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Selective Medial Release Technique Using the Pie-Crusting Method for Medial Tightness During Primary Total Knee Arthroplasty

Chul-Won Ha, MD, PhD [a], Yong-Beom Park, MD [a, *], Choong-Hee Lee, MD [a], Soo-Ik Awe, MD [a], Yong-Geun Park, MD [b]

[a] Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea
[b] Department of Orthopedic Surgery, Jeju National University Hospital, Jeju National University School of Medicine, Jeju, South Korea

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ABSTRACT

Background: The pie-crusting method is popular in releasing lateral tightness during primary total knee arthroplasty (TKA) but is not well described for medial release. We established a selective medial release technique using the pie-crusting technique and investigated the effectiveness and safety of the technique during primary TKA.

Methods: We retrospectively reviewed 729 primary TKAs with varus deformity between October 2009 and June 2012. Medial tightness in flexion was released by traditional subperiosteal stripping for the anterior portion of the medial collateral ligament (aMCL). Medial tightness in extension was released by the pie crusting for the tight fibers in the posterior portion of the MCL and/or posteromedial corner structures (pMCL/PMCS). Clinical outcomes were evaluated by Knee Society (KS) scores and the Western Ontario and McMaster Universities Osteoarthritis Index. Any complications, including late medial instability that may be related to our surgical technique, were carefully inspected.

Results: Among the 729 knees, 170 (23.3%) required subperiosteal stripping for balancing in flexion only, 186 (25.5%) required the pie-crusting for balancing in extension only and 142 (19.5%) required subperiosteal stripping and the pie-crusting for balancing in flexion and extension. The KS knee score was improved from 52.5 to 83.4, KS function score from 58.2 to 91.9, and Western Ontario and McMaster Universities Osteoarthritis Index from 42.7 to 21.8 ($P < .001$, all). No specific complications related to our technique were identified.

Conclusions: The selective medial release technique appears to be an effective and safe method to obtain a balanced mediolateral gap in primary TKA.

The pie-crusting method is a well-known procedure for correcting tightness of the lateral stabilizing structures, such as the iliotibial band, lateral collateral ligament, or posterolateral corner structures in valgus knees [1-4]. The controlled lengthening of the contracted lateral structure is possible by multiple transverse incisions under maximal extension space distraction using laminar spreaders [1-3]. However, the applicability of the pie-crusting technique for the medial release in varus knees is unclear and so is used yet for the release of tight medial gap in primary total knee arthroplasty (TKA) procedures.

The most popular technique for the release of medial tightness is subperiosteal stripping of the superficial medial collateral ligament (MCL) of the tibia [5-7]. However, in knees with severe medial tightness, the possibility of complete detachment of the MCL by an extensive subperiosteal release and the resultant medial instability during primary TKA has been a concern [8]. Moreover,

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* Reprint requests: Yong-Beom Park, MD, Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-ro, Gangnam-gu, Seoul, 135-710, South Korea.

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subperiosteal release of posteromedial corner structures (PMCS), such as posterior oblique ligament and semimembranosus insertions, is often cumbersome or less effective in our hands.

Recent reports described the use of the pie-crusting method for medial release [9-11]. However, these reports were exploratory experiences in a small number of patients that lacked a detailed or refined description of the surgical technique. We have refined the pie-crusting technique of selective medial release. Medial tightness in flexion is released by the traditional subperiosteal stripping for the anterior portion of the MCL (aMCL). Medial tightness in extension is released by the pie-crusting method for the posterior portion of the MCL and/or posteromedial corner structures (pMCL/PMCS).

We hereby describe our technique in detail and report the results of our technique by addressing 3 questions: (1) How many of the patients are managed with the pie crusting of the pMCL/PMCS according to our selective release technique? (2) Can the intraoperative medial tightness in extension be effectively corrected by the pie-crusting technique? (3) Is the pie crusting of the pMCL/PMCS safe?

Materials and Methods

We retrospectively reviewed prospectively collected data of 740 consecutive varus knees of 508 patients who underwent primary TKAs between October 2009 and June 2012. Primary TKAs with severe preoperative ligament instability that needed constrained TKAs were excluded. Among them, 11 knees of 7 patients were lost to follow up. Thus, 729 knees of 501 patients (98.5%) comprised the cohort of this study with a mean follow-up of 3.3 years (range, 2-4.7 years). There were 273 unilateral and 228 bilateral procedures. The mean age of the patients was 68.1 years (range, 47-94 years). The mean body mass index was 26.7 kg/m^2 (range, 15.1-40.6 kg/m^2). The diagnoses were osteoarthritis in 712 (97.7%) patients, osteonecrosis of the medial condyle in 13 (1.8%), and rheumatoid arthritis in 4 (0.5%). This study was approved by the Institutional Review Board at our institution.

