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ORIGINAL ARTICLE

Retrospective Cohort Study

# Failure rate, return-to-sports and magnetic resonance imaging after meniscal repair: 119 patients with 7 years mean follow up

Juan Pablo Zicaro, Nicolas Garrido, Ignacio Garcia-Mansilla, Carlos Yacuzzi, Matias Costa-Paz

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## Abstract

### *BACKGROUND*

One of the most important factors to consider in relation to meniscal repair is the high failure rate reported in the existing literature.

### *AIM*

To evaluate failure rates, return to sports (RTS) rate, clinical outcomes and magnetic resonance image (MRI) evaluation after meniscus suture repair for longitudinal tears at a minimum 2-year-follow-up.

### *METHODS*

We conducted a retrospective review of meniscal repairs between January 2004 and December 2018. All patients treated for longitudinal tears associated or not with an anterior cruciate ligament reconstruction (ACL-R) were included. Meniscal ramp lesions, radial and root tears, associated with multiligament injuries, tibial fracture and meniscal allograft transplants were excluded. Surgical details and failure rate, defined as symptomatic patients who underwent a revision surgery, were analyzed. As isolated bucket handle tears (BHTs) were usually associated with higher failure rates, we compared BHTs and not BHTs associated or not with an ACL-R. Since 2014, the inside-out technique using cannulas and suture needles with 2-0 Tycron began to predominate. In addition, the number of stitches per repair was increased. In view of differences in surgical technique, we compared two different cohorts: before and after 2014. We recorded the RTS according to the level achieved and the time to RTS. Lysholm and IKDC scores were recorded. Patients were studied with x-rays and MRI as standard postoperative control.

### *RESULTS*

One hundred and nineteen patients were included with a mean follow up of 7 years (SD: 4.08). Overall failure rate was 20.3% at a mean 20.1 mo. No statistically significant differences were found when comparing failure for medial and lateral

meniscal repair (22.7% and 15.3%, $P = 0.36$), BHTs and not BHTs (26% and 17.6%, $P = 0.27$), isolated or associated with an ACL-R (22.9% and 18%, $P = 0.47$), or when comparing only BHTs associated with an ACL-R (23% and 27.7%, $P = 0.9$) or not. When comparing cohorts before and after 2014, we found a significant decrease in the overall failure rate from 26% to 11% ($P < 0.03$). Isolated lesions presented a decrease from 28% to 6.6% ($P = 0.02$), BHTs from 34% to 8% ($P = 0.09$) and those associated with an ACL-R from 25% to 10% ($P = 0.09$). Mean RTS time was 6.5 mo in isolated lesions and 8.64 mo when associated with an ACL-R. Overall, 56% of patients returned to the same sport activity level. Mean pre and postoperative Lysholm scores were 64 and 85 ($P = 0.02$), and IKDC 58 and 70 ($P = 0.03$). Out of 84 asymptomatic patients evaluated with MRI, 39% were classified as "not healed" and 61% as "healed".

*CONCLUSION*

Even though the overall failure rate of our series was 20.3%, we found a statistically significant decrease from 26% to 11%, not only for isolated lesions, but also for BHT's and those associated with an ACL-R when comparing our series in two different cohorts, most probably due to improvements in surgical technique.

**Key Words:** Meniscus repair; Bucket handle tears; Meniscal suture; Failure rate; Longitudinal meniscus tears



**Core Tip:** One of the most important factors to consider in relation to meniscal repair is the high failure rate reported in the literature. In this retrospective cohort we observed that new and improved suturing techniques have shown significantly lower failure rates, encouraging the need for meniscal repair whenever possible.

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## INTRODUCTION

Due to the high rate of osteoarthritis observed after partial or total meniscectomy[1], meniscal repair techniques have been gaining significance over the last decades[2], total meniscectomy being particularly important in young patients and athletes[3]. Moreover in the case of Anterior cruciate ligament reconstruction (ACL-R), meniscal deficiency is frequently associated with residual rotational laxity affecting long term clinical outcomes[4-6]. Consequently, it is mandatory to preserve the meniscus when performing an ACL-R whenever possible.

The rate of meniscus repair has increased over the past few decades, along with the number of revision surgeries due to failed repair[6-8]. All-inside sutures required mainly for posterior horn lesions had historically been associated with higher failure rates and revision surgery[9]. Recent studies have shown that improvement in surgical strategies coupled with the development of more sophisticated suture devices, has led to an improvement in the success rate of meniscal preservation[10,11].

In our institution, the number of meniscal repairs has been growing exponentially since 2010. In addition, techniques have been changing over time. Therefore, the main purpose of our study was to evaluate failure rates after meniscus suture repair. As secondary objectives we analyzed return to sports (RTS) rate, clinical outcomes and magnetic resonance image (MRI) evaluation.

## MATERIALS AND METHODS

After institutional review board approval, we performed a retrospective review of prospectively collected registry data including all patients treated with meniscal repair at our institution between January 2004 and December 2018. We included patients operated on vertical meniscal tears. Ramp lesions, radial lesions and root tears were excluded, as well as patients with meniscal allograft transplant, associated with multiligament knee injuries and patients with less than a two-year follow-up.

