel. The study included patients who had knee arthroscopy for a preoperative diagnosis of torn meniscus. This study did not include patients who had cruciate ligament reconstruction, meniscal repair procedures, concurrent osteotomy, patellar realignment, surgery for synovial disease (e.g. rheumatoid arthritis, pigmented villonodular synovitis) or ipsilateral previous knee surgery. Additional exclusion criteria were patients with varus or valgus clinical deformity (normal alignment was estimated as intercondylar distance at the knee of <6 cm and intermalleolar distance at the ankle of <8 cm), moderate-to-severe arthritic signs on preoperative weight-bearing radiographs (i.e. Kellgren–Lawrence grade >1 [11]) or worker compensation claim related to their operated knee.

Of the 226 patients that were eligible for inclusion, 201 had consented to participate and completed a 12-month follow-up (133 males, 68 females). The mean age was 44.4 ± 14.7 years (Table 1).

Evaluation, surgical technique and follow-up

All preoperative evaluations and operations were undertaken and reported by three senior, high-volume orthopaedic surgeons (each performs between 250 and 300 procedures annually) who work together in an academic knee arthroscopy regional referral centre. Preoperative data included demographic details, detailed patient history, Tegner activity scale, Lysholm knee scoring questionnaire [1] and visual analogue scale (VAS) for pain (Table 1).

The indication for knee arthroscopy in the case of diagnosed meniscal tear was an unresolved knee pain and activity limitation for at least 8 weeks. All candidates had plain radiography and magnetic resonance imaging (MRI) of the knee prior to surgery.

Surgery was done under general anaesthesia with the patient in a supine position. A leg holder and tourniquet were placed around the thigh of the affected leg. Standard anterolateral and anteromedial knee portals were used. Diagnostic arthroscopy with a 30° 4-mm scope was performed to evaluate abnormal findings of menisci, ligaments and cartilage. At surgery, cartilage lesions were probed, measured and then graded from 0 to 4 according to the International Cartilage Repair Society (ICRS) classification [2]. One point was added if more than a single compartment was involved. The pattern of meniscal tear was also recorded. In this study, bucket handle-type tears involved the posterior horn and midportion of the meniscus, radial tear types involved the midportion, discoid tear types involved all portions and degenerative (complex) tear types involved the posterior horn. Meniscal tears were trimmed until a stable peripheral rim was reached. Bucket handle tears required removal of up to two-thirds of the meniscal tissue, while other types required removal of up to one-third of the meniscal tissue. All patients were discharged from the hospital at the day of surgery with anti-inflammatory prescribed for the first 2 weeks and were instructed for gradual self-rehabilitation by illustrated handouts. The handouts were translated from the 'Knee Arthroscopy Exercise Guide' at 'http://orthoinfo.aaos.org/topic.cfm?topic=A00300'.

Table 1 Patient preoperative and operative characteristics

Variable	Values
Age	44.4 ± 14.7
Male: female	133:68
Right: left side	119:82
Body mass index, kg/m^2	26.9 ± 4.3
Comorbidities of ASA level 2	39 (19 %)
Smokers	59 (30 %)
Preceding injury	76 (38 %)
Duration of symptoms in months	5.4 ± 3.5
Tegner activity scale	3.9 ± 1.8
Knees with medial meniscal tear	144 (71 %)
Knees with lateral meniscal tear	43 (21 %)
Tear pattern: bucket handle, radial, discoid, degenerative	24 (12 %), 55 (28 %), 6 (3 %), 110 (55 %)
Knees with cruciate tear	23 (11 %)
Degree of chondral lesion by ICRS	1.4 ± 1.7

ASA American Society of Anesthesiologists level of physical status, *ICRS* international cartilage repair society

The patients were interviewed at 12 months after the index operation to complete the Lysholm knee scoring scale, visual analogue scale (VAS) and overall satisfaction from surgery (yes/no). A substantial pain relief (SPR) was defined as VAS <2. The time interval to gain SPR from the index surgery was also recorded.

