CASE REPORT

Posterior root medial meniscus reconstruction: an option in chronic posterior root meniscal injury management

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SUMMARY

Posterior root medial meniscus (PRMM) tears have shown to be biomechanically equivalent to complete meniscectomy. Drawbacks from PRMM tears repair are unsatisfactory healing rates. In this case report, we outlined a PRMM reconstruction with gracilis graft healing outcome in chronic PRMM tear case, based on clinical and MRI evaluation. A 60-year-old man reported a chief complaint of increasing pain on the right knee joint in the last 1 year after a deep-flexion injury. On MRI investigation, we confirmed the chronic PRMM tear as Osteoarthritis Kellgren-Lawrence grade II. Then, we planned to perform a PRMM reconstruction with gracilis graft per arthroscopy. At the 6-month MRI evaluation, we found healing of the attached PRMM on its footprints, with intact graft transition from the meniscus to the tibial bone tunnel.

BACKGROUND

The posterior root medial meniscus (PRMM) tear is a threatening condition which requires immediate treatment. This tear has shown to be biomechanically equivalent to complete meniscectomy. The medial meniscal function loss will increase the direct pressure to the medial articular cartilage and therefore hastens the occurrence of secondary osteoarthritis.¹

Although the pull-out technique has been so far considered the recommended repair technique to manage PRMM tears, it is associated with relatively low healing rates. A systematic study by Feucht *et al* found only 62% patients achieved 'complete' healing, 34% 'partial' healing and 4% 'failed' healing.^{2,3} The unsatisfactory healing outcome may be caused by the fact that the fixation is only given to the high strain non-absorbable suture fixed on the anterior tibia cortex. This construct has been reported to have significantly weaker fixation to the tibia than the native root.^{2,3} Additionally, the healing process only occurs between the meniscus and the raw surface of the PRMM attachment on the tibia bone. The contact healing area is considered too small to resist the centrifugal pressure as a transformation force from the patient's weight. These circumstances may retear or redisplace the repaired PRMM during the postsurgery rehabilitation phase when the patient starts standing, walking and doing other weight-bearing exercises. Lee *et al* developed the arthroscopy technique using gracilis

autograft to reconstruct the PRMM tear focused on using the ligament like structure as transitions into the fibrocartilaginous structure of the meniscal body.⁴ We also thought that gracilis autograft could overcome the unsatisfactory healing outcome in meniscal root repair.

In this case report, we outlined the gracilis graft-PRMM reconstruction healing outcome in chronic PRMM tear case, based on the clinical and MRI evaluation.

CASE PRESENTATION

A 60-year-old man, with no significant medical-surgical history, came to the outpatient clinic at Thammasat University Hospital, Bangkok, Thailand. The patient's chief complaint was the increasing pain at the posteromedial right knee joint in the last 1 year. The pain started after having obtained a deep-flexion injury during a fall on a slippery floor. The pain exacerbated during squatting and going upstairs. The pain did not improve after a 1-year conservative treatment. There were no history of locking and giving way. On the clinical examination, we found tenderness at a posteromedial aspect of the right knee joint without deformity and swelling. There was no limitation in the active and passive range of motion at the affected knee joint. In fact, we found negative McMurray test, anterior-posterior drawer test and varus-valgus test.

INVESTIGATIONS

A review of the radiographic imaging was performed. There were a slight medial joint space narrowing of the right knee joint and small osteophytes without any subchondral cyst and sclerosis. We found in the MRI investigation, meniscal extrusion, cleft sign (T2 fat suppression coronal view) and ghost sign (T2 fat suppression sagittal view) (figure 1).

DIFFERENTIAL DIAGNOSIS

We diagnosed this patient with chronic PRMM tear and Osteoarthritis Kellgren-Lawrence grade II.

TREATMENT

We performed the PRMM reconstruction with gracilis graft per arthroscopy. In the preoperative setup, the patient was placed in a supine position with the affected knee at 90° flexion with the use

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Figure 1 (A) MRI fat suppression T2 coronal view showed medial meniscus extrusion >3 mm. (B) MRI fat suppression T2 sagittal view showed ghost sign at posterior root medial meniscus.

of a pneumatic tourniquet. Spinal anaesthesia with sedation was performed in this case.

The arthroscopic technique with a 30° arthroscope consisted of four steps, as follows:

Figure 2 Gracilis autograft harvesting. The patient is in the supine position with right knee flexion 90° in hanging position. (A). Gracilis tendon insertion identification (B). Whip-stitched suture configuration at end limb of gracilis tendon, followed by gracilis tendon autograft harvesting.

