



## Medium Term Results in Meniscal Repair: Can Lifestyle Influence the Clinical Outcome?

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### Abstract

**Purpose:** To improve the current knowledge of factors influencing the success and the clinical outcome of meniscal repair, focusing on patients' lifestyle and on the surgical techniques applied.

**Methods:** Sixty-six meniscal sutures were carried out in the period between January 2012 and July 2017 at the Santa Maria Hospital of Borgo Val di Taro, 14 of which were isolated and 52 associated with the reconstruction of the anterior cruciate ligament. Competitive and non-competitive sportsmen as well as smoker and non-smoker groups were formed retrospectively.

For each patient, VAS and functional scores (Tegner Lysholm and Modified Cincinnati) were collected before the surgery and during the follow-up.

**Results:** Isolated meniscal sutures registered a 21% failure rate while for those associated with Anterior Cruciate Ligament (ACL) reconstruction; the failure rate was only of 4%.

Smoking and the absence of competitive sport activity before surgery were associated with lower clinical results. Different surgical techniques did not show any statistically significant difference.

**Conclusion:** Data collected in our study shows that lifestyle-related factors may have a significant effect on the clinical outcome of the operated knee. Smoking is associated with lower clinical results. Sport activity level has an impact on the outcome of meniscal repair surgeries. Similar clinical improvement trend, assessed through scores, was demonstrated both in the competitive and non-competitive groups, but higher average values were observed in the first group, preoperatively as well as postoperatively.

**Keywords:** Meniscus; Suture; Repair; Meniscal repair; Meniscal sutures; ACL; Reconstruction; Smoking; Physical activity; Sports medicine; Outcome; Influencing factor

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### Introduction

Today, menisci are considered essential structures for their role in forces distribution and in the assimilation of mechanical shocks applied on the knee's articulation [1]. Studies in literature showed that the widely adopted meniscus removal procedure (meniscectomy) leads to a reduction of the distribution area of joint contact by 75%, to an increase in peaks of local contact forces up to 235% and to an increased antero-posterior movement of the femur on the tibia [2]. These biomechanical alterations have been related to the early arthrosis changes demonstrated in patients undergoing extensive meniscal removal [3].

The better healing rate of meniscal suture associated with Anterior Cruciate Ligament (ACL) reconstruction, compared to isolated sutures demonstrated by Canon et al. [4] and subsequently confirmed, proves that biological stimulation plays a fundamental role. This is believed to be mediated by the release of growth factors and pluripotent cells deriving from the femoral and tibial medullary canal drilling during the surgical procedure of ACL reconstruction [5]. Moreover, the outer third of the meniscus contains the perimeniscal capillary plexus, and the distance of the tear from the menisco-capsular junction (0 mm to 2 mm) has been identified as one of the greatest predictors for healing [6].

This dependence on an optimal biological vascularity/stimulation for tissue repair has led us to suggest that factors related to lifestyle (e.g. Smoking habit, sedentary life, obesity) may have negative

effects on it. The aim of the present study was to investigate factors influencing the success and the clinical outcome of our meniscal repair procedures. In order to reach this, aim we have retrospectively evaluated 66 patients who had surgery at the U.O. of Orthopedics and traumatology of Santa Maria Hospital of Borgo Val di Taro in the period between January 2012 and July 2017, looking for correlations between the therapeutic success and the patients' lifestyles or the surgical variables of each case.

## Methods

Patients eligible for this study were retrospectively selected from the database of the surgical registry of Santa Maria Hospital of Borgo Val di Taro in the period between January 2012 and July 2017. Sixty six patients, both male and female, with diagnosis of meniscal injury, were treated with a meniscal suture with or without reconstruction of the ACL, which represent the cohort of our study. Indications for meniscal repair were: Age (under 50 years old), reducibility of lesion and its localization in the red/grey area of the meniscus. Surgical techniques employed were "All inside", "Inside-Out" and "Outside-In". The analysis of the surgical registry allowed to obtain different information, particularly: The age during the surgery, the type and location of the meniscal lesions, the coexistence of associated lesions, the treatment of associated lesions, the suture technique used and the number of stitches used.

