



Combined Pullout Repair and Centralization for Medial Meniscus Posterior Root Tear

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Introduction

Medial meniscus posterior root tear (MMPRT) is usually accompanied by meniscus extrusion. Our research found that MMPRT and genu varus were the risk factors of medial meniscus extrusion [1]. Meniscus extrusion means the peripheral border of the meniscus is located outside the tibial plateau margin, and when the distance between the peripheral border of the meniscus and the tibial plateau margin is greater than 3 mm, it is considered as meniscus extrusion clinically [2]. Theoretically, meniscus extrusion will result in hoop strain failure under axial loading, leading to a condition biomechanically similar to a total meniscectomy. It can lead to osteoarthritis due to a decreased tibiofemoral contact area and increased contact pressure [3]. A number of researches showed that meniscus extrusion was correlated with femorotibial joint cartilage injury and subchondral bone marrow lesions [4–6]. It has been reported that the repair of MMPRT was an effective method for the treatment of meniscus extrusion complicated with MMPRT [7]. However, there is increasing recognition that meniscus root repair alone is not always able to

completely correct extrusion [8–10]. Therefore, we try to combine medial meniscus posterior root repair (MMPRR) by pullout suture with meniscus centralization to restore the nearly normal position of medial meniscus.

Surgical Techniques

Surgical Indications for MMPRT

The indication for operation of MMPRT includes age ≤ 65 years, ineffective conservative treatments lasting for 3 months, Kellgren-Lawrence grade \leq II, lower extremity varus less than 5° , BMI < 30 , medial meniscus extrusion < 4.5 mm, being able to follow a rigorous postoperative rehabilitation program. For patients with KL grade $> II$ and varus $> 5^\circ$, we would add high tibial osteotomy (HTO) if the patient's extra-articular deformity was located on the tibial side.

Trans-Tibial Pullout Repair Technique and Meniscus Centralization

According to the patient's condition, epidural anesthesia or general anesthesia was selected. The patient is placed in the supine position, with tourniquet used, and a baffle is placed on the lateral thigh tourniquet level to facilitate opening the medial space of the knee joint.

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Surgical Approach

The surgical approach was established, including the high anterolateral portal and standard anteromedial portal. The lateral portal was the observation approach, and the standard anteromedial portal was used as the working portal. MMPRT was firstly confirmed and the cartilage in the medial compartment was evaluated.

The anteromedial assistant portal was established approximately 1–1.5 cm lateral to the standard anteromedial portal. The assistant bends the affected knee 15° and externally rotation. If the medial space was difficult to open, the medial collateral ligament (MCL) could be released using the pie-crusting technique.

Evaluation of MMPRT

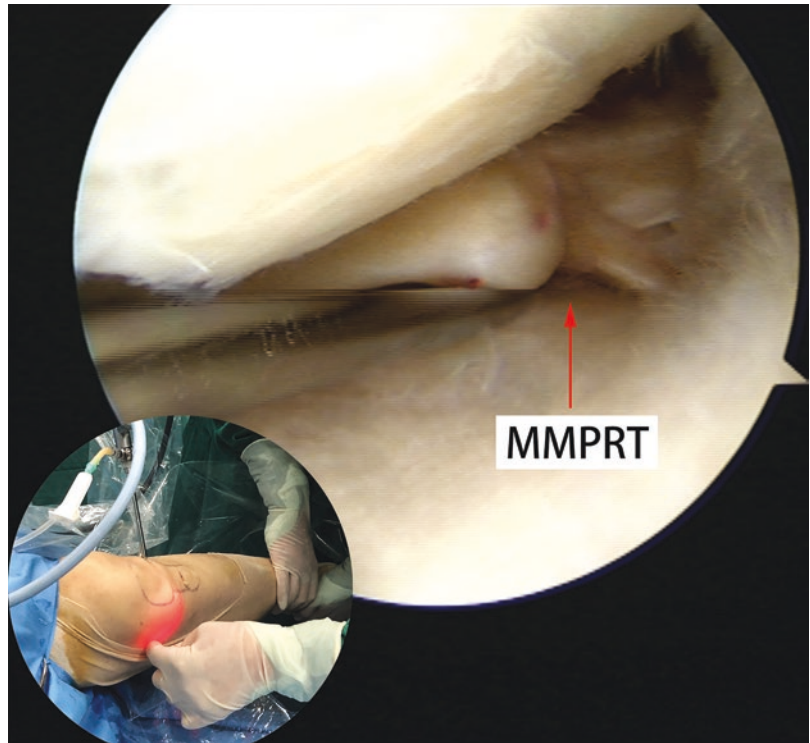
The type of MMPRT was examined with a probing hook and the quality of the meniscus was assessed (Fig. 6.1). The scar tissue, degenerated tissue, and irregular fragments were removed with a punch forceps or arthroscopic shaver for adequate freshening. Then pull the root tissue slightly, if it was easy to return to the original footprint, suture process would be performed. If

it was difficult to return to the footprint, the meniscotibial ligaments need to be released and meniscus centralization was performed before the repair of MMPRT.