All surgical procedures were performed by the same surgical team, followed by a standard rehabilitation protocol. Variables analyzed included the patient's gender and age, tear type and surgical technique. Repair was registered as follows: all-inside, inside-out, outside-in. Failure was defined as symptomatic patients who underwent a revision surgery due to re-rupture at the previously treated portion of the meniscus. Historically, higher healing rates have been associated with meniscal repair in the setting of an ACL-R[12], as well as small vertical lesions have been compared to Bucket Handle Tears (BHTs)[9,13]. Hence, we analyze our cohort in different subgroups: Meniscal repairs associated with

ACL-R compared to isolated meniscal repairs, and BHTs compared to non BHTs.

In addition, rate and time to RTS, subsequent surgeries, preoperative and postoperative subjective assessment (Lysholm and IKDC scores) were reported, and postoperative complications were recorded and analyzed.

X-rays and MRI were routinely obtained during follow-up in order to evaluate meniscal healing. Results were classified and categorized as: "Not healed", when a gap greater than 2 mm was present in the repaired meniscus with a hyperintense continuous homogeneous line (Figure 1) and "healed", when continuity was observed (Figure 2). MRI categorization did not define failure, only a description of the images even in asymptomatic patients.

### *Indication and Surgical technique*

All inside sutures were indicated for posterior horn lesions. Inside-out technique was usually indicated for lesions of the middle third of the meniscus. In selected cases, anterior horn and posterior horn lesions (using a postero-medial or postero-lateral approach to retrieve the sutures) were also treated with this technique. In the case of inside-out technique, specific cannulas were introduced through the contralateral portal, and long needles with 2-0 Tycron sutures were passed through. Outside-in technique was indicated for the anterior third of the meniscus, using 2-0 Tycron sutures or 0 PDS sutures.

In the case of BHTs, usually, two or three of these techniques were combined. In most cases, all-inside devices were used for the posterior horn in combination with inside-out or outside-in techniques for the rest of the meniscus. When all-inside devices were not available, the inside-out technique was used, retrieving the stitches through a postero-medial or postero-lateral approach.

One of the greatest changes in our surgical approach was to begin to perform multiple vertical stitches spaced every 4 mm using cannulas for the inside-out technique with 2-0 Tycron sutures as compared to most sutures performed prior to 2014 using few horizontal inside-out 0 PDS stitches (Figure 3).

Regarding ACL-R, either using hamstrings graft or bone-patellar tendon-bone, we performed transportal anatomic technique, maintaining the anatomic insertion footprint in both the femur and the tibia.

### *Postoperative Rehabilitation Protocol*

Two different protocols were used after surgery for three different scenarios: isolated lesions, lesions associated with ACL-R and BHTs.

Isolated lesions, as well as those associated with an ACL-R were allowed for immediate partial weight bearing using a knee brace for three weeks. Flexion was limited to 90° for the first three weeks with progressive mobilization until complete flexion. Non-impact activities were allowed after three weeks. RTS was allowed by the fourth month. When associated with an ACL-R, RTS was determined according to the ACL-R protocol.

BHTs were indicated for non-weight bearing and flexion 0-70° for three weeks, followed by partial weight bearing for three more weeks and progressive flexion to 90°. After that period, progressive flexion and non-impact activities were indicated until complete range of motion. Impact sports activities were allowed from the fifth month onwards or according to the ACL-R protocol.

### *Statistical analysis*

Descriptive statistics including means, standard deviations, median and quartile ranges were deemed appropriate to assess the available demographic, surgical, physical examination and patient-reported outcome data. Statistical hypothesis testing was performed using the Fisher exact test and Wilcoxon rank-sum test. Chi-square test was performed for categorical data. Analysis was performed with 95%CIs, and $P$ values < 0.05 were considered statistically significant. All statistical analyses were performed using STATA version 15.

## RESULTS

A total of 140 patients underwent a meniscal repair during the study period. Ten patients did not meet the inclusion criteria and eleven were lost in follow-up. There were no patients whose meniscus was re-ruptured and declined receiving revision surgery. Therefore, 119 patients were included in the study, 83% ($n$ = 99) males, with a mean age of 27.1 years (SD: 8.02). Mean follow-up was 7 years (SD: 4.08). Table 1 shows the number of meniscal sutures, the distribution for isolated or BHT's, associated or not with an ACL-R, failure rates and time to failure.

### *Total*

Overall failure rate was 20.3% (24/119) at a mean of 20.1 mo (range 11-60 mo). We found no statistically significant differences when comparing BHT's with not BHT's (26% and 17.6%, $P$ = 0.27), associated with an ACL-R with isolated repairs (18% and 22.9%, $P$ = 0.47), or BHT's associated or not with an ACL-R (23% and 27.7%, $P$ = 0.9) (Table 1).

No significant difference was found when comparing overall failure rate for medial *vs* lateral meniscal repair (22.7% and 15.3%, $P$ = 0.36), though medial meniscus lesions were more frequently associated with an ACL-R than lateral meniscus lesions (70% and 41%) (Table 2).