Out of the total number of patients, 57 were available for an outpatient follow-up while the other 9 only for a phone interview. The average follow-up time was 37 months with a maximum of 76 months and a minimum of 24 months. Informed consent was obtained by each patient in the study.

### Lifestyle information, giving particular attention to

Pre-intervention sports activities, smoking habits, height, weight and post-intervention return to sport, were recorded by the authors.

Physical examination of the knee was carried out by an experienced orthopedic surgeon, which was focused on the assessment of specific meniscal tenderness by palpation of the medial joint line and by McMurray and Apley tests. Further attention was paid to the evaluation of joint and ligament stability using the Lachman, Jerk and anterior/posterior drawer tests to investigate the cruciate ligaments and the varus-valgus stress test to evaluate collateral ligaments.

Finally, the patients were asked to complete the VAS scale (Visual Analogue Scale) and two questionnaires Tegner Lysholm Knee Scoring Scale [7], Modified Cincinnati Rating System Questionnaire [8], which have been designed to give information as to how the knee pain has affected the subjects' ability to manage in everyday life. These scores are done routinely for knee reconstruction surgery in Santa Maria Hospital of Borgo Val di Taro. The postoperative evaluation of the scores (collected during the follow-up) was compared with the preoperative evaluation collected before the surgery in order to understand how much the intervention has contributed to improve the quality of life and the activity of the subject, to understand which factors have influenced the outcome of the intervention and to what extent.

### In particular, the authors analyzed

- 1) The rate of patients who underwent clinical healing;
- 2) The differences in success between the isolated meniscus suture and the ones associated with ACL reconstruction.

**Table 1:** The cohort.

Patients			
Number of patients	66		
Male	49	17	Female
	74%	26%	
Mean surgery age [years]	27.5		
min [years]	18	47	max [years]
Average BMI	24.5		
Smokers	21	45	Non-smokers
	32%	68%	
Clinical successes	61	5	Meniscal suture failure
	92%	8%	
Isolated meniscal lesions	14	52	ACL reconstruction
	21%	79%	

**Table 2:** Failure, success and ACL reconstruction.

ACL association	2	50	52
% within row	3.80%	96.20%	
%within column	40%	82%	
Isolated meniscal repair	3	11	14
% within row	21.40%	78.60%	
%within column	60%	18%	
<b>Total</b>	<b>5</b>	<b>61</b>	<b>66</b>
% within row	7.50%	92.50%	
%within column	100%	100%	

**Table 3:** Sport activity.

Sport activity			
Competitive ( $\geq 3$ workouts a week)	38		
Non-competitive (<3 workouts a week)		14	
Any physical activity			14
<b>Total</b>	<b>58%</b>	<b>21%</b>	<b>21%</b>

- 3) Surgical clinical outcomes through functional scores;
- 4) The correlation between the patients' lifestyle (sport activity, BMI and smoking habits) and surgical therapeutic outcomes.
- 5) The evaluation of the clinical outcomes in complex sutures extended to the two menisci or bucket-handle;
- 6) The localization of the suture and its correlation with clinical healing;
- 7) Suture technique used and its correlation with clinical healing.

### Data analysis

The analysis of the data obtained from the surgical registers and from the clinical visits allowed the authors to divide the cohort as described in Tables 1-5.

Meniscal suture failure was defined as the need to perform a meniscectomy as a result of meniscal repair [9].

### Statistics

The variables subjects of our statistical analysis were mainly the cases of therapeutic success/failure. The outcome obtained in the

**Table 4:** Lesion Location.

Lesion location			
<b>Medial meniscus - 44</b>			
Posterior horn	27		
Body		3	
Extended from the posterior horn to the body		14	of which 5 bucket-handle injuries
Total	61%	7%	32%
<b>Lateral meniscus - 14</b>			
Posterior horn	9		
Extended from the posterior horn to the body		5	of which 5 bucket-handle injuries
<b>Bilateral lesions - 8</b>			
Posterior horn involvements	9		
Extended from the posterior horn to the body		7	of which 6 bucket-handle injuries

**Table 5:** Techniques.

Techniques				
"All-inside" technique		43		
"Inside-out" technique			11	
"Outside-in" technique				3
Association of two techniques - "All-inside and Inside-Out"				5
Association of two techniques - "All-inside and Outside-in"				
Total		65%	17%	5% 8%

scores and in the VAS, scales were compared with the study sample characteristics.