Suture of Medial Meniscus Posterior Root

The suture hook was placed 5–7 mm from the broken end of the meniscus, which was adjacent to the posterior capsular as the first suture. A PDS II suture was conducted and pulled out through the anteromedial assistant portal, subsequently a NO. 5 Ethicon suture was knotted with this PDS II suture and pulled out from the anteromedial assistant portal. The second suture was positioned about 3–4 mm ahead of the first one (Fig. 6.2), then another PDS II suture was conducted and pulled out from the anteromedial assistant portal. The PDS II suture and the NO. 5 Ethicon suture were pulled out through the anteromedial assistant portal with a suture gripper to avoid soft tissue entanglement. The two ends of the NO. 5 Ethicon suture and PDS II suture were knotted, and the NO. 5 Ethicon suture was drawn out by

Fig. 6.1 Arthroscopic view of medial meniscus posterior root tear, the distance could be observed from the broken end of medial meniscus posterior root to its footprint. *MMPRT* medial meniscus posterior root tear



pulling another end of the PDS II suture from the standard anteromedial portal. The NO. 5 Ethicon suture formed a “U” shape below the meniscus, and the two free ends of NO. 5 Ethicon suture were pulled out from the anteromedial assistant portal (Fig. 6.3).

Fig. 6.2 The suture hook was placed on the upper surface of medial meniscus through the standard anteromedial portal. The first puncture point was adjacent to posterior capsule and 5–7 mm away from the broken end of MMPRT; the second puncture point was 3–4 mm away from the first one