The senior author of this study performed all the TKAs in a single institute using a measured resection technique. A medial parapatellar approach was used for every case. An intramedullary alignment guide was used for preparation of the femur, and distal resection was made at 5° valgus with respect to the femoral anatomic axis. An extramedullary alignment guide was used for the preparation of the tibia. Patellar tracking was checked intraoperatively with trial components in place using the towel clip technique [12]. All the TKAs were posterior cruciate ligament substitute design according to the senior author's preference, and all the components were fixed with cement in every case. The NexGen LPS (Zimmer, Warsaw, IN) was used in 387 knees, Triathlon (Stryker, Mahwah, NJ) in 231 knees, and Vanguard (Biomet, Warsaw, IN) in 111 knees. The reason for this mixture was principally from logistics and contractual issues.

The knee joint was exposed through a midline skin incision and medial parapatellar arthrotomy. In each case, the deep MCL was released during the exposure, while paying attention not to release the superficial MCL attached more distally at the proximal tibia. The bone resections were performed before any soft tissue release procedures, as in the typical measured resection technique [13,14]. After the completion of bone resections, the flexion-extension gap balancing was achieved provisionally in a conventional manner. Then, the mediolateral soft tissue balancing was performed. Any tightness in medial or lateral compartment of the extension gap was evaluated by inserting a handled spacer block with a thickness that snugly fits into the gap while the knee was extended. Medial tightness typically opened the lateral space. The same procedure was performed for the flexion gap with 90° of knee flexion. The gap imbalance in extension was measured using a Vernier caliper with a spacer block inserted. The gap imbalance in flexion was assessed by tightness using a spacer block but not measured as numerical values. The medial release was performed according to the principles of selective release of tight structures in primary TKA [5,15]. Accordingly, medial tightness in flexion only (Fig. 1A) was addressed by releasing the aMCL by subperiosteal stripping off the proximal tibia (Fig. 1B). When there is a medial tightness in extension only (Fig. 2A), the pie-crusting method was applied only to the tight fibers of the pMCL/PMCS (Fig. 2B). In detail, a laminar spreader was used in the medial compartment to give tension to the contracted medial structures while the knee was maintained in full extension. Synovial tissues covering the MCL along the articular side were removed to ensure good palpation of the tight fibers in the pMCL/PMCS. Finally, multiple pie-crusting small incisions were made using a No. 11 blade in a transverse plane at the pMCL/PMCS. The initial release by pie crusting was applied on the tightest band in the pMCL or PMCS, and mediolateral stability was rechecked. Then, if needed, the second tightest band in the pMCL or PMCS was released by pie crusting, followed by the next tightest band, and so on. The blade was inserted about 2 to 3 mm deep on each pass for penetration of the tight fibers. Two or 3 pie crusts with intervals of about 5 mm were usually needed to release the tightest band before rechecking the mediolateral balance. The pie crusting was applied in a titrating manner (ie, for the tightest fibers one by one), which was enabling a fine-tuning of the release of the pMCL/PMCS. In case of medial tightness both in flexion and in extension, we strongly recommend performing the subperiosteal release of the aMCL first and then pie crusting of the pMCL afterward. After completing the release, the medial opening was measured with a spacer block inserted using a Vernier caliper while applying valgus stress to the knee. This algorithmic approach of the selective release technique using the pie-crusting method allowed sufficient release of the tight medial structures without total detachment of the MCL from extensive subperiosteal stripping, even in knees with severe medial contracture (Fig. 3).

For the assessment of the percentage of patients receiving pie crusting of the pMCL/PMCS according to our selective release technique [5,15], patients were categorized into 4 groups. Group 1 had no release of the aMCL or pMCL/PMCS because there was no medial tightness in flexion and in extension. Group 2 had subperiosteal release of the aMCL only because there was a medial tightness only in flexion. Group 3 had pie crusting of the pMCL/PMCS only because there was a medial tightness only in extension. Group 4 had subperiosteal release of the aMCL and the pie crusting of the pMCL/PMCS because there was medial tightness both in flexion and in extension (Table 1).

The amount of medial tightness before the medial release (ie, the amount of lateral opening while the snug-fitting spacer block is inserted) and the procedures performed for the aMCL or the pMCL/PMCS were recorded prospectively during surgery. Clinical outcomes were evaluated on the range of motion, Knee Society knee scores, Knee Society function scores, and Western Ontario and McMaster Universities Osteoarthritis Index scores preoperatively and postoperatively at 6 weeks, 3, 6, and 12 months, and annually thereafter. Any complications including medial instability related to the surgical technique, especially the pie-crusting method using a No. 11 blade for the medial tightness in extension, were carefully inspected. Full-length and standing anteroposterior, lateral, and Merchant's views were acquired at each follow-up visit and assessed for limb alignment, component positioning, and any features of loosening. Mediolateral stability was evaluated by manually applied stresses in full extension and 30° of knee flexion at each follow-up visit and recorded in the medical record.