For the descriptive analysis of the continuous variables position, dispersion and shape indices were calculated. Where relevant, standard errors and relative confidence intervals at 95% were reported.

Qualitative features, that is to say, categorical variables were reported in frequency tables and expressed as: Absolute frequencies, relative frequencies, cumulative frequencies and percentages.

Comparisons between continuous variables groups were carried out with parametric (ANOVA for repetitive measures, T-test) and non-parametric tests (Mann-Whitney U test). In particular, the last one was preferred to T-test when data showed a clear deviation from the Gauss Normal distribution and therefore the validity of the T-test was doubtful.

Comparisons between categorical variables were performed using the Chi-squared test and the Fisher exact test for both continuous and categorical variables, the results were considered statistically significant for a p-value minor to 5% ( $p < 0.05$ ).

## Results

### Clinical healing

A therapeutic success was obtained in 92% of the cases, with 5 failures and 61 clinical healings, defined by the improvement of the clinical picture and a meniscectomy following suture being unnecessary.

### Association with ACL reconstruction

Meniscal sutures associated with the reconstruction of the ACL

were almost 80% of the total. 96% of these resulted in a therapeutic success. Among the 16 isolated meniscal repairs, 21% resulted in a therapeutic failure (Table 2). Chi-squared test showed that there is a significant difference ( $P=0.027$ ) between the success rate of isolated sutures and those associated with ACL reconstruction. However, the statistical importance of this relationship is weakened by the scarce number of failures as demonstrated by the continuity correction ( $P=0.101$ ).

### Performance of Functional Scores and VAS Scale

The rating obtained in functional knee scores and VAS scale showed a statistically significant positive trend between pre-surgery and post-surgery ratings. This increment was widely superior in the successful group of surgeries compared to the ones which failed (Graphics 1-3).

The pain improvement trend, evaluated through the VAS scale is significantly different between pre- and post-surgery ( $P<0.001$ ) and between successes and failures ( $P=0.018$ ). Absolute score difference between successes and failures is statistically significant ( $P=0.001$ ).

As far as the Lysholm score is concerned, the same conclusions can be drawn: there is a significant difference in the score trend between pre-surgery and post-surgery ( $P<0.001$ ) showing a clinical improvement following the surgical procedure. This trend is particularly different between the successful and failure groups ( $P=0.002$ ). There is a significant difference also between the outcomes, evaluated through the absolute score, between successes and failures ( $P=0.07$ ).

Also, for the Modified Cincinnati Rating System Questionnaire, the clinical improvement trend is significantly different between pre- surgery and post-surgery ( $P<0.001$ ) and between successes and failures ( $P<0.001$ ). The Absolute score difference between successes and failures is statistically significant ( $P=0.011$ );

### Lifestyle

**Sports activity:** A comparable increment trend was observed between "competitive" and "non-competitive/not athletic" groups. However, those who were doing sports at a competitive level when the pathology occurred showed significantly higher score rates both in pre-surgery and post-surgery. The same result was demonstrated for the VAS scale (Graphics 4-6).

The analysis of values obtained in the VAS scale showed no significant differences between the two groups in terms of improvement trend between pre-surgery and post-surgery ( $P=0.180$ ) but the absolute values obtained both preoperatively and postoperatively were significantly more favourable in the agonist group ( $P<0.01$ ).

The same argument could refer to the data obtained in the Tegner-Lysholm score analysis. The difference between absolute scores in pre-surgery and post-surgery score was significant ( $P<0.05$ ).

The analysis obtained with the Modified Cincinnati score showed that there was not a statistical significance in terms of improvement trend difference ( $P=0.933$ ) between the two groups but, on the contrary, there was a significant difference ( $P=0.001$ ) between the absolute results in pre- surgery and post-surgery score.

