Clinical outcomes of meniscus repair and partial meniscectomy: Does tear configuration matter?

Jonathan Zhi-Wei Gan¹, Denny TT Lie² and Wen Qiang Lee³

Abstract
Purpose: We report our experience with the effect of location and configuration of meniscal tears on clinical outcomes.
Methods: A retrospective review of patients who underwent partial meniscectomy or meniscal repair between 2008 and 2016 was conducted. One hundred fourteen knees in 106 patients were included, comprising 43 partial meniscectomies and 71 meniscal repairs. Patients were graded pre- and postoperatively with the International Knee Documentation Committee (IKDC) score and Tegner Activity Level Scale. Meniscal tears were classified according to location (anterior horn, body, posterior horn, and others) and type (radial, horizontal, longitudinal, and complex) and subgroups were analyzed for their effect on outcomes. Results: All tears, whether treated with partial meniscectomy or repair, showed significant improvement in postoperative scores (p<0.05); 39.47% of tears involved the posterior horn alone, 10.53% involved the body alone, 3.51% involved the anterior horn alone, and 46.49% were complex tears that spanned more than one area. Complex tears treated with repair had significantly better scores (IKDC, p=0.002; Tegner, p=0.008) than complex tears treated with meniscectomy. Longitudinal tears showed results suggesting better short-term outcomes with meniscectomy than with repair (IKDC, p=0.036; Tegner p=0.018), a potential statistical anomaly. Horizontal and radial tears showed no significant difference in outcomes, regardless of treatment. Tears in different locations (anterior horn, body, posterior horn, and others) showed no significant difference in outcomes, regardless of treatment. Conclusion: Meniscal surgery yields significant improvement in postoperative scores. Complex tears showed significantly better postoperative scores when treated with repair.

Keywords
clinical outcomes, meniscectomy, meniscus, repair

Introduction
The function of the meniscus in the knee has been extensively researched and well-documented. Menisci function as shock absorbers to impact when walking,¹ aid in load distribution to reduce excessive contact pressure,² and reduce friction and aid in lubrication.³ Intact menisci also act as secondary stabilizers, limiting excess motion and translation,⁴ particularly in anterior cruciate ligament (ACL)-deficient knees.⁵,⁶ The meniscus is subject to large tensile stresses as it absorbs shock and distributes load.⁷

The purpose of our study was to determine whether outcomes are affected by meniscal tear location and configuration, as well as method of operative management. We hypothesize that outcomes of meniscal repair may differ based on the location of the tear, the configuration of the tear, as well as the type of surgery performed (meniscal repair vs. partial meniscectomy).

¹Department of Orthopaedic Surgery, Singapore General Hospital, Singapore
²Singapore General Hospital, Singapore
³Independent researcher

Corresponding author:
Jonathan Zhi-Wei Gan, Department of Orthopaedic Surgery, Singapore General Hospital, Outram Road, 169608 Singapore.
Email: j.ganzw@gmail.com
Materials and methods

Patient selection

A retrospective review was conducted. Potential patients at a large tertiary hospital in Singapore were identified through the use of operating theater and clinical records. Patients who underwent either partial meniscectomy or meniscal repair (without ACL injury) between 2008 and 2016 by a single surgeon at a large tertiary hospital in Singapore were considered for inclusion in the study. IRB approval was obtained from the relevant authority (Singapore Centralized Institutional Review Board, reference number 2016/3000, approval letter dated December 11, 2016).

The following patient groups were excluded: Patients with concomitant ACL injury and meniscal repair who only underwent meniscal repair (meniscal repair in ACL-deficient knees) and patients who underwent meniscal transplant as treatment.

One hundred fourteen knees in 108 patients met the criteria and were included, comprising 43 partial meniscectomies and 71 meniscal repairs. No patients were lost to follow-up during this study. Patient demographics are included in Table 1.