Standard diagnostic arthroscopy

First, the standard anterolateral portal was established, and next it was followed by the creation of an anteromedial working portal. The medial meniscus was examined with an arthroscopic probe at approximately 20°–30° knee flexion with a valgus and external foot rotation. Then, we performed an outside-in selective percutaneous deep MCL, medial collateral ligament pie-crusting release, with controlled valgus force, to open medial joint space. Afterwards, the torn posterior root of the medial meniscus was identified.

Graft harvesting

The gracilis graft was selected as the donor for the PRMM reconstruction. The skin was incised 2 cm distal and medial to the tibia tuberosity. The average length of the skin incision was 2 cm. Then, we identified the upper border of the sartorius fascia and created subperiosteally in an inverted L fashion. Furthermore, the gracilis tendon was released at its insertion and from the surrounding soft tissues. The end of the graft was sutured in a whip-stitched fashion. The gracilis graft was subsequently harvested by a graft harvesting instrument, and then prepared on the back-table. We obtained a 4.5 × 290 mm single strand gracilis graft and a double-strand gracilis graft with 5.5 mm diameter (figure 2).

Posterior root medial meniscus repair

We performed the procedure in a valgus and external rotation position. The anterolateral portal was used as the viewing portal, while the anteromedial portal was used as the working portal. The bony footprint of the PRMM was refreshed by an arthroscopy shaver. An arthroscopic curette was used to debride the normal root attachment on the posteromedial tibia for the medial meniscus. The hip joint guide pin (Acuflex Director Drill Guide; Smith & Nephew) which was used in this case due to its low-profile construction was inserted through the anteromedial portal with the view obtained from the anterolateral portal. The next step was to drill the tibia to create a bone tunnel with a 2.5-mm-diameter guide pin from the anteromedial aspect of the proximal tibia through the meniscal root footprint, followed by reaming of the tibial tunnel with an Endobutton 4.5 mm drill (Smith & Nephew). Afterwards, we gradually reamed the tibial bone tunnel from 5.5 mm to 6 mm diameter tibial reamer. Next, we inserted a loop suture relay (PDS II suture; Johnson & Johnson) and retrieved the suture with a suture retriever through the anteromedial portal (figure 3).

The sutures in the root of the medial meniscus were placed from the anteromedial portal. A no. 0 Ultrabraid (Smith-Nephew) folded in its mid-portion and was loaded into the lower jaw of the True-Pass (Smith-Nephew). Then, a True Pass was placed under the root of the medial meniscus, near its normal bony attachment. The trigger of the device was deployed and the upper jaw captured the suture. Thereafter, the True-Pass was pulled out of the joint and brought the no. 0 Ultrabraid suture out of the anteromedial portal. Meanwhile, the no. 0 Ultrabraid suture was released from the True-Pass as a U-shaped loop outside the portal. The Ultrabraid was used as a shuttle and then, the dilation process was performed.

Dilatation procedure

Moreover, the no. 0 Ultrabraid acted as a shuttle to two no. 2 Ethibond (Conmed-Linvatec) sutures to enlarge the hole inside the PRMM. Afterwards, two no. 5 Ultratape sutures were used to make further dilation. The postdilatation diameter of meniscal

Figure 3 PRMM repair. The patient is in the supine position with right knee extension, valgus and slight external rotation. The anterolateral portal is viewing portal. The anteromedial portal is working portal. (A) Detached PRMM was identified. (B) Inserting femoral drill guide (low-profile construction guide) and drilling with 2 mm guide wire. (C) 4.5 mm Endobutton reaming (D) Inserting no. 2 PDS as suture shuttle relay. PRMM, posterior root medial meniscus.

penetration was considered sufficient for the insertion of a 4.5×290 mm (single strand) gracilis graft. The gracilis graft was inserted through the meniscal hole with a single no. 5 Ultratape as the shuttle suture.

The threads on both ends of the graft were retrieved with a suture retriever above the posterior horn of the medial meniscus, pulled out to the anteromedial portal and inserted to the no. 2 PDS loop until the gracilis graft passed through the tibial tunnel with a PDS as the shuttle relay (figure 4). Finally, we carefully performed the graft retensioning; the cortical fixation was performed in an extension position using a bioabsorbable screw.

Figure 4 PRMM repair. The patient is in the supine position with right knee extension, valgus and slight external rotation. The anterolateral portal is viewing portal. The anteromedial portal is working portal. (A) Inserting no. 0 Ultrabraid through PRMM with True Pass (Smith-Nephew). (B) Enlarge the hole inside PRMM with two no. 2 Ethibond, using Ultrabraid as a shuttle suture. (C) Enlarge the hole inside PRMM with two Ultratape, using Ethibond as a shuttle suture. (D) PRMM with gracilis autograft. PRMM, posterior root medial meniscus.

Figure 5 Six months postoperative range of motion evaluation. (A,B) Full-extension of right knee joint. (C) Flexion right knee joint.