**BMI:** The statistical analysis has highlighted that the BMI did not influence the clinical success of the surgery. BMI average values were almost equal between "success" and "failure" groups;

**Smoking:** The comparison between smokers and non-smokers regarding score rating, showed that the firsts were associated with lower outcome results at the limit of statistical significance, P=0.011 to P=0.016 for Tegner-Lysholm and Modified Cincinnati respectively. The same cannot be affirmed for the values obtained with the VAS scale where the difference between the two groups resulted far from statistical significance (P=0.12) (Graphics 7-9).

**Medial-lateral repairs associated with bucket-handle injuries:** Contemporary repairs extended to both the menisci, medial and lateral, were not directly connected with lower clinical results which could be evaluated through scores and VAS scale.

The authors found average values associated with bilateral lesions which were more favourable than unilateral lesions but these data were not significant (P>0.05).

On bucket-handle lesions, the same evaluation could be done.

**Location of the repair:** All 5 of the failed meniscal sutures were located in the medial meniscus.

One of these was located in the posterior horn, while the remaining 4 were extended to the body region.

The statistical analysis of the distribution of suture failures showed that meniscal sutures extending from the posterior horn to the middle body, were more prone to re-tear compared to a simple posterior horn repair, with a statistical significance (P=0.033). As many as 4 of the 5 failures occurred in repairs located at this level and only 1 in a suture located at the posterior horn, considering that the number of meniscal body-horn repairs was decidedly lower than those performed at the meniscal posterior horn alone (14 vs. 27).

**Suture Technique used:** No statistical relationship was found between suture technique and clinical healing.

## Discussion

The analysis of data obtained from the study helps to understand how some factors may influence the therapeutic success and the clinical outcome in meniscal sutures.

Several studies show better long terms results, both from a clinical outcome point of view, assessed through functional scores and from a reduced incidence of osteoarthritic degenerative changes that can be assessed radiographically, compared to meniscectomy techniques (even partial) of the meniscus [10]. However, while biomechanical results suggest that meniscal repair should always be carried out; these assessments do not consider implications that may result from the failure of a meniscal repair [11].

The menisci have a poor regenerative capacity in the 2/3 central areas corresponding to the white avascular and aneural zones, on the contrary, the proximity of the perimeniscal capillary plexus to the peripheral ring facilitates the healing processes (red zone of the meniscus) [12] several attempts have been made to try to obtain an ideal biological stimulation to optimize healing and eventually extend the use of sutures also to the avascular region, such as the use of fibrin clots [13] or bleeding techniques through chondral microperforations [14] which gave positive results.

Lozano and Cannon [15] have previously described how the failure rate of meniscal sutures varies from 0% to 43.5% with an average value of 15%, a percentage of success higher than 92% is at the upper extreme of the case studies in the literature. Therefore, our

data confirm that, when performed in compliance with therapeutic indications, meniscal repair presents an acceptable risk of failure in relation to the long-term prognostic significance of meniscal preservation. This risk, equal to 21% in isolated meniscal sutures, was reduced to less than 4% when anterior cruciate ligament reconstruction was performed in association with meniscal repair. Biological stimulation to repair is therefore confirmed as one of the most important factors in ensuring the correct healing of the meniscal tissue following suture, as firstly hypothesized by Cannon and Vittori and subsequently confirmed by other authors [11].

Both in the failures and in the successes the clinical outcome, evaluated through the scores, was positive with an improvement trend at the last follow-up. However, patients who had failed to achieve sufficient clinical well-being required further meniscectomy to remove the injured meniscus portion. In 9 cases even if therapeutic success was achieved, it was not possible to bring the clinical condition back to pre-lesion level and some meniscal symptoms remained. In 3 of these cases, patients define themselves only partially satisfied. There are several factors that may have contributed to this partial recovery, including insufficient rehabilitation, the presence of comorbidity or incorrect lifestyles, though these hypotheses should be deeply studied and confirmed.

Patients' lifestyle seems to be an important factor in determining the clinical outcome, particularly with regards to the level of sports activity before surgery and the smoking habits.