There was an increase in the number of stitches, from a mean of 1.4 (SD: 1.01) to 3.5 (SD: 2.31) for BHTs and 1.2 (SD: 0.5) to 2.1 (SD: 1.1) for isolated repairs. We found a statistically significant decrease (Table 3) in overall failure rate after meniscal repair from 26% for 67 meniscal repairs in the period between 2004 and 2014 to 11% for 52 repairs after that period ($P$ = 0.03) as for isolated lesions (not associated with an ACL-R) with a decrease from 28% (9/32) to 6.6% (1/15) after 2014 ($P$ = 0.02). Although there was no statistically significant difference, overall BHT's failure rate decreased from

**Table 1 Demographic data and overall failure rate, *n* (%)**

| Overall meniscal sutures | | | |
|---|---|---|---|
| | **Total** | **Failure** | **Time to failure, months** |
| Total sutures | 119 (100) | 24 (20.3) | 20.1 |
| BHT | 34 (28) | 9 (26.4) | 20.8 |
| Not BHT | 85 (72) | 15 (17.6) | 19.7 |
| Posterior horn | 37 (43) | 7 (18.9) | 19.1 |
| Body | 43 (50) | 8 (18.6) | 20.2 |
| Anterior horn | 5 (7) | 0 (0) | 0 |
| Associated w/ACL-R | 71 (60) | 13 (18.5) | 17 |
| ACL-R + BHT | 17 (23) | 4 (23) | 12.5 |
| ACL-R + Not BHT | 54 (77) | 9 (16.6) | 19.1 |
| Isolated | 48 (40) | 11 (22.9) | 23.8 |
| BHT | 18 (37) | 5 (27.7) | 27.6 |
| Other | 30 (63) | 6 (20) | 20.6 |

BHT: Bucket handle tear; ACL-R: Anterior cruciate ligament reconstruction.

**Table 2 Descriptive data for medial and lateral meniscus, *n* (%)**

| Location | Total | Failure | Time (months) |
|---|---|---|---|
| Medial meniscus | 80 | 18 (22.7) | 18 |
| ACL-R[1] | 56 (70) | 11 (19.6) | 16.6 |
| Isolated | 24 (30) | 7 (29) | 18.5 |
| Lateral meniscus | 39 | 6 (15.3) | 28.5 |
| ACL-R[1] | 16 (41) | 2 (12.5) | 19.5 |
| Isolated | 24 (59) | 4 (16) | 33 |

[1]Results represent patients treated with sutures associated with ACL-R.
ACL-R: Anterior cruciate ligament reconstruction.

34% (8/23) to 8% (1/12) ($P$ = 0.09), and meniscal sutures associated with an ACL-R decreased from 25% (9/35) to 10% (4/37) ($P$ = 0.09).

### *RTS and Subjective Scores (Patient-Reported Outcome Measures)*

Overall mean time to RTS was 7.8 mo (SD: 2.77), 6.55 mo (SD: 2.36) for isolated lesions and 8.64 mo (SD: 2.72) when associated with an ACL-R. At the final follow-up, 67 patients (56%) returned to the same activity level, 28 (24%) reported a lower activity level and 3 patients (2%) decided not to return to sport activities. Twenty-one patients (18%) did not practice any sports at all.

The mean pre and postoperative Lysholm score was 64 (SD: 10.2) and 85 (SD: 14.08) respectively ($P$ = 0.02) and the mean pre and postoperative IKDC score was 58 (SD: 7.51) and 70 (SD: 10.22), respectively ($P$ = 0.03).

### *Radiological assessment*

Eighty-four asymptomatic patients (71%) were evaluated with X-rays and MRI at a mean 3 years postoperative. X-rays did not reveal arthritic changes during that period. A total of 33 MRI's (39%) were classified as "not healed" and 51 (61%) as "healed". It is important to emphasize that these were asymptomatic, active patients.

### *Complications*

No intraoperative complications were reported. As to postoperative complications, two cases (1.6%) presented septic arthritis in the setting of an ACL-R and were treated with arthroscopic irrigation and debridement followed by intravenous antibiotics for four weeks, and one (0.8%) patient was operated on for isolated meniscal repair presented a

**Table 3 Demographic data and failure rates for patients operated before and after 2014, *n* (%)**

| Period | 2004-2013 | | 2014-2018 | | *P* value |
|---|---|---|---|---|---|
| Age yr (range) | 25.94 (16-48) | | 28.21 (18-59) | | 0.72 |
| Gender, female | 13 (19) | | 7 (13) | | 0.12 |
| Total | *n* | Failure | *n* | Failure | 0.03 |
| | 67 | 18 (26) | 52 | 6 (11) | |
| Associated w/ACL-R | 35 (52) | 9 (25) | 37 (71) | 4 (10) | 0.09 |
| BHT | 11 (31) | 3 (27) | 5 (14) | 1 (20) | 0.63 |
| Not BHT | 24 (69) | 6 (25) | 32 (86) | 3 (9) | 0.11 |
| Isolated | 32 (48) | 9 (28) | 15(29) | 1 (6.6) | 0.02 |
| BHT | 11 (34) | 5 (45) | 7 (47) | 0 (0) | 0.05 |
| Not BHT | 21 (66) | 4 (19) | 8 (53) | 1 (12) | 0.57 |
| BHT[1] | 23 (34) | 8 (34) | 12 (23) | 1 (8) | 0.09 |

[1]The results represent the overall bucket handle tear before and after 2014.
BHT: Bucket handle tear; ACL-R: Anterior cruciate ligament reconstruction.

