

Meniscal Repair for Radial Tears of the Midbody of the Lateral Meniscus

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Background: Radial meniscal tears historically have been treated by partial meniscectomy, although they are more biomechanically detrimental than longitudinal tears. Clinical results after meniscal repair for radial tears of the midbody of the lateral meniscus have been reported rarely.

Study Design: Case series; Level of evidence, 4.

Methods: Fourteen consecutive patients who had radial tears of the midbody of the lateral meniscus underwent arthroscopic repair. Inclusion criteria were radial tears involving the red-red or red-white zone. All patients underwent all-inside meniscal repair using absorbable sutures. Postoperative evaluation was performed using joint-line tenderness, McMurray test, range of motion, and follow-up magnetic resonance imaging (MRI) scan at 6 months postoperatively. Lysholm knee score and Tegner activity level were evaluated at last follow-up. In 4 patients, second-look arthroscopies were performed.

Results: The average follow-up was 36.3 months. No patient had joint-line tenderness. Three patients complained of pain or a click on McMurray test. The mean follow-up range of motion was 138.6°. Follow-up MRI scans demonstrated that 5 (35.7%) menisci were healed, 8 (57.1%) were partially healed, and 1 (7.1%) was not healed. The follow-up Lysholm score was 94.7 (range, 81-100; standard deviation [SD] = 6.4) and Tegner score was 5.7 (range, 3-7; SD = 1.4). Second-look arthroscopies in 4 patients showed partial healing of meniscal tears.

Conclusion: Meniscal repair for radial tears of the midbody of the lateral meniscus may be an effective, alternative treatment to partial meniscectomy.

Keywords: meniscal repair; radial tear; midbody; lateral meniscus

Important functions of the meniscus are load bearing and shock absorption. These functions are maintained by mostly circumferential fibers of the collagen bundles of the meniscus.¹⁰ Therefore, radial tears of the meniscus are more biomechanically detrimental than longitudinal tears.³ However, most radial tears are treated by partial meniscectomy. Meniscal repair may be an alternative treatment for radial tears involving the red-red or red-white zone to preserve the important functions of the meniscus. Meniscal repair for radial tears of the meniscus have been rarely reported. van Trommel et al⁹ repaired 5 radial tears of the lateral meniscus using outside-in

sutures enhanced by fibrin clot. Noyes and Barber-Westin⁶ reported 4 cases of radial tear repairs using inside-out sutures. Tao and Beach⁸ used a Caspari suture punch to repair 1 radial tear of the lateral meniscus. Therefore, the purpose of this prospective study was to describe the surgical technique and clinical outcomes after all-inside suture repair for radial tears of the midbody of the lateral meniscus.

MATERIALS AND METHODS

Twenty-one patients with radial tears of the midbody of the lateral meniscus underwent meniscal repair from December 2004 to October 2007 in a single center by a single surgeon. Tears involving the red-white or red-red zone were considered indications for meniscal repair. Patients with tears involving only the white-white zone, tears of the anterior or posterior horns, other tear types within the midbody, associated ligament injuries, joint-space narrowing seen radiographically, an abnormal contralateral knee joint, and/or lost or insufficient follow-up were excluded from this study. Fourteen patients available for at least 24 months of follow-up were enrolled in this study. All patients signed an informed consent form. The study protocol was reviewed and approved by our institutional review board.

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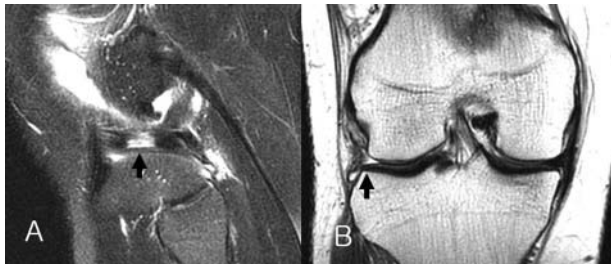


Figure 1. A, sagittal MRI view demonstrating a radial tear (arrow) of the midbody of the lateral meniscus in a 19-year-old patient. B, coronal MRI view demonstrating absent midbody of the lateral meniscus due to radial tear (arrow).

The medical records of 14 patients were reviewed. There were 11 male and 3 female patients whose mean age was 29.9 years (range, 16-52 years). The causes of injury were sports in 9 and unknown in 5 patients. The average duration of symptoms was 6 months and 3 weeks (range, 10 days-4 years). Thirteen patients had incomplete discoid lateral menisci and 1 had a normal lateral meniscus. One patient had a meniscal cyst and underwent arthroscopic decompression, 1 had grade II chondromalacia of the lateral tibial plateau, and 1 had grade IV chondromalacia on the trochlea treated with microfracture.