Pre- and postoperative grading was performed with the International Knee Documentation Committee (IKDC) score and Tegner Activity Level Scale (Tegner Score). Scores were obtained via interview with the patient. All postoperative scores were obtained in July 2016 via phone interview.

The Tegner activity scale is a reliable measure of outcomes of arthroscopic knee surgery, evaluating performance and activity levels before and after surgery.8 The IKDC is a similar score that documents the function and activity and is often used together with the Tegner score.9

Tears were graded under direct visualization during arthroscopy. Tear configuration was described as horizontal, longitudinal (including bucket handle), radial, or complex/degenerative. Tear location was described as being located in the anterior horn, body, or posterior horn, roughly corresponding to the three radial zones of the meniscus. Tears spanning more than one area were classified as “others”; 39.47% of tears involved the posterior horn alone, 10.53% involved the body alone, 3.50% involved the anterior horn alone, and 46.49% were tears that spanned more than one area (others) (Table 2). Mean follow-up duration was 22.4 months.

Statistical analysis

The mean IKDC scores pre- and postoperatively were evaluated using the paired t-test (two-tailed). The Wilcoxon signed-rank test was used to evaluate the pre- and post-operative Tegner scores. Outcomes between types of tears were compared using Kruskal–Wallis or Mann–Whitney U-test as appropriate (if not normally distributed) and one-way analysis of variance (if normally distributed). Bonferroni correction was applied as appropriate. Data analysis was performed using R (Version 3.22) (R Core Team, 2015).

Results

The results of meniscectomy and repair were good and have been reported in an earlier paper.10,11 Tegner scores and IKDC scores of patients who underwent partial meniscectomy or meniscal repair showed significant improvement.

In patients who underwent partial meniscectomy, the IKDC score improved from 46.3 (±18.4) preoperatively to 80.4 (±23.6) postoperatively (p < 0.001). The Tegner score improved from 2.91 (+1.0) preoperatively to 4.91 (+1.5) postoperatively (p < 0.001).

In patients who underwent meniscal repair, the IKDC score improved from 46.0 (±15.9) preoperatively to 83.9 (±15.2) postoperatively (p < 0.001). The Tegner score improved from 2.65 (+1.2) to 4.76 (+1.1) postoperatively (p < 0.001).

Results by location and configuration of tear

Impact of treatment on different tear configurations. Complex meniscal tears treated with repair had significantly better postoperative scores (IKDC, p = 0.002; Tegner, p = 0.008) than complex tears treated with meniscectomy (Table 3).

Longitudinal tears treated with meniscectomy had significantly better scores (IKDC, p = 0.036; Tegner, p = 0.018) than longitudinal tears treated with repair (Table 4).

The treatment of horizontal and radial tears with meniscectomy or repair yielded similar outcome scores, with no significant difference in outcome scores between treatment types (Tables 5 and 6).

Impact of treatment on tears in different locations.

Anterior horn tears: Only two patients had anterior horn tears. No meaningful statistical analysis was performed in view of the small sample size of anterior horns. The incidence of anterior horn tears in our study was 3.51% (4 of 114 meniscal tears).

Body, posterior horn, and other tears: There was no significant difference in outcome scores regardless of whether treatment with meniscectomy or repair was performed.

Discussion

Our analysis showed that meniscal tears have good outcomes regardless of treatment with partial meniscectomy or repair. The IKDC score (measuring patients’ perception of outcome) and Tegner Activity Level Scale (measuring patients’ knee function) both showed significant improvement.

Most studies thus far have compared the results of partial meniscectomy and repair. Most papers concur in
concluding that meniscal repair has superior results to partial meniscectomy. A meta-analysis by Xu and Zhao showed that meniscal repairs have better long-term outcomes. Other studies have showed similar good results. Different types of tears have varying biomechanical properties and configurations. As a result, they may require individualized treatment that takes into account these factors. Our study subclassifies meniscal tears by configuration and location. This allows analysis of the optimal treatment for each location and configuration of meniscal tear. Certain configurations of tear occur infrequently, and these outcomes cannot be reliably analyzed due to low statistical power.