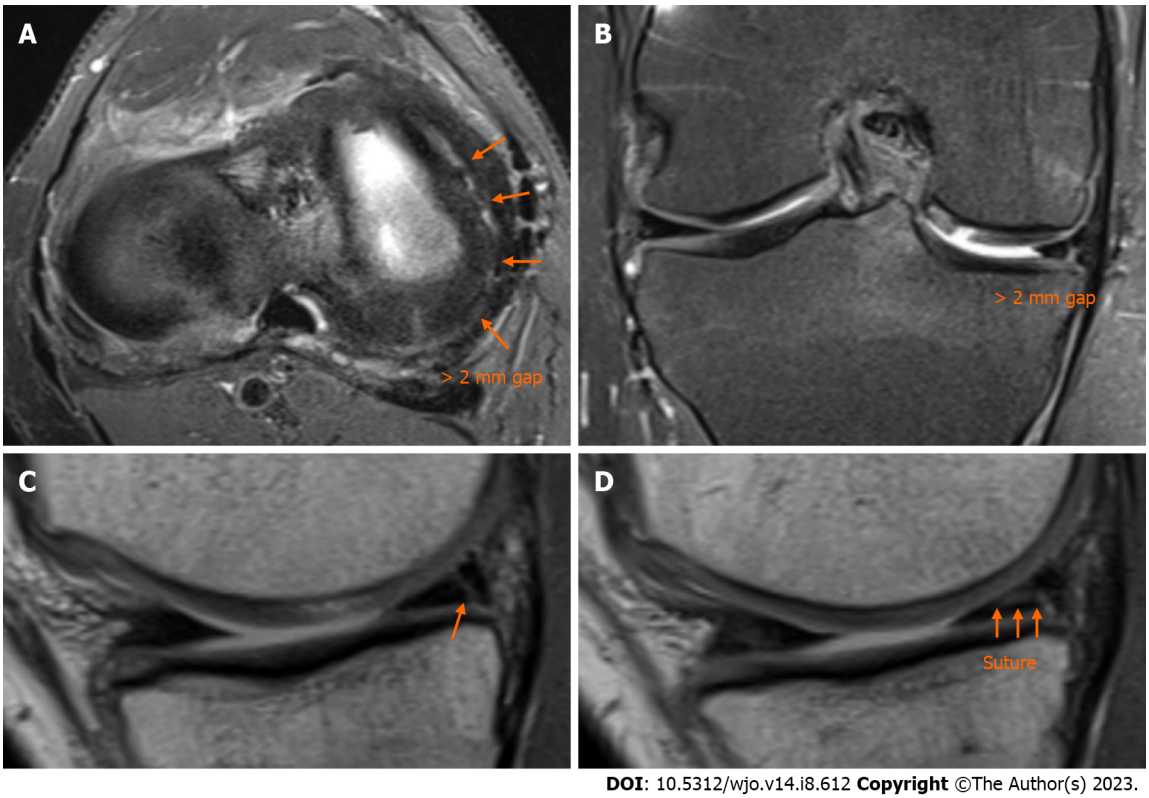


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**Figure 1 Two-years postoperative magnetic resonance imaging classified as "not healed".** This asymptomatic patient was treated with a bucket handle tears suture associated with Anterior cruciate ligament reconstruction. A: Axial plane showing a more than 2 mm gap; B: Same gap in the coronal plane; C: The posterior horn in the sagittal plane shows a gap less than 1mm wide in the meniscus; D: The transversal line in the posterior horn of the meniscus pointed by the arrows is the suture crossing from anterior to posterior.

superficial wound infection which was treated with oral antibiotics for 10 d.

## DISCUSSION

The most important finding of our study was that even though the overall failure rate was 20.3% (26% for BHTs, 18%

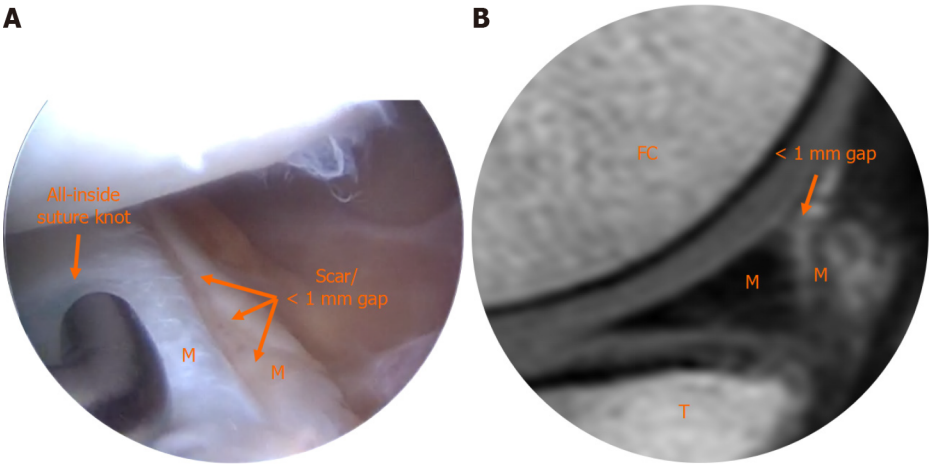


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**Figure 2 Second look arthroscopy and postoperative magnetic resonance imaging.** A: Shows a second look arthroscopy 1 year after posterior horn meniscus repair; B: The < 1 mm gap classified as "healed" in the magnetic resonance is confirmed in the arthroscopy with a fibrous stable scar. FC: femoral condyle, M: Meniscus, T: Tibia.