Independent predictors for improvement

In order to predict improvement during the first year after APM, we have used the sixteen following variables as independent predictors.

Preoperative variables

The preoperative variables included age, gender, limb side, height, weight, body mass index (BMI), comorbidities [defined by the American Society of Anesthesiologists (ASA) level of physical status], smoking, Tegner activity scale at baseline, Lysholm knee score at baseline, preceding injury and duration of preoperative symptoms.

Arthroscopic findings

The following were the arthroscopic findings: degree of cartilage lesions at arthroscopy according to the ICRS, medial or lateral meniscus involvement, type of meniscal tear, concomitant cruciate tear (not reconstructed). The study was approved by the institutional review board of the hospital, ID Number 299-13 RMC.

Statistical analysis

Results were expressed by mean and standard deviation with an accuracy of one decimal place. Paired *t* test was used to compare between pre- and post-operative clinical scores. A power calculation was performed to find an adequate sample size for multivariate regression. For the given sixteen predictor variables and for a type I error of 0.05 with effect size of 0.2, the necessary sample size to reach a power of 0.9 was 134 observations. The correlation between different variables was calculated by the Spearman's correlation coefficient. The Lysholm clinical score at the last follow-up and the time interval for SPR were modelled as a function of the above sixteen predictor variables with the use of multivariate stepwise regression analysis. A p value <0.05 was considered statistically significant.

Results

The mean follow-up time was 13.5 ± 2.4 months. At the last follow-up, the mean Lysholm score improved by 14.6 points (95 % confidence interval, 10.4–18.8, $P < 0.001$), from 68.0 ± 16.1 to 82.6 ± 19.6 points, the VAS decreased from a mean of 5.7 ± 1.4 to 3.8 ± 0.7 points ($p < 0.001$) and 153 (76 %) patients declared they were satisfied to have had the operation. The mean time interval for SPR (i.e. VAS <2) was 3.5 ± 1.5 months. No patient had concomitant severe systemic disease, 162 patients had normal health status (ASA level-1) and 39 patients had mild systemic disease (ASA level-2). The various operative findings at arthroscopy are shown in Table 1. Significant correlations between the different variables are shown in Table 2.

Table 2 Correlation coefficient matrix (Spearman) of statistically significant relations between variables ($P < 0.0001$)

	Age	Tegner activity scale	Degree of chondral lesion by ICRS
Tegner activity scale	−0.6		
Degree of chondral lesion by ICRS	0.6	−0.4	
Male gender		0.4	−0.4
Medial meniscal tear	0.4		

Multivariate stepwise regression analysis using the above sixteen preoperative variables and operative findings as independent predictors was performed twice for two dependent variables, 'post-operative Lysholm score' and 'time to SPR'. The results showed that females and patients with lower preoperative Lysholm score were correlated with lower post-operative Lysholm score, while females and patients with lateral meniscal tears (compared to medial meniscal tears) were correlated with longer time to SPR (Table 3).

None of the participants had a second knee arthroscopy during the time of the study. There were no infections, thromboembolic episodes or permanent nerve injuries.

Discussion

The most important findings of the present study were that after twelve months from APM, there was a clinically significant improvement with most patients achieving SPR at an average of 3.5 months, whereas female gender, lateral meniscal tear and lower preoperative functional score were relatively correlated to worse post-operative function and longer rehabilitation time.

Many variables may affect the recovery and end results after APM. The literature is mainly focused on factors that affect long-term outcome [3, 6, 8–10, 13, 14, 16, 18]. Two recent studies have prospectively followed patients for 12 months after APM.