**Distribution of tears**

With complex/other type tears excluded, our study shows that posterior horn tears are more likely to occur (73.77%) than tears in the body (19.67%) or anterior horn (6.56%). The mechanism of posterior horn root tears has been hypothesized to be due to squatting or high-flexion exercises of the knee and in one study has been suggested to often be due to slight knee flexion while descending stairs. Anterior horn tears may occur with activities performed in the knee in extension (e.g. kicking during soccer). Given the older average age of patients in our study (average age 42 years), the distribution of tears in our study suggests that most patients are injured during low-energy flexion injuries, rather than higher energy, forceful extension injuries.

**Complex tears**

Our results suggested that complex meniscal tears had significantly better postoperative scores when treated with repair rather than meniscectomy. This could be due to the nature of the tear; complex meniscal tears cross multiple zones of the meniscus and tend to be larger and more extensive. If treated with partial meniscectomy, a larger amount of meniscus tends to be removed. This would speed the progression of osteoarthritis due to increased focal pressures on articular cartilage as a result of loss of load distribution function. These lesions are therefore more suitably treated with repair (where possible) than with partial meniscectomy.

**Longitudinal tears**

Longitudinal tears treated with partial meniscectomy showed better scores (IKDC, $p = 0.036$; Tegner $p = 0.018$) than longitudinal tears treated with repair, with the $p$-values just below our chosen significance level of $p = 0.05$.

Other studies have demonstrated the importance of long-term preservation of the meniscus and have shown good medium-term results with repair of longitudinal medial meniscal tears. In our study, regardless of treatment with repair or partial meniscectomy, there was vast significant improvement in both IKDC and Tegner scores.

### Table 1. Patient demographics.

|                     | Partial meniscectomy | Meniscal repair | Total |
|---------------------|----------------------|-----------------|-------|
| Total number of cases | 43                   | 71              | 114   |
| Age (years)         | $40.9 \pm 15.0$      | $42.0 \pm 15.7$ |       |
| Male/female         | 29/14                | 46/25           |       |
| Number of months postsurgery | $27.6 \pm 27.0$ | $19.2 \pm 18.9$ |       |

### Table 2. Results of meniscectomy and repair.

|                    | Preoperation | Postoperation | $p$ Value |
|--------------------|--------------|---------------|-----------|
| **Meniscectomy ($n = 43$)** |              |               |           |
| IKDC               | $46.3 \pm 18.4$ | $80.4 \pm 23.6$ | <0.001    |
| Tegner             | $2.91 \pm 1.0$  | $4.91 \pm 1.5$  | <0.001    |
| **Meniscal repair ($n = 71$)** |              |               |           |
| IKDC               | $46.0 \pm 15.9$ | $83.9 \pm 15.2$ | <0.001    |
| Tegner             | $2.65 \pm 1.2$  | $4.76 \pm 1.1$  | <0.001    |

IKDC: International Knee Documentation Committee.

*Values are mean ± standard deviation unless otherwise stated.

---

13. Supplementary Table 3.
14. Complex tears may occur with activities performed in the knee in extension (e.g. kicking during soccer). Given the older average age of patients in our study (average age 42 years), the distribution of tears in our study suggests that most patients are injured during low-energy flexion injuries, rather than higher energy, forceful extension injuries.

**Table 2. Results of meniscectomy and repair.**

|                    | Preoperation | Postoperation | $p$ Value |
|--------------------|--------------|---------------|-----------|
| **Meniscectomy ($n = 43$)** |              |               |           |
| IKDC               | $46.3 \pm 18.4$ | $80.4 \pm 23.6$ | <0.001    |
| Tegner             | $2.91 \pm 1.0$  | $4.91 \pm 1.5$  | <0.001    |
| **Meniscal repair ($n = 71$)** |              |               |           |
| IKDC               | $46.0 \pm 15.9$ | $83.9 \pm 15.2$ | <0.001    |
| Tegner             | $2.65 \pm 1.2$  | $4.76 \pm 1.1$  | <0.001    |

IKDC: International Knee Documentation Committee.