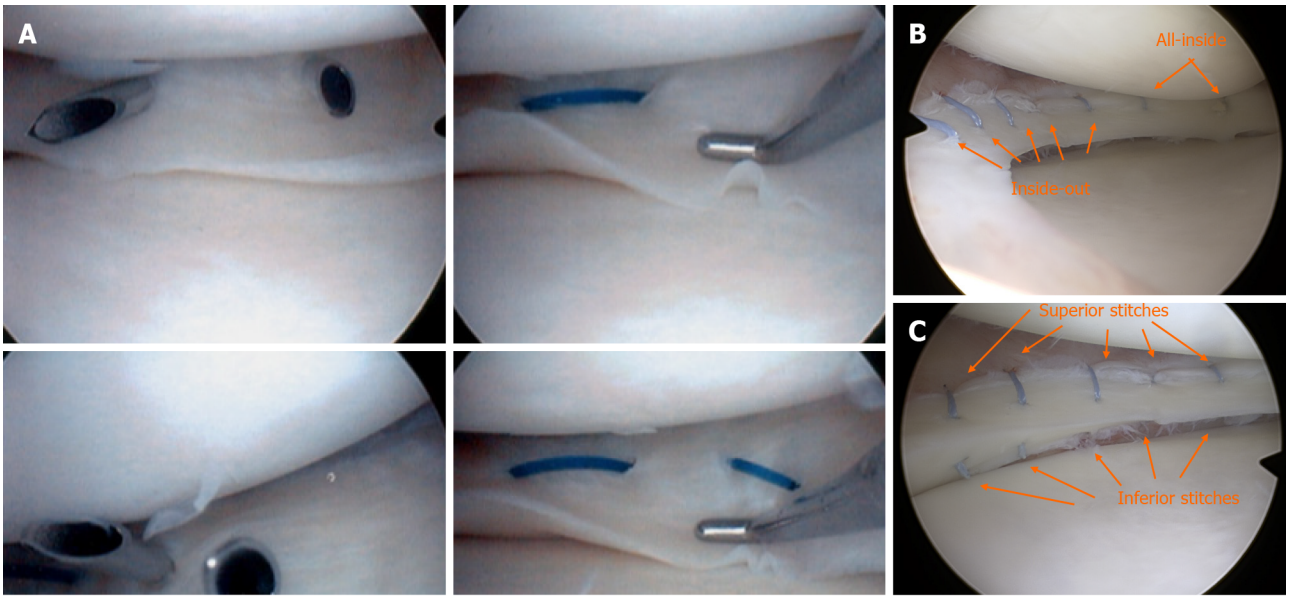


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**Figure 3 Arthroscopic view of repaired bucket handle tear.** A: Shows a bucket handle tear repaired in 2012 using 3 PDS stitches with an outside-in technique; B and C: Show a bucket handle tear repaired in 2016 using 10 inside-out and 2 all-inside 2-0 nonabsorbable high resistant sutures.

when associated with an ACL-R and 22% for isolated lesions), we found a significant decrease of failure rate when comparing two different cohorts in view of differences in surgical technique from 26% to 11% ($P$ = 0.03). Not only for isolated lesions (from 28% to 6.6% for isolated lesions, $P$ = 0.02), but also BHTs (from 34% to 8%, $P$ = 0.09) and those associated with an ACL-R (from 25% to 10%, $P$ = 0.09). These findings add to a growing body of literature on the importance of surgical technique when analyzing failure rate after meniscal repair[7,9,14,15]

For the last two decades meniscal preservation has become the main goal for treatment of meniscal lesions. In 2013, Abrams *et al*[16] reported that between 2005 and 2011 the incidence of meniscal repair has doubled in the United States. This tendency has continued to increase up to date, thus becoming the gold standard procedure when deciding the fate of a meniscus repairable lesion nowadays[1-17].

Systematic reviews prior to 2012, reported failure rates of 18% to 23%[7,15,16] after meniscal repair. Fillingham *et al*[9] in 2017 compared inside-out *vs* modern all-inside devices techniques and reported similar functional outcomes, with equivalent anatomical and clinical failure rates: 11% and 10% respectively. These results were interestingly lower when compared to 17% and 19% previously reported by Grant *et al*[14] in 2012. Fillingham *et al*[9] also found that all-inside repairs had an average of 2 stitches, while inside-out had an average of 3. Therefore, they associated the inside-out technique with more complex lesions.

When we analyzed the overall failure rate for meniscal sutures in our series, we found 20.3% with a mean time to failure of 20.1 mo, which is very similar to prior reports in the literature[7,16,18]. Moreover, an overall failure rate for isolated lesions of 22.9%, (27.7% for BHTs) and 18.5% when associated with an ACL-R (23% for BHTs) was found.