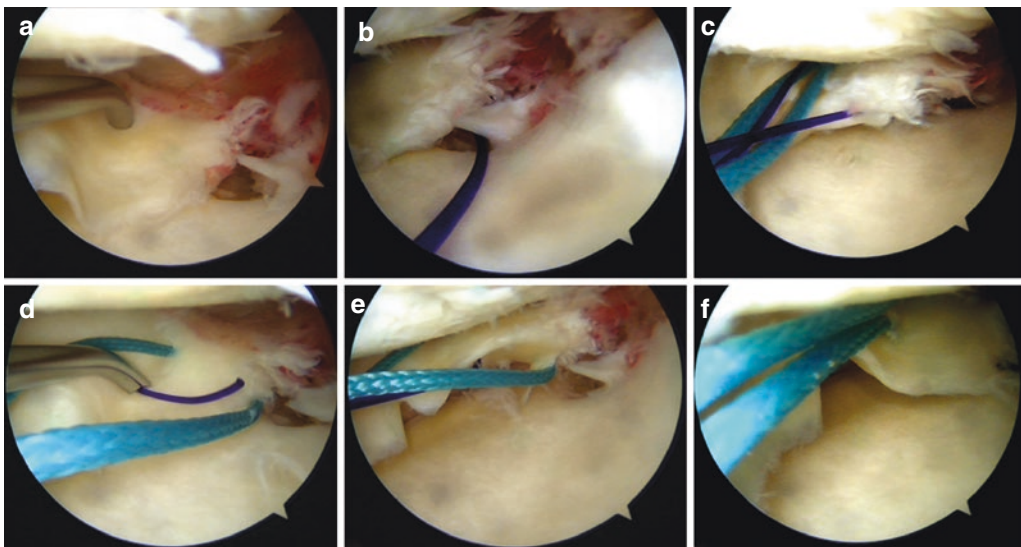
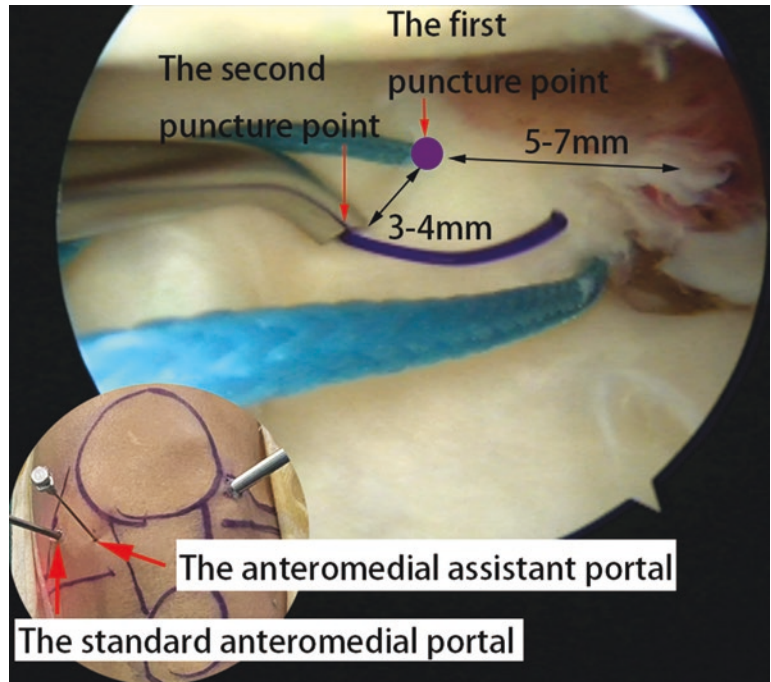
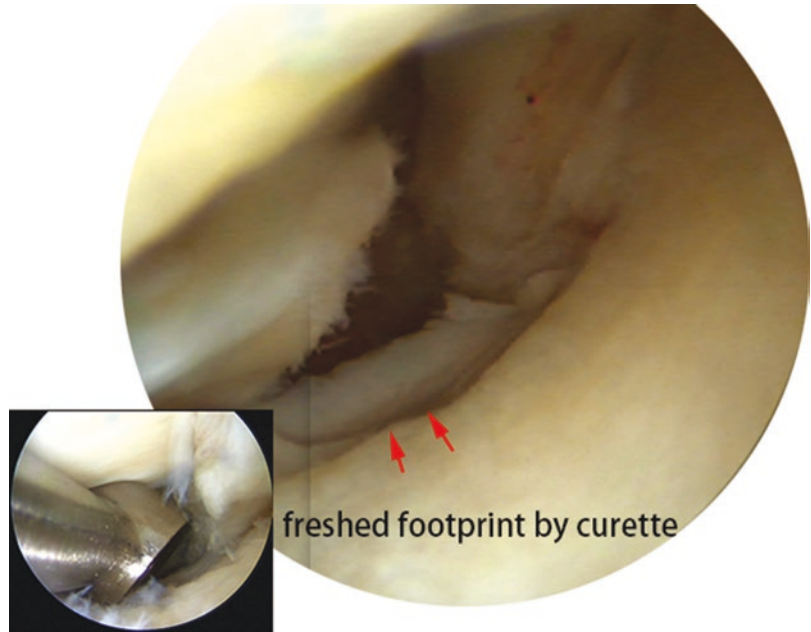


Fig. 6.3 Arthroscopic views of suturing medial meniscus posterior root. (a) The first puncture point. (b) Pulling out the PDS II suture through the anteromedial assistant portal. (c) Pulling out the No. 5 Ethicon suture by drawing the PDS II suture through the anteromedial assistant portal. (d) The second puncture point. (e) Pulling out another

PDS II suture through the anteromedial assistant portal. (f) Knotting the two ends of the No. 5 Ethicon suture and PDS II suture, and the No. 5 Ethicon suture was drawn out by pulling another end of the PDS II suture from the standard anteromedial portal

Fig. 6.4 Adequately freshening the footprint by removing cartilage



Establish the Tibial Tunnel

The internal entrance of tibial tunnel was located in the anatomic position with reference to the remnant stump of the medial meniscus posterior root and closed to the posterior cruciate ligament. After the footprint was identified, the cartilage was removed with a curette and arthroscopic shaver for adequate freshening (Fig. 6.4). Subsequently, the tibial tunnel was created by use of an anterior cruciate ligament reconstruction tibial tunnel guide, which was introduced through the parapatellar high antero-medial portal. Under the guide instruction, a skin incision about 1.5–2 cm was made in the medial

corresponding part of proximal tibial. Then a Kirschner wire was drilled along the guide, which identified in central footprint area of the medial meniscus posterior root under arthroscopy (Fig. 6.5). And then a 4.5-mm hollow drill was used to make the tibial tunnel along the Kirschner wire. The Kirschner wire was pulled out, and the PDS II suture was introduced. The two ends of NO. 5 Ethicon suture and the end of PDS II suture were pulled out simultaneously through the anteromedial assistant portal with a suture gripper. Then two ends of NO. 5 Ethicon suture and the PDS II suture were knotted and pulled out through the tibial tunnel entry