Definite diagnosis of radial tear of the midbody of the lateral meniscus was made by consecutive sagittal views by MRI. All MRI examinations were performed with a 1.5-T unit (Signa; GE Healthcare, Waukesha, Wisconsin). All radial tears demonstrated findings including the truncated triangle, cleft, marching cleft, and ghost signs (Figure 1).³

All patients underwent all-inside meniscal repairs using No. 1 polydioxanone (PDS) sutures. Arthroscopic portals used included an anterolateral portal and a modified anteromedial portal located at a point crossed by the medial edge of the patellar tendon and the inferior border of the patella. The knee was placed in a "figure-4" position. Arthroscopic examination confirmed a radial tear of the midbody of the lateral meniscus involving the red-red or red-white zone of the lateral meniscus (Figure 2). Gentle debridement was performed at the tear site and surrounding capsule using a motorized shaver. A 45° suture hook (Linvatec, Largo, Florida) loaded with a No. 1 PDS suture was inserted through the anteromedial portal. This hook penetrated the posterior part of the lateral meniscus from the upper surface (Figure 3A). The leading limb of the suture was advanced sufficiently into the knee joint and the suture hook was removed. A suture grasper was inserted through the anteromedial portal and the leading limb of suture was retrieved. While viewing with arthroscope through the anteromedial portal, a crescent suture hook loaded with a No. 1 nylon suture was inserted through the anterolateral portal and penetrated the anterior part of the lateral meniscus from the upper surface. The leading limb of the nylon was advanced sufficiently into the knee joint and the suture hook was removed. A suture grasper was inserted through the anterolateral portal and the leading limb was retrieved. The arthroscope was

then placed in the anterolateral portal, and a suture grasper inserted through the anteromedial portal to retrieve 2 strands of nylon suture. The leading limb of the PDS suture was then passed through a loop of the leading limb of nylon suture (Figure 3B). The opposite limb of nylon suture was pulled, allowing the leading limb of PDS suture to penetrate the anterior part of the meniscus from the lower to the upper surface (Figure 3C). A nonsliding knot was then tied using standard arthroscopic methods (Figure 3D) and a horizontal suture was placed using all-inside meniscal repair technique. One or two sutures were placed according to the length of the radial tear (Figure 4).

After surgery, toe-touch weightbearing was recommended for 6 weeks, followed by a gradual increase of weightbearing over the following 4 weeks. Range of motion exercises were allowed from 0° to 90° of flexion for 6 weeks and full squatting was permitted 3 months after surgery. Jogging began after 12 weeks and return to sports activity was allowed after 6 months.

Postoperative evaluation of meniscal status was performed using physical examination criteria, specifically joint-line tenderness, McMurray test, range of motion, and follow-up MRI. Tegner activity level and the Lysholm knee score were determined. Follow-up MRI scans were obtained 6 months postoperatively for all patients to evaluate meniscal healing, although patients did not complain of any symptoms after surgery. The magnetic resonance images were interpreted by a musculoskeletal radiologist who had no previous information about the patients. The meniscus was considered healed if there was no fluid signal within the meniscus on sagittal and coronal views, partially healed if the number of image cuts showing tears on sagittal views on follow-up MRI decreased compared with preoperative MRI, and not healed if there was no change between preoperative and follow-up MRI. In 4 patients, second-look arthroscopies were performed. The length of the meniscal tear was measured with a probe and compared with that measured at the index operation.

The Mann-Whitney test was used to compare preoperative and postoperative values of the range of motion, Lysholm knee score, and Tegner activity level. Analysis was performed using SPSS software (SPSS for Windows release 12.0, SPSS, Chicago, Illinois) and significance was assumed at $P < .05$.