The analysis of the evolution of failure rate during our research yields a significant decrease when comparing our series in two different periods. Even though patients treated after 2014 have a shorter follow up, we consider that it is enough to establish a comparison considering that the overall mean time to failure was 20 mo. There might be multiple factors to explain this decrease in failure rates. Most horizontal mattress sutures (usually no more than 2 stitches) were replaced for vertical sutures (one stitch every 5 to 10 mm), which provides more stability and prevents meniscal cutout [19]. This resulted in an increase in the number of stitches, from a mean of 1.4 (SD: 1.01) to 3.5 (SD: 2.31) for BHTs (Figure 3) and 1.2 (SD: 0.5) to 2.1 (SD: 1.1) for isolated repairs, and it continues to increase up to date. Another important factor might be an improvement in the all-inside devices for meniscal sutures as reported in clinical[9] and biomechanical [20] studies.

Blanchard *et al*[21] reported an overall RTS rate of 83% after 8.7 mo in 21 studies evaluated after isolated meniscal repair. Other authors reported variable time to RTS from 4.2[22,23], 5.6[24] and 5.5[25] mo. When associated with an ACL-R time to RTS is reported from 8.2 (64 Vanderhave) to 11.8 mo (48 Logan). We found a mean RTS of 6.55 mo (SD: 2.36) for isolated lesions and 8.64 mo (SD: 2.72) when associated with an ACL-R. After a mean of 7 years follow-up, only 56% returned to the same activity level and 24% reported a lower activity level. Though this seems to be a low RTS rate, many authors have reported better outcomes after meniscal repair compared with meniscectomy (2018 KSSTA Phillips, 2014 AJSM Westermann, 2021 OJSM Blanchard).

Regarding the role of MRI as a postoperative control measure, we found that it was not useful in evaluating meniscal repairs. We found that 39% out of the 85 asymptomatic patients that performed a routine MRI presented an image compatible with a "not healed" repair. The report even suggested a "failure" or "rupture" of the repair. All of these patients were asymptomatic and performing regular sport activities. Faunø *et al*[26] in 2020 reported 72% sensitivity for finding meniscal re-ruptures in 80 symptomatic patients who underwent a revision surgery. Yamasaki *et al*[27] suggested a T2 mapping to improve the sensitivity for unhealed meniscus after comparing standard and T2 mapping MRI for 26 asymptomatic patients who underwent a second look arthroscopy.

The role of biologics in the setting of meniscal repair in order to increase the chance of healing and reduce failure rate is still controversial and very few clinical studies have been reported. In a recent systematic review, Haunschild *et al*[28] reported that there was considerable heterogeneity in the reporting and preparation of platelet rich plasma (PRP) used for augmentation, and concluded that there was insufficient evidence to support the use of PRP to improve meniscal healing and reduce failure rate. Controversially, Zaffagnini *et al*[29] and Sochacki *et al*[30] reported an improvement in survival rate after isolated meniscal repair augmented with PRP.

### *Strengths and limitations*

The limitations of our study need to be acknowledged. First, the main limitation was the retrospective design, yielding an analysis limited to the data available in the medical record database, with potential for selection bias. Second, the fact that we considered asymptomatic patients and analyzed the results as "healed" or "not healed" for MRI subsequent analysis without a second-look arthroscopy confirmation. And finally, the lack of radiographic evaluations which did not allow us to evaluate any degenerative progression.

Despite these limitations, the large sample size and subgroup analysis, as well as the long term follow-up of 7 years constitute a major strength of our study.

## CONCLUSION

The overall meniscal repair failure rate after a mean follow-up of 7 years was 20.3%, with 26% for BHTs, 18% when associated with an ACL-R and 22% for isolated lesions. Interestingly, when comparing our series in two different cohorts in view of differences in surgical technique, we found a decrease from 26% to 11% ($P = 0.03$), 28% to 6.6% ($P = 0.02$) for isolated lesions, 34% to 8% ($P = 0.09$) for BHT's, and 25% to 10% ($P = 0.09$) for meniscal sutures associated with an ACL-R. The mean time for return-to-sports was 6.5 mo for isolated meniscal repairs and 8.6 when associated with an ACL-R. Finally, MRI was not efficient for evaluating the condition of the meniscal repair in asymptomatic patients. It is recommended that care should be taken when considering MRI as a routine control practice after meniscal repair.

## ARTICLE HIGHLIGHTS

### *Research background*

We perform a large number of meniscal repairs every year. Our surgical techniques have been improving along the years, and with it, the outcomes achieved.

### *Research motivation*

We observed a great improvement over the years in our patient outcomes. That is why we decided to analyze and report the long-term results of our series.

### *Research objectives*
To analyze the failure rate and compare outcomes in our series of patients operated on for longitudinal meniscal lesions. It is important to understand that improvement in the number of stitches and surgical technique is associated with better outcomes than what is reported in the literature.

### *Research methods*
We retrospectively analyzed and compared demographic data, surgical details, return to sport and failure rate using specific statistical tools.

### *Research results*
In our series we found an important decrease in failure rates by improving our surgical technique and increasing the number of stitches. Even so, there is still a high percentage of patients in whom this type of repair fails. It is very important to continue investigating complementary methods that can help to further reduce this failure rate.

### *Research conclusions*
The new theory provided by the paper is that the failure rate may continue to fall even further.

### *Research perspectives*
Future work could compare the same type of sutures with biological augmentation such as platelet-rich plasma or stem cells.