Non-athletic or non-competitive patients obtained lower average scores both in the pre-surgery and in the post-surgery periods, compared to competitive ones, while the trend of clinical improvement was overlapping. This correlation needs further investigations to clarify how a competitive sport activity, improving muscular trophism and the basic clinical situation can predispose to better medium- and long-term results.

Although the authors highlighted that the BMI did not influence the clinical success of the surgery in this cohort of patients, it would have been interesting to investigate whether a BMI greater than 30 influenced the outcome but the candidates for this analysis were insufficient (only 4).

In 2014, Blackwell, Schmitt and others [16] had already investigated smoking as a possible risk factor for the failure of meniscal sutures, demonstrating that smokers have a significantly higher risk of failure than non-smokers during the first 15 months after surgery. In this study, the authors had observed how smokers presented lower clinical post-operative scores. Bearing in mind the limits of the sample size, there is a need to continue this investigation and confirm these data, with multivariate analysis. It is possible that smoking, which negatively influences tissue vascularity/tissue oxygenation, prevents meniscal healing and the optimization of the operated knee clinical picture.

In this study, despite all failures were in the medial meniscus, neither did the laterality, medial or lateral, nor the complexity of the meniscal lesion significantly influence the success or clinical outcome of the surgery.

In cases in which both menisci were sutured and in the case of bucket-handle lesions, no statistically inferior clinical results were obtained, assessed through the scores and the VAS scale. This data is in favor of meniscal repair even in those complex lesions which in the past were considered difficult to repair but for which there is

currently a widespread consensus in the literature as described by LaPrade and others [10].

The risk of meniscal suture failure was significantly higher for lesions extending from the posterior horn to the body of the meniscus. As for the surgical techniques used, we did not find any statistically significant difference in determining surgical success. Although we consider that the surgeon's experience and familiarity with the technique used are inextricably connected with the success of the therapy, several studies have been published to discover the optimal repair technique. Grant and others [17] in a recent literature review, compared 19 scientific studies finding no difference in success and clinical outcome, between the "all-inside" and "inside-out" techniques, for this reason we consider them equal and safe.

Our study has several limitations in addition to its retrospective nature: Being a single centered study the number of patients is reduced, and the number of groups on which statistical evaluations have been made is limited (as already highlighted in the results section).

## Conclusions

The medium and long-term clinical results confirm the efficacy of arthroscopic treatment with sutures as a valid alternative to meniscectomy in the treatment of meniscal tears in the cases selected, respecting the therapeutic indications.

The association with the anterior cruciate ligament reconstruction remains a favourable factor in determining the success of the meniscal suture.

Smoking is associated with lower clinical results, whereas competitive sports activity is a positive factor for the clinical-functional recovery of the operated knee.

Factors associated with lifestyle may influence the clinical outcome of the operated knee. It is particularly important to better understand the determining factors linked to surgery success and the patients' expectations to therefore perform the most appropriate treatment for each case.

We strongly believe in the importance of supporting the adoption of a healthy lifestyle whose benefits would be relevant also for the meniscal repair.

## Graphics

- 1- Success and failure, pre and post-surgery mean values: TREND AND ABSOLUTE VALUES, VAS SCALE
- 2- Success and failure, pre and post-surgery mean values: TREND AND ABSOLUTE VALUES, LYSHOLM SCORE
- 3- Success and failure, pre and post-surgery mean values: TREND AND ABSOLUTE VALUES, MODIFIED CINCINNATI SCORE
- 4- Competitive and non-competitive sport, pre and post-surgery mean values: SPORT ACTIVITY, VAS SCALE
- 5- Competitive and non-competitive sport, pre and post-surgery mean values: SPORT ACTIVITY, LYSHOLM SCORE
- 6- Competitive and non-competitive sport, pre and post-surgery mean values: SPORT ACTIVITY, MODIFIED CINCINNATI SCORE
- 7- Smokers and non-smokers, pre and post-surgery mean

values: SMOKE, VAS SCALE

- 8- Smokers and non-smokers, pre and post-surgery mean values: SMOKE, LYSHOLM SCORE

- 9- Smokers and non-smokers, pre and post-surgery mean values: SMOKE, MODIFIED CINCINNATI SCORE

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