RESULTS

All patients were evaluated at 6 weeks, 3 months, 6 months, 1 year, and yearly after surgery. The average follow-up was 36.3 months (range, 24-54). No patients complained of lateral joint pain at last follow-up. On examination, 5 patients manifested joint-line tenderness and 11 showed a positive McMurray test preoperatively. At last follow-up, no patient had joint-line tenderness; however, 3 patients complained of pain or a click on McMurray test. The mean range of motion was 137.5° 9.4° preoperatively and 138.6° 5.3° postoperatively; there was no significant difference. The preoperative mean Tegner activity

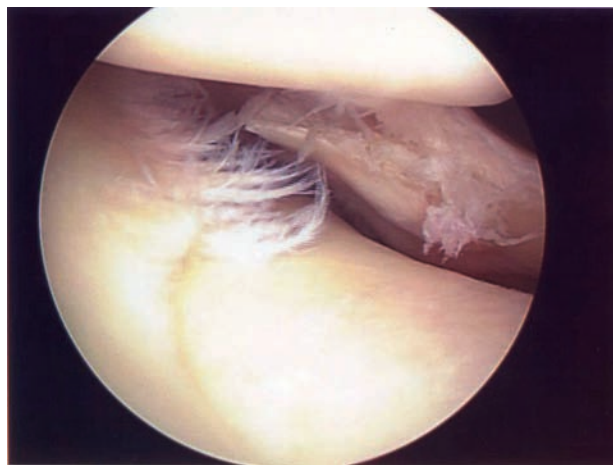


Figure 2. A midbody radial tear of a discoid lateral meniscus, dividing the anterior and posterior segments, in a 47-year-old woman.

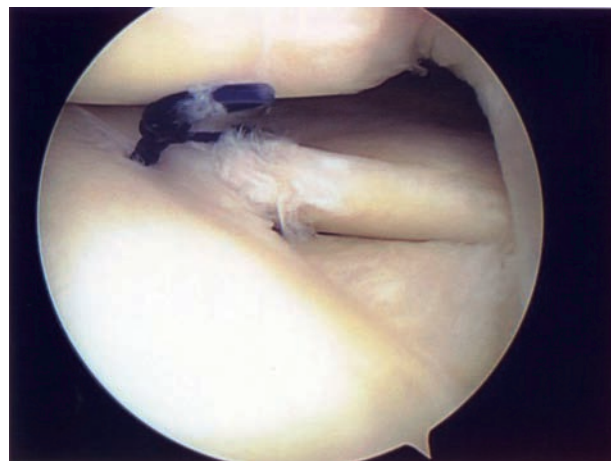


Figure 4. Arthroscopic view of a radial tear of the discoid lateral meniscus repaired using all-inside suture repair in a 47-year-old woman.

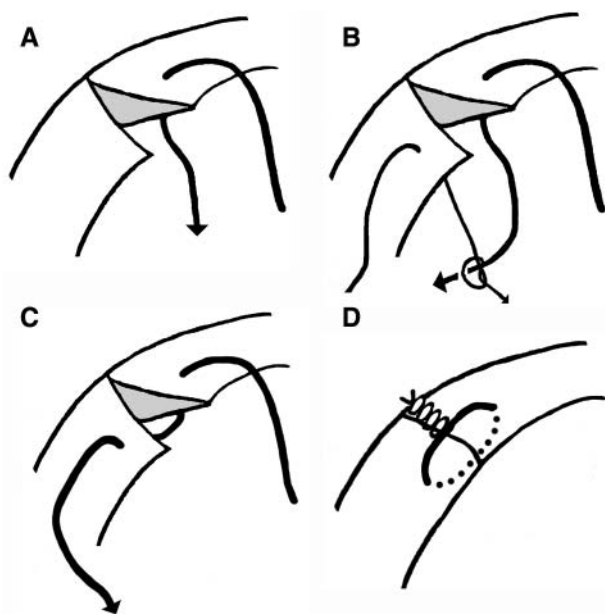


Figure 3. Sequential diagram of the all-inside meniscal repair technique (see text for details).

level was 4 (range, 1-8) and the mean Lysholm score was 73.7 (range, 36-90). At last follow-up, the mean Tegner activity level was 5.7 (range, 3-7) and the mean Lysholm score was 94.7 (range, 81-100). Eight patients were rated excellent and 6 rated good by Lysholm score. Improvements in both the Tegner activity level and Lysholm scores were statistically significant ($P = .049$ and $<.0001$, respectively) (Table 1).

Follow-up MRI scan showed that 5 (35.7%) of the 14 menisci were healed, 8 (57.2%) were partially healed, and 1 (7.1%) was not healed. Two patients demonstrated meniscal extrusion on follow-up MRI. Among those

patients with a positive McMurray test, 2 patients had partially healed menisci and 1 had a healed meniscus. Second-look arthroscopy was performed for 4 patients who had partially healed menisci diagnosed by MRI to evaluate meniscal healing 6 months after surgery. Among these patients, 2 patients complained of pain on the McMurray test and 2 did not.