Fig. 6.5 Creating a 4.5-mm tibial tunnel using an ACL reconstruction tibial tunnel guide

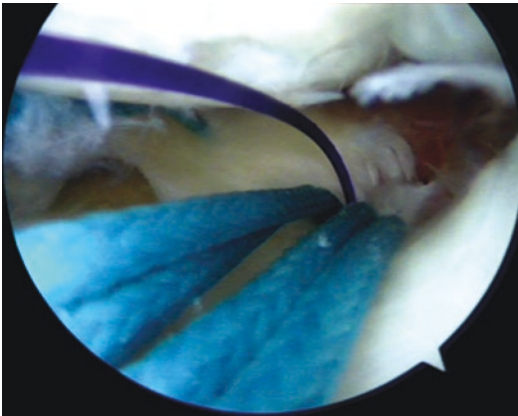
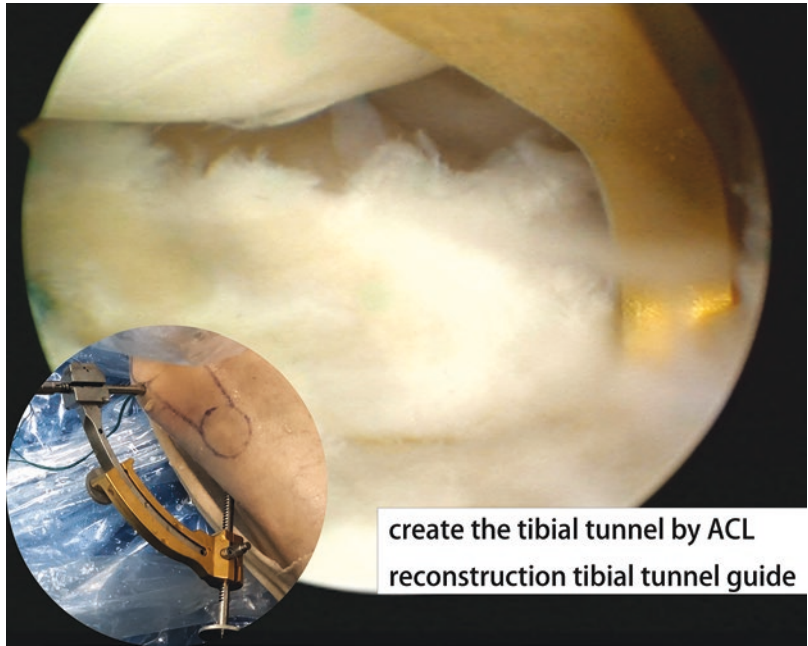


Fig. 6.6 The two ends of No. 5 Ethicon suture and the PDS II suture were knotted and pulled out through the tibial tunnel entry

(Fig. 6.6). Tighten the suture and confirm the meniscus gets a good reduction.

Fixation at the Tibial Side

The two ends of stitched suture were inserted into the adjacent holes in the middle of the Endobutton (S&N, Fig. 6.7). The button was placed attached to the tibial periosteum to avoid mingled with soft tissue. Then, the knot fixation was carried out under the arthroscopic monitoring to ensure that the meniscus tension was moderate.

Meniscus Centralization

During the operation, we considered to perform meniscus centralization in the following two conditions: (1) The medial meniscus posterior root could not be pulled to the footprint; (2) The medial meniscus posterior root could be pulled to the footprint, but the meniscus body was still protruding out of the tibial plateau edge. First, the meniscotibial ligaments were released, the area under the meniscus adjacent to the joint capsule

Fig. 6.7 The fixation of the tibial side (the two ends of stitched suture were inserted into the adjacent holes in the middle of the Endobutton, and then it was tied and fixed on the medial side of the proximal tibia)