*Values are mean ± standard deviation unless otherwise stated.
scores. The results that favor partial meniscectomy may be a statistical anomaly.

We feel that longer term follow-up will demonstrate regression of outcome scores in patients treated with meniscectomy (particularly in view of the borderline significance demonstrated in our results) and would like to continue follow-up of patients in our study to determine whether this hypothesis is borne out.

Other factors affecting healing

**Age:** The mean age of patients in our study was 40 years in both groups. While some studies have reported that age affects the outcomes of meniscus repair, Steadman et al. showed that when followed up long term (more than 10 years), there was no difference in outcomes between patients under and over 40. Majeed et al. found no effect of age on outcomes, with similar repair failure rates in patients below and above 25 years old. Kotsovolos et al. reported that age did not affect outcomes at 18 months.

**Tears in red–white zone:** Barber-Westin and Noyes found in their meta-analysis of red–white tears that patient age, chronicity of injury, involved tibiofemoral compartment, gender, and concurrent ACL reconstruction did not adversely affect the results of repairs in the red–white zone. The healing rate was 83% overall (inside-out 81% + all-inside 86%).

**Concurrent ACL reconstruction:** Meniscal repairs tend to have better outcomes when concurrent ACL reconstructions are performed (assuming the presence of an ACL tear). A systematic review found that concurrent ACL reconstruction had no adverse effects on meniscal repair. This may be due to the formation of fibrin clots and the release of cytokines when bone tunnels are drilled.

**Medial versus lateral meniscus:** Steadman et al. found in their study with minimum 10-year follow-up that there was no significant difference in failure rate based on which meniscus was repaired.

**Anterior horn tears—Low incidence**

We were unable to draw meaningful conclusions about the results of anterior horn tears due to the small numbers of patients who were diagnosed with tears in this location. However, our findings do show that isolated tears of the anterior horn appear to be relatively uncommon (incidence

| Table 3. Results of differential treatment of complex tears. |
|-------------------------------------------------------------|
| **Lesion type** | **Preoperative IKDC** | **Postoperative IKDC** | **Preoperative Tegner** | **Postoperative Tegner** |
| Complex (meniscectomy) | 42.1 (± 12.6) | 64.5 (± 24.2) | 2.8 (± 0.7) | 3.8 (± 1.1) |
| Complex (repair) | 45.2 (± 14.3) | 87.6 (± 14.7) | 2.6 (± 1.1) | 5.1 (± 1.2) |

IKDC: International Knee Documentation Committee.

| Table 4. Results of differential treatment of longitudinal tears. |
|---------------------------------------------------------------|
| **Lesion type** | **Preoperative IKDC** | **Postoperative IKDC** | **Preoperative Tegner** | **Postoperative Tegner** |
| Longitudinal (meniscectomy) | 52.8 (± 17.4) | 92.3 (± 17.5) | 3.1 (± 0.9) | 6 (± 1) |
| Longitudinal (repair) | 51.7 (± 17.2) | 81.7 (± 17) | 2.8 (± 1.4) | 4.7 (± 1.4) |

IKDC: International Knee Documentation Committee.

| Table 5. Results of differential treatment of horizontal tears. |
|-------------------------------------------------------------|
| **Lesion type** | **Preoperative IKDC** | **Postoperative IKDC** | **Preoperative Tegner** | **Postoperative Tegner** |
| Horizontal (meniscectomy) | 47.7 (± 17.2) | 89.9 (± 18.5) | 2.8 (± 1.2) | 5.2 (± 1.5) |
| Horizontal (repair) | 46.5 (± 15.9) | 82.9 (± 14.3) | 2.7 (± 1.1) | 4.6 (± 0.9) |