Postoperative rehabilitation

The patient was allowed to do toe-touch weight bearing at post-operation day 14. The patient's knee was put in a hinged knee brace with full knee extension. At weeks 2 to 4, 0°–90° range of motion with 50%wt bearing was allowed. Then, from weeks 4 to 6, progressive weight bearing as tolerated was started. Six weeks after the surgery, we removed the knee brace. We encouraged full weight bearing after weaning off the brace.

OUTCOME AND FOLLOW-UP

When he presented to us 6 months after surgery, the patient felt improvement in the affected knee joint. He did not experience any pain during sitting, standing, going upstairs and downstairs. We suggested him to be cautious in every activity, involving in deep knee flexion or squatting. The range of motion in the right knee joint was normal with full range of flexion and extension (figure 5). At 6-month follow-up, the MRI showed disappearing ghost signs, graft-meniscal connection, meniscal to foot-print attachment and graft-bone healing (figure 6).

DISCUSSION

The trans-tibial pull-out repair technique at PRMM tear facilitates anatomic reduction, fixation of the meniscal root and prevents displacement. One study reported that an in-situ

Figure 6 (A) Six months postoperative MRI fat suppression T2 coronal view of right knee showed gracilis graft inside the bone tunnel as a transition structure between meniscus to the bone. (B) Reduced PRMM to its attachment. (C) MRI fat suppression T2 sagittal view showed a disappearing ghost sign. PRMM, posterior root medial meniscus.

pull-out repair of a radial tear restored the joint contact pressure and area to a condition similar to its intact state. This technique can facilitate accurate positioning for the posterior horns.^{5,6}

Nevertheless, the fixation construct has been reported to have significantly weaker fixation to the tibia than the native root because it is only given by the high strain non-absorbable suture fixed on the anterior tibia cortex. Feucht *et al* reported a 2.2 mm displacement of the meniscal root repaired with the trans-tibial pull-out technique under cyclic loading in a pig model due to the length of the meniscus suture repair construct (bungee effect).^{2,3} Unsatisfactory healing rates, as displayed by one systematic review, are partly related to the weak pull-out strength of the repair technique.²

A systematic study by Feucht *et al* found only 62% patients achieved 'complete' healing, 34% 'partial' healing and 4% 'failed' to heal.^{2,3} On a second look arthroscopic evaluation, the healing status was rated as 'complete' in 48% patients, 'partial' in 42% and 'failed' in 10%.^{3,7,8} From an MRI evaluation, the healing status after a mean of 29.5 months postoperatively was rated as 'complete' in 69% patients, 'partial' in 28% and 'failed' in 3%.^{2,3,9} The impact of incomplete or failed healing on functional results and osteoarthritis progression are still controversial. Several studies observed better functional results in patients with complete healing while incomplete healing correlated with a progression to cartilage degeneration.

The PRMM reconstruction with gracilis graft was probably an option which is expected to overcome the limitation of the arthroscopic transtibial pull-out repair technique. A literature mentioned that a PRMM reconstruction with gracilis graft could be performed to manage the PRMM tear, especially in degenerated and fibrocartilaginous roots with the goal of restoring the anatomic and firm fixation of the meniscal root to bone.⁴ The gracilis graft's aperture fixation with interference screw was assumed to create shorter construct to increase meniscal root refixation stiffness strength and reduce the potential for suture failure due to abrasion of the suture-bone interface. The graft-tunnel width ratio is minimised so that it can improve the fixation stiffness and prevent micro-motion or the bungee effect, which occurred in the arthroscopic transtibial pull-out repair technique of PRMM repair.⁴ The larger diameter and blunt area surrounding the graft will prevent the PRMM from being cut through while maintaining the pull-out forces. Moreover, the healing process in a PRMM repaired by the gracilis graft covers three points, that is, meniscal-graft, meniscal-bone and bone-graft. This three-point healing increases the likelihood to obtain complete PRMM healing and prevent complications due to incomplete or failed healing process.

Limitations of this technique are related to the donor site morbidity and time consumed for the graft preparation. Meticulous preparation and dilatation of the hole on the PRMM are necessary to prevent subsequent tears of PRMM and strangulated graft when it is passing through the PRMM. Further studies

are necessary to demonstrate the biomechanical properties of PRMM reconstruction with gracilis graft and the correlation with the functional outcome.

Learning points

- ▶ Gracilis graft-posterior root medial meniscus (PRMM) reconstruction can overcome the unsatisfactory healing outcome of meniscal root repair.
- ▶ The healing rates are improved because the PRMM reconstruction with gracilis graft technique creates more secure fixation than PRMM transtibial pull-out repair technique to minimise micro-motion or bungee effect.
- ▶ Meticulous preparation and dilatation of the hole on the PRMM are necessary to prevent subsequent tears of PRMM and strangulated graft when it is passing through the PRMM.

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