At second-look arthroscopy, the length of the radial tear, compared with that measured at the index operation, decreased and the menisci were considered partially healed in 4 patients. Suture knots were completely absorbed with no evidence of articular cartilage injury. Among the 4 patients, a 19-year-old student demonstrated partial healing at second-look arthroscopy (Figure 5) and MRI at postoperative 6 months. However, his MRI showed complete healing of the repaired meniscus at 2.5 years after surgery (Figure 6). There were no complications associated with surgery.

DISCUSSION

Radial tears of the menisci are relatively common. Magee et al⁴ reported a 14% incidence of radial tears in 200 patients who underwent arthroscopy. In their series, the most common location of a radial tear was the midbody of the lateral meniscus. Radial tears of the meniscus are most commonly treated with partial meniscectomy. However, partial meniscectomy has been shown to greatly increase contact pressure. In experimental studies, excision of 15% to 34% of the meniscus has been shown to increase contact pressure by more than 350%.^{1,7} Meniscectomy for radial tears within the vascular zone of the meniscus transects circumferential fibers, rendering the meniscus with reduced function. Therefore, meniscal repair should be considered for radial tears involving the red-red or red-white zone.

Meniscal repairs are performed rarely for radial tears. van Trommel et al⁹ reported 3 cases of complete healing

TABLE 1
Demographics and Clinical Outcomes of the Patients

Case	Age at Surgery, y	Discoid	No. of Sutures	Postoperative Lysholm	Postoperative Tegner	Follow-up MRI	Follow-up Arthroscopy
1	16	Yes	2	94	7	Partial healing	
2	26	Yes	2	100	6	Complete healing	
3	35	Yes	2	90	6	Partial healing	
4	22	Yes	2	100	7	Complete healing	
5	24	Yes	2	81	4	Partial healing	
6	40	Yes	2	90	3	Partial healing	Partial healing
7	52	Yes	2	95	7	Partial healing	Partial healing
8	27	Yes	2	100	6	Complete healing	
9	17	Yes	2	86	3	Complete healing	
10	41	Yes	2	100	5	Partial healing	
11	39	Yes	2	100	7	No healing	
12	21	Yes	2	100	6	Partial healing	Partial healing
13	40	Yes	2	90	6	Complete healing	
14	19	No	2	100	7	Partial healing	Partial healing

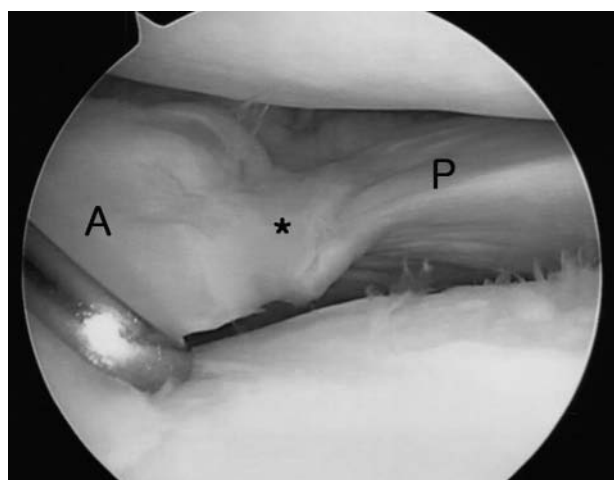


Figure 5. Arthroscopic view 6 months after surgery demonstrating connecting tissue at the previous tear site (*) in a 19-year-old patient: A, anterior segment; P, posterior segment.

and 2 of partial healing after outside-in repairs for 5 radial tears of the lateral meniscus. They augmented the repair with fibrin clot. Noyes and Barber-Westin⁶ reported that 4 patients had no complaints of pain after inside-out repairs of radial tears involving the avascular zone. They confirmed partial healing of a repaired meniscus by second-look arthroscopy in 1 patient. Tao and Beach⁸ used a suture punch to suture 1 radial tear of the lateral meniscus. Their patient was asymptomatic at final follow-up by subjective evaluation. Haklar et al² reported complete healing by assessment with MRI of repaired radial tears of the lateral meniscus using nonabsorbable suture in 5 patients.