IKDC: International Knee Documentation Committee.

| Table 6. Results of differential treatment of radial tears. |
|------------------------------------------------------------|
| **Lesion type** | **Preoperative IKDC** | **Postoperative IKDC** | **Preoperative Tegner** | **Postoperative Tegner** |
| Radial (meniscectomy) | 45.2 (± 24) | 82.5 (± 22.5) | 2.9 (± 1.4) | 5.1 (± 1.6) |
| Radial (repair) | 41.1 (± 16.2) | 83.4 (± 16.4) | 2.5 (± 1.3) | 4.7 (± 1.1) |

IKDC: International Knee Documentation Committee.
in our study: 3.51%). This may be explained biomechanically by the increased mobility of the anterior horn.26

Limitations
Our study was not a randomized controlled trial, opening the possibility of selection bias, whether by patient preference for type of operation or by surgeon preference. Patient preference: As part of an informed consent process, patients were informed of options for management of their meniscal tears, and some expressed a preference for one option over another (e.g. a preference for meniscal repair), where possible. Our study had a mean follow-up duration of approximately 2 years. Follow-up for longer periods may show clearer differences in outcomes of treatment.

Interviews were conducted by a single person to limit interobserver variability.

Looking forward—Future research. Further research on the outcomes of differential treatment of meniscal tears in different locations and configurations is needed to determine whether different tears may benefit more from meniscal repair or partial meniscectomy. Future randomized controlled trials with sufficient power may be better able to determine whether certain tears may benefit more from specific treatment.

Conclusions
Meniscal surgery yields significant improvement in postoperative scores. Complex meniscal tears had significantly better postoperative scores when treated with repair rather than meniscectomy. Our results suggested that longitudinal meniscal tears had better short-term postoperative scores when treated with meniscectomy rather than repair. These findings, particularly the latter, suggest that further, larger studies with longer follow-up duration are warranted to determine whether specific treatment modalities should be recommended based on meniscal tear location and configuration.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs
Jonathan Zhi-Wei Gan https://orcid.org/0000-0002-8594-3969
Wen Qiang Lee https://orcid.org/0000-0003-1488-3556