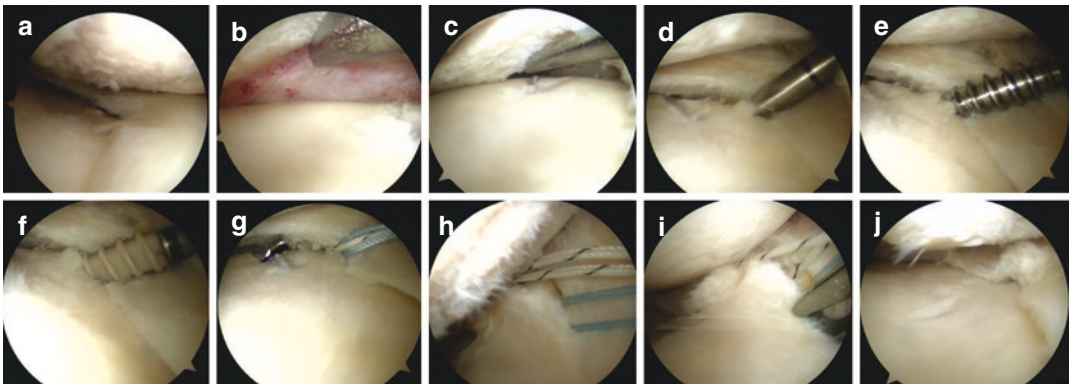
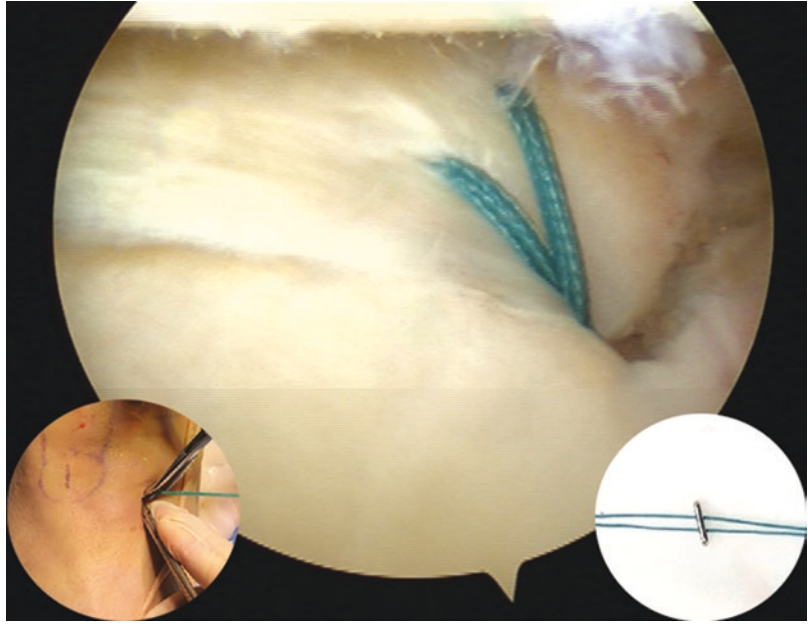


Fig. 6.8 Arthroscopic views of meniscus centralization. Medial meniscus extrusion was obvious (a); Release meniscotibial ligament (b, c); Implant anchor (d, e, f);

Pass the anchor suture through the meniscus (g, h); Knot the anchor suture (i); The meniscus extrusion was corrected (j)

using the arthroscopic shaver [11], until the meniscus can be pulled back [12, 13]. The suture anchor was placed in the middle of the covering area of the normal meniscus. The four sutures of the anchor were passed through the synovial margin of the body of the medial meniscus with suture hooks. The four stitches were even distributed. The free edge of the meniscus was pulled to the center with a tissue gripper, and the synovial edge of the meniscus was as close as possible to the edge of the tibial plateau. The four sutures were pulled out from the anteromedial portal with a

suture gripper, and then the anchor sutures were matched and knotted, respectively. Finally, the meniscus was moved centrally (Fig. 6.8). The distance between the footprint and the torn edge of the medial meniscus posterior root became closer.

Open Wedge HTO

For the patients with MMPRT accompanied by genu varus greater than 5° , the OWHTO surgery was performed first [14]. During the oper-

ation, we will release the medial collateral ligament regularly, so that the medial space could be enlarged to facilitate to repair the medial meniscus posterior root. In addition, during the preparation of the tibial tunnel, screw B and screw C of plate may interfere with the tunnel. So special care must be required to prevent the Kirschner wire or drill from breaking. One solution was to adjust the angle of the ACL reconstruction tibial tunnel guide. The rest of the steps are the same as the MMPRR as described above.

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