An all-inside suture repair technique was used in this study. Although this method is technically demanding, it provides several advantages. This technique allows normal meniscal movement, instead of bunching of the meniscus to the capsule when an inside-out or outside-in technique

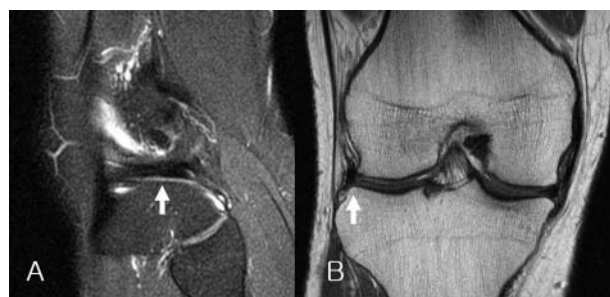


Figure 6. Follow-up MRI at 2.5 years postoperatively in a 19-year-old patient: A, completely healed radial tear (arrow) of the midbody of the lateral meniscus on sagittal view; B, well-visualized midbody (arrow) of the lateral meniscus on coronal view.

is performed. This method may prevent neurovascular complications and the need for an additional skin incision to retrieve suture materials. Use of absorbable sutures prevents the potential complications seen with the use of bio-absorbable meniscal implants. However, meticulous care is required to avoid any scratching of cartilage of the tibial plateau when penetrating the meniscus with the suture hook.

We used PDS sutures in this study rather than nonabsorbable suture. According to the manufacturer's manual, PDS is an absorbable suture and is gradually absorbed between 6 and 8 months after surgery. As opposed to longitudinal tears of the meniscus, repaired radial tears of the meniscus must withstand distraction forces generated by axial loading during walking. Maintenance of meniscal repair integrity during the healing phase is crucial. The reasons for our preference of PDS over nonabsorbable suture in this study include the ability of PDS to maintain 60% of original strength until postoperative 6 weeks and concern regarding the risk of cartilage injury by nonabsorbable suture knots on the upper surface of the meniscus. This is the rationale for the recommendation of

toe-touch weightbearing for 6 weeks and gradual increase of weightbearing for another 4 weeks. Moreover, radial tears repaired with PDS in most patients were healed completely or partially by objective assessment with MRI.

Assessment of meniscal healing has been based on subjective evaluations, joint-line tenderness, sense of catching, effusion, and a positive McMurray test by most surgeons. However, postoperative clinical presentations after meniscal repair do not necessarily correlate with meniscal healing. Therefore, second-look arthroscopy or MRI is necessary for objective evaluation after meniscal repair. Magnetic resonance imaging was used to evaluate meniscal healing in this study. In the early phase of this study, second-look arthroscopy was recommended for 4 patients to evaluate meniscal healing. Findings at arthroscopy were compared with those of follow-up MRI. After the first 4 patients, follow-up MRI was recommended for all patients.

Among 4 patients, follow-up MRI of a 19-year-old student demonstrated partial healing of the repaired meniscus and second-look arthroscopy at 6 months after surgery showed connecting tissue at the previous tear site. Follow-up MRI at 2.5 years after surgery revealed meniscal tissue of isosignal intensity without any cleft at the previous tear site. This finding suggests that the connecting tissue appeared to remodel into normal meniscus over time. Haklar et al² confirmed full healing of a repaired radial meniscal tear by MRI, but they did not report the point in time of MRI after surgery.

Because radial tears heal with intervening scar, progressive spreading at the repair site can alter normal meniscal geometry, adversely influencing mechanical function.⁵ This result may be visible as extrusion of the midbody on follow-up MRI. In this study, follow-up MRI showed extrusion of the midbody of the lateral meniscus in 2 patients. Their MRI showed complete healing and Lysholm/Tegner scores at final follow-up were 100/6 and 95/7, respectively.

This study had several advantages. The study population was very homogeneous. All patients had radial tears of the midbody of the lateral meniscus. Patients with other types of tears or other horn tears were excluded. The same repair method and suture materials were used in all patients. All patients underwent the same postoperative rehabilitation protocol. All patients were evaluated by MRI to objectively assess meniscal healing.

There were several limitations in this study. First, there was no comparison group with meniscectomy for patients

with radial tears involving the red-white or red-red zone. Second, the number of patients in the study was small. Third, follow-up MRI scans were performed in the early postoperative period rather than in long-term follow-up. Most patients declined follow-up MRI after 1 year postoperatively because of absence of symptoms.

CONCLUSION

Clinical outcomes after all-inside repairs of radial tears involving the red-red or red-white zone of the lateral meniscus showed satisfactory results by subjective and objective evaluations. Therefore, meniscal repair rather than meniscectomy should be considered for these patients.

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