The predictive factors that are associated with the number of sutures used during meniscal repair

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Research article

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Abstract

Purpose

To investigate factors associated with the consumption of a large number of sutures during arthroscopic meniscus repair procedures.

Methods

All patients who received meniscal repair, with or without concomitant anterior cruciate ligament (ACL) reconstruction, in our hospital from January 2015 to December 2019 were included in the current study. Demographic data (sex, age, body mass index (BMI), and injury-to-surgery interval) and surgical data (the site of the tear, side of the meniscus, presence of an ACL rupture or not and the number of sutures) were retrospectively collected from our medical records. The number of sutures was divided into two groups (1–2 sutures versus >2 sutures). The stitching process was implemented through an all-inside technique using a meniscal repair device (Fast-Fix; Smith & Nephew). According to the length and stability of the meniscal tear, one to seven sutures were used. Univariate analysis consisted of chi-square tests. Multivariate logistic regression was then performed to adjust for confounding factors.

Results

A total of 242 patients, including 168 males and 57 females, was finally included. In the univariate analysis, we found that those patients who underwent meniscus repair within one month after meniscus tear were more likely to need fewer sutures than those who underwent surgery more than one month after injury (70/110 versus 59/115, $p = 0.062$). In total, 75/109 (68.8%) lateral meniscal tears were repaired with fewer sutures than medial (34/72, 47.2%) and bilateral meniscus injuries (20/44, 45.4%; $p = 0.003$). In the multivariate analysis, we found that the duration of injury (OR, 2.06; 95% CI, 1.16–3.64, $p = 0.013$), presence of an ACL injury (OR, 3.76; 95% CI, 1.97–7.21, $p < 0.001$) and the side of the meniscus (OR, 0.31; 95% CI, 0.14–0.65, $p = 0.002$) were associated with the number of sutures used during meniscal repair procedures.

Conclusions

Patients who underwent meniscal repair within one month after meniscus tear, especially lateral menisci tears, were more likely to need fewer sutures.

Study Design

Case-control study; level of evidence, 3.

Background
The meniscus is the second stabilizer in the knee joint and can slow the progression of osteoarthritis (OA) by absorbing shock and transmitting load[8, 11, 14]. When meniscal tearing occurs, there are three options: nonoperative treatment, partial or total meniscectomy and meniscal repair. Nonoperative treatment has been regarded as an important choice to relieve knee pain and improve function, especially in patients with degenerative tears[22]. However, when the meniscal injury is serious or nonoperative treatment fails, an arthroscopic procedure must be performed. Many observational studies have demonstrated that meniscectomy can dramatically improve pain and knee function at short-term follow-up, but the loss of meniscal tissue also leads to the onset of early osteoarthritis[9, 19]. Compared with meniscectomy, meniscal repair can preserve meniscal tissue, thus restoring its biomechanical function and reducing the risk of developing knee OA in the future.

In the above setting, a consensus has been reached that meniscal tissue should be preserved as much as possible[4, 8, 24]. The decision as to whether to repair the injured meniscus is made by the surgeon. The indications for repair that surgeons usually consider include (1) the location of the meniscal tear and whether vascularity is adequate enough to enhance the rate of healing of the meniscus, and (2) the severity of the meniscal injury and whether the remaining meniscal tissue is adequate to make the repair viable[12].

The number of sutures is usually affected by the length of the meniscal tear. Theoretically, the longer the tear, the more sutures will be used[3, 23]. Patients often consult about the fee for the meniscal repair procedure preoperatively, but the surgeons cannot give them an accurate answer as it depends on the number of sutures, which are relatively expensive (560 dollars for one suture). Thus, we performed this study to investigate factors that are associated with a larger number of sutures so that we can inform patients about the probable surgical cost before surgery and reduce it. Additionally, identifying these factors can also prevent worsening of meniscal tears.

**Method**

Institutional review board approval was waived. In the current study, 242 patients received meniscal repair, with or without concomitant anterior cruciate ligament (ACL) reconstruction, in our hospital from January 2015 to December 2019. All operations were performed by three highly experienced surgeons using a uniform procedure.