## FOOTNOTES

**Author contributions:** Zicaro JP and Garrido N analyzed the data and wrote the manuscript; Garcia-Mansilla I contributed with research and data analysis; Yacuzzi C and Costa-Paz M contributed to the number of patients operated on; Costa-Paz M is the head of the sector; All authors have read and approve the final manuscript.

**Institutional review board statement:** The study was reviewed and approved by the "Ethics Committee of the Hospital Italiano" (CEPI) Institutional Review Board, No. 5458.

**Informed consent statement:** Due to the retrospective nature of our study no informed consent was required.

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## REFERENCES

1 **Laible C**, Stein DA, Kiridly DN. Meniscal repair. *J Am Acad Orthop Surg* 2013; **21**: 204-213 [PMID: 23545726 DOI: 10.5435/JAAOS-21-04-204]
2 **Verdonk R**, Madry H, Shabshin N, Dirisamer F, Peretti GM, Pujol N, Spalding T, Verdonk P, Seil R, Condello V, Di Matteo B, Zellner J, Angele P. The role of meniscal tissue in joint protection in early osteoarthritis. *Knee Surg Sports Traumatol Arthrosc* 2016; **24**: 1763-1774 [PMID: 27085362 DOI: 10.1007/s00167-016-4069-2]
3 **Mintzer CM**, Richmond JC, Taylor J. Meniscal repair in the young athlete. *Am J Sports Med* 1998; **26**: 630-633 [PMID: 9784808 DOI: 10.1177/03635465980260050601]
4 **Warren RF**, Levy IM. Meniscal lesions associated with anterior cruciate ligament injury. *Clin Orthop Relat Res* 1983; 32-37 [PMID: 6822002 DOI: 10.1097/00003086-198301000-00008]
5 **Stein T**, Mehling AP, Welsch F, von Eisenhart-Rothe R, Jäger A. Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. *Am J Sports Med* 2010; **38**: 1542-1548 [PMID: 20551284 DOI:

10.1177/0363546510364052]
6 **Paxton ES**, Stock MV, Brophy RH. Meniscal repair versus partial meniscectomy: a systematic review comparing reoperation rates and clinical outcomes. *Arthroscopy* 2011; **27**: 1275-1288 [PMID: 21820843 DOI: 10.1016/j.arthro.2011.03.088]
7 **Nepple JJ**, Dunn WR, Wright RW. Meniscal repair outcomes at greater than five years: a systematic literature review and meta-analysis. *J Bone Joint Surg Am* 2012; **94**: 2222-2227 [PMID: 23318612 DOI: 10.2106/JBJS.K.01584]
8 **Yeo DYT**, Suhaimi F, Parker DA. Factors Predicting Failure Rates and Patient-Reported Outcome Measures After Arthroscopic Meniscal Repair. *Arthroscopy* 2019; **35**: 3146-3164.e2 [PMID: 31699269 DOI: 10.1016/j.arthro.2019.06.016]
9 **Fillingham YA**, Riboh JC, Erickson BJ, Bach BR Jr, Yanke AB. Inside-Out Versus All-Inside Repair of Isolated Meniscal Tears: An Updated Systematic Review. *Am J Sports Med* 2017; **45**: 234-242 [PMID: 26989072 DOI: 10.1177/0363546516632504]
10 **Barber FA**, Herbert MA, Richards DP. Load to failure testing of new meniscal repair devices. *Arthroscopy* 2004; **20**: 45-50 [PMID: 14716278 DOI: 10.1016/j.arthro.2003.11.010]
11 **Borden P**, Nyland J, Caborn DN, Pienkowski D. Biomechanical comparison of the FasT-Fix meniscal repair suture system with vertical mattress sutures and meniscus arrows. *Am J Sports Med* 2003; **31**: 374-378 [PMID: 12750129 DOI: 10.1177/03635465030310030801]
12 **Westermann RW**, Wright RW, Spindler KP, Huston LJ; MOON Knee Group, Wolf BR. Meniscal repair with concurrent anterior cruciate ligament reconstruction: operative success and patient outcomes at 6-year follow-up. *Am J Sports Med* 2014; **42**: 2184-2192 [PMID: 25023440 DOI: 10.1177/0363546514536022]
13 **Rubman MH**, Noyes FR, Barber-Westin SD. Arthroscopic repair of meniscal tears that extend into the avascular zone. A review of 198 single and complex tears. *Am J Sports Med* 1998; **26**: 87-95 [PMID: 9474408 DOI: 10.1177/03635465980260013301]
14 **Grant JA**, Wilde J, Miller BS, Bedi A. Comparison of inside-out and all-inside techniques for the repair of isolated meniscal tears: a systematic review. *Am J Sports Med* 2012; **40**: 459-468 [PMID: 21737837 DOI: 10.1177/0363546511411701]
15 **Ayeni O**, Peterson D, Chan K, Javidan A, Gandhi R. Suture repair versus arrow repair for symptomatic meniscus tears of the knee: a systematic review. *J Knee Surg* 2012; **25**: 397-402 [PMID: 23150349 DOI: 10.1055/s-0032-1313752]
16 **Abrams GD**, Frank RM, Gupta AK, Harris JD, McCormick FM, Cole BJ. Trends in meniscus repair and meniscectomy in the United States, 2005-2011. *Am J Sports Med* 2013; **41**: 2333-2339 [PMID: 23863849 DOI: 10.1177/0363546513495641]
17 **Weber J**, Koch M, Angele P, Zellner J. The role of meniscal repair for prevention of early onset of osteoarthritis. *J Exp Orthop* 2018; **5**: 10 [PMID: 29607459 DOI: 10.1186/s40634-018-0122-z]
18 **Elmallah R**, Jones LC, Malloch L, Barrett GR. A Meta-Analysis of Arthroscopic Meniscal Repair: Inside-Out versus Outside-In versus All-Inside Techniques. *J Knee Surg* 2019; **32**: 750-757 [PMID: 30130810 DOI: 10.1055/s-0038-1668123]
19 **Buckley PS**, Kemler BR, Robbins CM, Aman ZS, Storaci HW, Dornan GJ, LaPrade RF. Biomechanical Comparison of 3 Novel Repair Techniques for Radial Tears of the Medial Meniscus: The 2-Tunnel Transtibial Technique, a "Hybrid" Horizontal and Vertical Mattress Suture Configuration, and a Combined "Hybrid Tunnel" Technique. *Am J Sports Med* 2019; **47**: 651-658 [PMID: 30624953 DOI: 10.1177/0363546518816949]
20 **Marchetti DC**, Phelps BM, Dahl KD, Slette EL, Mikula JD, Dornan GJ, Bucci G, Turnbull TL, Singleton SB. A Contact Pressure Analysis Comparing an All-Inside and Inside-Out Surgical Repair Technique for Bucket-Handle Medial Meniscus Tears. *Arthroscopy* 2017; **33**: 1840-1848 [PMID: 28754246 DOI: 10.1016/j.arthro.2017.04.013]
21 **Blanchard ER**, Hadley CJ, Wicks ED, Emper W, Cohen SB. Return to Play After Isolated Meniscal Repairs in Athletes: A Systematic Review. *Orthop J Sports Med* 2020; **8**: 2325967120962093 [PMID: 33283001 DOI: 10.1177/2325967120962093]
22 **Wiley TJ**, Lemme NJ, Marcaccio S, Bokshan S, Fadale PD, Edgar C, Owens BD. Return to Play Following Meniscal Repair. *Clin Sports Med* 2020; **39**: 185-196 [PMID: 31767105 DOI: 10.1016/j.csm.2019.08.002]
23 **Alvarez-Diaz P**, Alentorn-Geli E, Llobet F, Granados N, Steinbacher G, Cugat R. Return to play after all-inside meniscal repair in competitive football players: a minimum 5-year follow-up. *Knee Surg Sports Traumatol Arthrosc* 2016; **24**: 1997-2001 [PMID: 25261222 DOI: 10.1007/s00167-014-3285-x]
24 **Logan M**, Watts M, Owen J, Myers P. Meniscal repair in the elite athlete: results of 45 repairs with a minimum 5-year follow-up. *Am J Sports Med* 2009; **37**: 1131-1134 [PMID: 19279222 DOI: 10.1177/0363546508330138]
25 **Vanderhave KL**, Moravek JE, Sekiya JK, Wojtys EM. Meniscus tears in the young athlete: results of arthroscopic repair. *J Pediatr Orthop* 2011; **31**: 496-500 [PMID: 21654455 DOI: 10.1097/BPO.0b013e31821ffb8d]
26 **Faunø E**, Sørensen OG, Nielsen TG, Lind M, Tvedesøe C. Magnetic resonance imaging can increase the diagnostic accuracy in symptomatic meniscal repair patients. *Knee Surg Sports Traumatol Arthrosc* 2020; **28**: 855-861 [PMID: 31073840 DOI: 10.1007/s00167-019-05523-1]
27 **Yamasaki S**, Hashimoto Y, Nishida Y, Teraoka T, Terai S, Takigami J, Nakamura H. Assessment of Meniscal Healing Status by Magnetic Resonance Imaging T2 Mapping After Meniscal Repair. *Am J Sports Med* 2020; **48**: 853-860 [PMID: 32167835 DOI: 10.1177/0363546520904680]
28 **Haunschild ED**, Huddleston HP, Chahla J, Gilat R, Cole BJ, Yanke AB. Platelet-Rich Plasma Augmentation in Meniscal Repair Surgery: A Systematic Review of Comparative Studies. *Arthroscopy* 2020; **36**: 1765-1774 [PMID: 32057981 DOI: 10.1016/j.arthro.2020.01.038]
29 **Zaffagnini S**, Poggi A, Reale D, Andriolo L, Flanigan DC, Filardo G. Biologic Augmentation Reduces the Failure Rate of Meniscal Repair: A Systematic Review and Meta-analysis. *Orthop J Sports Med* 2021; **9**: 2325967120981627 [PMID: 33709004 DOI: 10.1177/2325967120981627]
30 **Sochacki KR**, Safran MR, Abrams GD, Donahue J, Chu C, Sherman SL. Platelet-Rich Plasma Augmentation for Isolated Arthroscopic Meniscal Repairs Leads to Significantly Lower Failure Rates: A Systematic Review of Comparative Studies. *Orthop J Sports Med* 2020; **8**: 2325967120964534 [PMID: 33283008 DOI: 10.1177/2325967120964534]

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