The first study by Fabricant et al. [7] has evaluated 126 consecutive APM procedures. During the first year, they noticed that female gender and worse osteoarthritis were

Table 3 Multivariate stepwise regression results

Dependent variable	Independent variable	Coefficient	Lower 95 % CI	Upper 95 % CI	Probability	R	R^2
Post-operative Lysholm score	Male gender	10.7	3.0	18.5	0.007	0.4	0.2
	Preoperative Lysholm score	0.4	0.1	0.6	0.003		
Time until SPR	Male gender	−0.7	−1.4	−0.1	0.017	0.4	0.2
	Lateral meniscal tear	1.1	0.4	1.8	0.002		

SPR substantial pain relief

associated with a slower rate of short-term recovery from APM. Similar to the work of Fabricant et al. [7], the present study sought to determine which patient variables are associated with rate of recovery from surgery after APM. In contrast, the present study did not include patients with preoperative osteoarthritis, nevertheless, chondral damage that was documented at surgery did not influence outcome. In the present study, knee reconstructive procedures and patients with worker compensation claims were excluded to avoid bias. The sixteen preoperative and operative variables that were analysed included age, gender, limb side, height, weight, BMI, number of comorbidities, smoking, Tegner activity scale, Lysholm knee score, preceding injury, duration of preoperative symptoms, degree of cartilage damage, medial or lateral meniscus involvement, type of meniscal tear and concomitant cruciate tear (not reconstructed). The extent of meniscectomy was not evaluated because of difficulties in accurate definition; however, bucket handle-type tears required more extensive meniscectomies that did not correlate with the outcome in the present study.

The second prospective short-term study was conducted by Sihvonen et al. [19]. This was a multicentre, randomised, double-blind, sham-controlled trial in 146 patients who had knee symptoms consistent with a degenerative medial meniscus tear and no knee osteoarthritis. Although the outcome did not differ between the study and control groups, the overall outcome improved in both groups at 12 months. In their study, no correlation analysis was performed between factors and outcome but as in our study, which included 110 (55 %) degenerative meniscal tears, there was a steep recovery at the first 6 months and especially at 2 months from baseline. This short recovery is also described in other studies [20].

The prediction of outcome after APM has been studied extensively [5, 6, 9, 14, 18]. Englund et al. [4] have found that factors associated with worse outcome after 16-year follow-up were degenerative meniscal lesions and extensive resections. On a systematic review by Salata et al. [18], the predictors of poor clinical or radiographic outcomes included total meniscectomy or removal of the peripheral meniscal rim, lateral meniscectomy, degenerative meniscal tears, presence of chondral damage, presence of hand osteoarthritis suggestive of genetic predisposition and increased BMI. Variables that were not predictive of outcome or were inconclusive or had mixed results included meniscal tear pattern, age, mechanical alignment, sex of patient, activity level and meniscal tears associated with anterior cruciate ligament (ACL) reconstruction. This review concluded that there is a lack of uniformity in the literature on this subject with a preponderance of lower-level evidence. It should be emphasised that variables that might predict long-term results cannot necessarily be generalised to implicate similar associations when considering short-term recovery from surgery.

This study is one of very few studies that were intentionally designed to discover associations between different factors and less favorable clinical outcome and recovery shortly after APM. The study included a large number of preoperative and operative variables that we have considered important to evaluate. Physicians can reassure candidates for APM beforehand that most of those variables will probably not affect the short-term recovery. Conversely, females, patients with lateral meniscal tear or with less favorable preoperative function may expect worse post-operative function and longer rehabilitation time. We believe that our conclusions can help surgeons in their decision-making and informing patients on the expected timeline for recovery.

The strengths of this study were the inclusion of a relatively large cohort of patients with prospective follow-up and the evaluation of wide spectrum of potential outcome predictors; however, it has several limitations. First, this was a single rather than multicentre study with only three surgeons involved. The results of their surgical technique and rehabilitation protocol may not reflect the results in other centers. Second, the follow-ups were performed by the surgeons themselves and not by an independent observer which may have biased the data. Finally, it is of the authors' interest to continue and follow the patients in order to compare between short- and long-term outcome predictors.

Conclusions

APM improved pain and function at the first year post-operatively with SPR at an average of 3.5 months. Female gender, lateral meniscal tear and less favorable preoperative

function were relatively correlated to worse post-operative function and longer rehabilitation time.