Demographic data (sex, age, body mass index (BMI), and injury-to-surgery interval) and intra-articular-related data (the site of the tear, the side of the meniscus, presence of an ACL rupture or not and the number of sutures) were retrospectively collected from our medical records. The injury-to-surgery interval was divided into an early group (≤ 1 month) and a delayed group (> 1 month). Age was classified into an older group (> 40 years) and a younger group (≤ 40 years), and BMI was classified into three groups (≤ 24 kg/m², 24–27 kg/m², and ≥ 27 kg/m² ). The number of sutures was classified into two groups (1–2 sutures versus > 2 sutures).
All cases of meniscal tears were diagnosed via physical examination and magnetic resonance imaging (MRI) and confirmed by arthroscopic findings. Standard anterolateral and anteromedial knee portals were used for all patients undergoing meniscal repair under general anesthesia. The stitching process was implemented through an all-inside technique using a meniscal repair device (Fast-Fix; Smith & Nephew). According to the length and stability of the meniscal tear, one to seven sutures were used.

An angle adjustable brace was used for all patients until 6 weeks after surgery. The angle of knee flexion was less than 45 degrees within 2 weeks after meniscal repair, 90 degrees within 4 weeks, and 120 degrees 6 weeks later and reach a similar angle as the uninjured side 8 weeks later after operation. Partial weightbearing was allowed until 4 weeks after surgery with the help of a crutch, and total weightbearing was encouraged 6 weeks after the operation.

Statistical analysis

Statistical analyses were performed with SPSS, version 23.0 (SPSS Inc., Chicago, IL, USA). In the univariate analysis, we used the chi-squared test to describe the associations between categorical variables and the number of sutures used during meniscal repair. Risk factors with a p value less than 0.1 in the univariate analysis were used in the multivariate analysis. In the multivariate analysis, we used binary regression to determine the independent risk factors for a larger number of sutures. Odds ratios and 95% confidence intervals (CIs) were reported. A p value less than 0.05 indicated statistical significance.

Results

In the current study, 242 patients, including 168 males and 57 females, with a mean age of 28.3 years (range from 10 to 63 years) who underwent meniscal repair in our hospital from January 2015 to December 2019 were included. Of these patients, 188 underwent concomitant ACL reconstruction, and 37 underwent isolated meniscal repair. The detailed data are shown in Table 1.
### Table 1
Demographic baseline data

|                  | ≤ 2 sutures | > 2 sutures | P-value |
|------------------|-------------|-------------|---------|
| **Gender**       |             |             | 0.603   |
| Male             | 98          | 70          |         |
| Female           | 31          | 26          |         |
| **Age**          |             |             | 1.000   |
| ≤40              | 112         | 83          |         |
| >40              | 17          | 13          |         |
| **Weight**       |             |             | 0.637   |
| ≤60              | 20          | 15          |         |
| 60–90            | 96          | 65          |         |
| ≥90              | 13          | 13          |         |
| **Site of tear** |             |             | 0.620   |
| Multiple         | 11          | 8           |         |
| Anterior         | 2           | 1           |         |
| Body             | 8           | 2           |         |
| Posterior        | 77          | 57          |         |
| **ACL injury**   |             |             | 0.311   |
| Yes              | 105         | 83          |         |
| No               | 24          | 13          |         |
| **Duration of injury** |       |             | 0.062   |
| ≤1month          | 70          | 40          |         |
| >1month          | 59          | 56          |         |
| **Side of meniscis** |         |             | 0.003   |
| Lateral          | 75          | 34          |         |
| Medial           | 34          | 38          |         |
| Both             | 20          | 24          |         |
| **Surgeons**     |             |             | 0.311   |
|        | ≤ 2 sutures | > 2 sutures | P-value |
|--------|-------------|-------------|---------|
| 1      | 58          | 45          |         |
| 2      | 41          | 23          |         |
| 3      | 30          | 28          |         |

Table 2
Multivariable analysis of factors associated with the number of sutures

|                          | Regression coefficient | 95%CI       | P-value |
|--------------------------|------------------------|-------------|---------|
| Duration of injury       | 2.06                   | 1.16 to 3.64| 0.013   |
| Side of meniscis         | 0.31                   | 0.14 to 0.65| 0.002   |

In the univariate analysis, we found that those patients who underwent meniscus repair within one month after meniscus tear were more likely to need fewer sutures than those who underwent surgery more than one month after injury (70/110 versus 59/115, p = 0.062). In total, 75/109 (68.8%) lateral meniscal tears were repaired with fewer sutures than medial (34/72, 47.2%) and bilateral tears (20/44, 45.4%; p = 0.003). In the multivariate analysis, we found that the duration of injury (OR, 2.06; 95% CI, 1.16–3.64, p = 0.013), presence of an ACL injury (OR, 3.76; 95% CI, 1.97–7.21, p < 0.001) and the side of the meniscus (OR, 0.31; 95% CI, 0.14–0.65, p = 0.002) were associated with the number of sutures used during the meniscal repair procedure.