References
1. Voloshin AS and Wosk J. Shock absorption of meniscectomized and painful knees: a comparative in vivo study. J Biomed Eng 1983; 5(2): 157–161.
2. Baratz ME, Fu FH, and Mengato R. Meniscal tears: the effect of meniscectomy and of repair on intraarticular contact areas and stress in the human knee. A preliminary report. Am J Sports Med 1986; 14(4): 270–275.
3. MacConaill MA. The movements of bones and joints; the synovial fluid and its assistants. J Bone Joint Surg Br 1950; 32-B(2): 244–252.
4. Thordlund JB, Creaby MW, Wrigley TV, et al. Knee joint laxity and passive stiffness in meniscectomized patients compared with healthy controls. Knee 2014; 21(5): 886–890.
5. Shoemaker SC and Markolf KL. The role of the meniscus in the anterior-posterior stability of the loaded anterior cruciate-deficient knee. Effects of partial versus total excision. J Bone Joint Surg Am 1986; 68(1): 71–79.
6. Musahl V, Citak M, O’loughlin PF, et al. The effect of medial versus lateral meniscectomy on the stability of the anterior cruciate ligament-deficient knee. Am J Sports Med 2010; 38(8): 1591–1597.
7. Fithian DC, Kelly MA, and Mow VC. Material properties and structure-function relationships in the menisci. Clin Orthop Relat Res 1990; 252: 19–31.
8. Briggs KK, Lysholm J, Tegner Y, et al. The reliability, validity, and responsiveness of the Lysholm score and Tegner activity scale for anterior cruciate ligament injuries of the knee: 25 years later. Am J Sports Med 2009; 37(5): 890–897.
9. Wera JC, Nyland J, Ghazi C, et al. International knee documentation committee knee survey use after anterior cruciate ligament reconstruction: a 2005-2012 systematic review and world region comparison. Arthroscopy 2014; 30(11): 1505–1512.
10. Xu C and Zhao J. A meta-analysis comparing meniscal repair with meniscectomy in the treatment of meniscal tears: the more meniscus, the better outcome? Knee Surg Sports Traumatol Arthrosc 2015; 23(1): 164–170.
11. Stein T, Mehling AP, Welsch F, et al. Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. Am J Sports Med 2010; 38(8): 1542–1548.
12. Paxton ES, Stock MV, and Brophy RH. Meniscal repair versus partial meniscectomy: a systematic review comparing reoperation rates and clinical outcomes. Arthroscopy 2011; 27(9): 1275–1288.
13. Furumatsu T, Okazaki Y, Okazaki Y, et al. Injury patterns of medial meniscus posterior root tears. Orthop Traumatol Surg Res 2019; 105(1): 107–111.
14. Hwang BY, Kim SJ, Lee SW, et al. Risk factors for medial meniscus posterior root tear. Am J Sports Med 2012; 40(7): 1606–1610.
15. Hagino T, Ochiai S, Sato E, et al. Footballer’s Lateral Meniscus: anterior horn tears of the lateral meniscus with a stable Knee. ISRN Surg 2011; 2011: 170402.
16. Haklar U, Donmez F, Basaran SH, et al. Results of arthroscopic repair of partial- or full-thickness longitudinal medial meniscal tears by single or double vertical sutures using the inside-out technique. Am J Sports Med 2013; 41(3): 596–602.
17. Kose O, Celiktas M, Egerci OF, et al. Prognostic factors affecting the outcome of arthroscopic saucerization in discoid lateral meniscus: a retrospective analysis of 48 cases. *Musculoskelet Surg* 2015; 99(2): 165–170.
18. Steadman JR, Matheny LM, Singleton SB, et al. Meniscus suture repair: minimum 10-year outcomes in patients younger than 40 years compared with patients 40 and older. *Am J Sports Med* 2015; 43(9): 2222–2227.
19. Majeed H, Karuppiah S, Sigamoney KV, et al. All-inside meniscal repair surgery: factors affecting the outcome. *J Orthop Traumatol* 2015; 16(3): 245–249.
20. Kotsovolos ES, Hantes ME, Mastrokalos DS, et al. Results of all-inside meniscal repair with the FasT-Fix meniscal repair system. *Arthroscopy* 2006; 22(1): 3–9.
21. Barber-Westin SD and Noyes FR. Clinical healing rates of meniscus repairs of tears in the central-third (red-white) zone. *Arthroscopy* 2014; 30(1): 134–146.
22. Mordecai SC, Al-Hadithy N, Ware HE, et al. Treatment of meniscal tears: an evidence based approach. *World J Orthop* 2014; 5(3): 233–241.
23. Tenuta JJ and Arciero RA. Arthroscopic evaluation of meniscal repairs: factors that effect healing. *Am J Sports Med* 1994; 22(6): 797–802.
24. Cannon WD and Vittori JM. The incidence of healing in arthroscopic meniscal repairs in anterior cruciate ligament-reconstructed knees versus stable knees. *Am J Sports Med* 1992; 20(2): 176–181.
25. Lee WQ, Gan ZW, and Lie DTT. Save the meniscus – Clinical Outcomes of Meniscal Repair versus Meniscectomy. Oral presentation, Singapore Orthopaedic Association 39th Annual Scientific Meeting, 2016.
26. Vedi V, Williams A, Tennant SJ, et al. Meniscal movement. An in-vivo study using dynamic MRI. *J Bone Joint Surg Br* 1999; 81(1): 37–41.