Conflict of interest All authors declare no financial relationships and no conflict of interests.

References

1. Briggs KK, Kocher MS, Rodkey WG, Steadman JR (2006) Reliability, validity, and responsiveness of the Lysholm knee score and Tegner activity scale for patients with meniscal injury of the knee. J Bone Joint Surg Am 88:698–705
2. Brittberg M, Winalski CS (2003) Evaluation of cartilage injuries and repair. J Bone Joint Surg Am 85:58–69
3. Burks RT, Metcalf MH, Metcalf RW (1997) Fifteen-year follow-up of arthroscopic partial meniscectomy. Arthroscopy 13:673–679
4. Englund M, Roos EM, Lohmander LS (2003) Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: a sixteen-year followup of meniscectomy with matched controls. Arthritis Rheumatol 48:2178–2187
5. Erdil M, Bilsel K, Sungur M et al (2013) Does obesity negatively affect the functional results of arthroscopic partial meniscectomy? A retrospective cohort study. Arthroscopy 29:232–237
6. Fabricant PD, Jokl P (2007) Surgical outcomes after arthroscopic partial meniscectomy. J Am Acad Orthop Surg 15:647–653
7. Fabricant PD, Rosenberger PH, Jokl P, Ickovics JR (2008) Predictors of short-term recovery differ from those of long-term outcome after arthroscopic partial meniscectomy. Arthroscopy 24:769–778
8. Faunø P, Nielsen AB (1992) Arthroscopic partial meniscectomy: a long-term followup. Arthroscopy 8:345–349
9. Herrlin SV, Wange PO, Lapidus G (2013) Is arthroscopic surgery beneficial in treating non-traumatic, degenerative medial meniscal tears? A five year follow-up. Knee Surg Sports Traumatol Arthrosc 21:358–364
10. Higuchi H, Kimura M, Shirakura K, Terauchi M, Takagishi K (2000) Factors affecting long-term results after arthroscopic partial meniscectomy. Clin Orthop Relat Res 377:161–168
11. Kellgren JH, Lawrence JS (1957) Radiological assessment of osteoarthrosis. Ann Rheum Dis 16:494–502
12. Kobayashi M, Nakamura S, Arai R et al (2009) Cartilage damage severity predicts clinical results after partial meniscectomy for horizontal degenerative tear of medial meniscus. Osteoarthr Cartil 17:S166
13. Matsusue Y, Thomson NL (1996) Arthroscopic partial medial meniscectomy in patients over 40 years old: a 5- to 11-year follow-up study. Arthroscopy 12:39–44
14. McDermott ID, Amis AA (2006) The consequences of meniscectomy. J Bone Joint Surg Br 88:1549–1556
15. Meredith D, Losina E, Mahomed NN, Wright J, Katz JN (2005) Factors predicting functional and radiographic outcomes after arthroscopic partial meniscectomy: a review of the literature. Arthroscopy 21:211–223
16. Rockborn P, Gillquist J (1995) Outcome of arthroscopic meniscectomy. A 13-year physical and radiographic follow-up of 43 patients under 23 years of age. Acta Orthop Scand 66:113–117
17. Roos E, Ostenberg A, Roos H, Ekdahl C, Lohmander LS (2001) Long-term outcome of meniscectomy: symptoms, function, and performance tests in patients with or without radiographic osteoarthritis compared to matched controls. Osteoarthr Cartil 9:316–324
18. Salata MJ, Gibbs AE, Sekiya JK (2010) A systematic review of clinical outcomes in patients undergoing meniscectomy. Am J Sports Med 38:1907–1916
19. Sihvonen R, Paavola M, Malmivaara A et al (2013) Finnish Degenerative Meniscal Lesion Study (FIDELITY) group. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. N Engl J Med 369:2515–2524
20. Umar M (1997) Ambulatory arthroscopic knee surgery results of partial meniscectomy. JPMA 47:210–213