Discussion

Many articles have demonstrated that the loss of meniscal tissue can lead to early onset of degenerative knee joint changes in the long term. Verdonk et al[21] and Hall et al[18] claimed that the removal of 30% of meniscal tissue may increase joint surface contact forces by approximately 300%. Thus, a consensus has been reached that meniscal tissue should be preserved as much as possible[4, 8, 24]. The already popularized method to preserve meniscal tissue is the arthroscopic meniscus repair procedure.

With the development of meniscal repair surgery, many suture devices, such as the RapidLoc, T-Fix and Fast-Fix, and three different techniques (inside-out, outside-in and all-inside) have been used[2, 16]. Several studies have been performed to investigate the clinical outcomes with different suture materials and repair techniques and have shown that the results are comparable with regard to the patient-reported outcomes and meniscal healing rate[5, 10, 15]. In our study, we used the Fast-Fix suture device for all patients with all-inside meniscal repair, which is the most widely used procedure. However, the Fast-Fix device is expensive. One of the most common questions that patients ask before surgery is how much they need to pay for the operation. However, that cannot be answered accurately, as the surgical cost is associated with the number of sutures. Given that the severity of meniscus tears can be indirectly reflected by the number of sutures used during the repair process, we implemented this study[3, 23]. First,
the predictive factors for a large number of sutures can help surgeons identify patients with a high risk of serious meniscus tears and advise them to undergo meniscus repair early. In addition, it is also helpful for surgeons to give patients an expectation of costs preoperatively, and the cost may be reduced for other patients if risk factors can be avoided.

In the current study, we found that patients who underwent meniscal repair within one month after meniscus tear were more likely to use few sutures. The meniscus is an important second stabilizer of the knee joint. When it tears, especially in those patients with ACL deficiency, the knee is unstable\cite{6, 17}. The meniscus becomes susceptible to additional force, particularly when surgery is delayed, and the incidence of subsequent meniscal and chondral lesions is significantly increased, which has been reported in a large number of studies\cite{7, 17, 20}. Thus, a severely teared menisci can only be repaired with a larger number of sutures. Additionally, our findings provide further evidence for the opinion that meniscal repair should be performed early.

Theoretically, medial menisci are more vulnerable to shear forces than lateral menisci. Because the medial meniscus is attached to the medial collateral ligament, its mobility is much larger than that of the lateral meniscus, which may subsequently increase the severity of meniscal tears\cite{1, 13}. Additionally, for most patients, arthroscopic surgery was delayed, which has been confirmed to be a potential risk factor for increased meniscal injury, especially in those patients with concomitant ACL rupture. Lateral meniscus tears are not associated with the injury-to-surgery interval\cite{7}. The above two reasons may explain why the medial meniscus is more likely to need more sutures to be repaired.

To identify factors that are associated with the number of sutures used during meniscal repair and thus reduce surgical cost and avoid meniscus tears becoming increasingly serious, we performed this study. Our results demonstrated that lateral meniscus injury and performing operations within one month after injury tend to require fewer suture devices. To our knowledge, this is the first study to investigate the risk factors that can increase the use of suture devices. Our findings can not only give patients an evidence-based opinion about the surgical cost preoperatively but also provide further evidence that arthroscopic surgery should be performed early (<1 month).

However, our study has some limitations. First, this study was conducted based on data from a single medical center in China. We are not sure whether our findings can be generalized to the general orthopedic population in other hospitals. Nevertheless, we hope this study can provoke attention and thinking about what factors are associated with the use of a large number of sutures and how to reduce surgical cost for patients. Finally, all arthroscopic meniscal repairs were performed by three different highly experienced surgeons; thus, option bias may exist. However, we believe this study reflects realistic clinical issues.

**Conclusion**

Those patients who underwent meniscal repair within one month after meniscus tear, especially lateral menisci tears, were more likely to need fewer suture devices.
Abbreviations

ACL
Anterior cruciate ligament
BMI
Body mass index
MRI
Magnetic resonance imaging

Declarations

Ethics approval and consent to participate

No patients’ private information is involved. Therefore ethics approval is not needed from our Research Ethics Committee and consent for participation was waived.

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analyzed during the current study will be available from author XXS on a reasonable request and no material or illustrations have been previously published

Competing interests

The authors declare that no benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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Author contributions

XXS participated in the design of the study, wrote the manuscript and performed the study, CWX and XXS collected and analyzed the data. DYC and QJ and XSQ designed and supervised the entire study. XXS was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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