Primary Results of Medial Epicondylar Osteotomy in Patients with Severe Bilateral Varus Knee Candidate for Total Knee Replacement

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Abstract

Background Total knee arthroplasty is a challenging task in patients with severe varus deformity. In most of these patients, an extensive medial release is needed that may lead to instability. Medial epicondylar osteotomy may be a better substitute for complete medial collateral release.

Materials and Methods Fourteen patients with bilateral knee osteoarthritis and severe varus deformity were enrolled in this study. In one side, the patients underwent medial epicondylar osteotomy for mediolateral imbalance if the only option was superficial medial collateral ligament (MCL) release. In contralateral side, the extensive medial release was performed and MCL was released either by pie-crusting technique or by subperiosteally release. The results of the two sides were compared. Patients were followed up for 12 months after the operation. Physical examination, clinical questionnaires, and radiography findings were recorded. Union of the osteotomies fragment and complications was evaluated.

Results The mean varus angle before surgery was 21.6 ± 4.7 degrees, which was corrected to 8.6 ± 2.9 degrees after operation with an extensive medial release. The mean varus angle of contralateral side was 22.6 ± 1.7 degrees, which was corrected to 7.5 ± 2.3 degrees following medial femoral epicondyle osteotomy. There was no significant difference in varus correction ($p = 0.1$). Medial joint line opening in valgus stress test was 2.7 ± 0.4 mm in the osteotomized side and 3.5 ± 0.9 mm in contralateral side. Mean range of motion for the osteotomized side was 97.8 ± 4.3 degrees and 100.7 ± 2.7 degrees for contralateral side ($p = 0.6$). Nonunion occurred in a case in the osteotomized side and no medial instability was observed in medial release or osteotomies sides. No statistical difference was recorded based on clinical questionnaires (Oxford and WOMAC [Western Ontario and McMaster Universities Osteoarthritis Index] scores).

Conclusion Medial epicondylar osteotomy is a safe technique with the well-controlled medial extensive release in the patients with severe varus deformity during total knee arthroplasty.

Keywords
- total knee arthroplasty
- epicondylar osteotomy
- medial collateral ligament

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Varus deformity is common during total knee arthroplasty (TKA). Management of deformity correction requires a continuous interplay between collateral ligament balance, assessment of the flexion and extension gaps, and maintenance of the mechanical axis. Due to preoperative deformity, some ligaments around the knee are contracted that will be carefully released in a stepwise manner to balance the soft tissues around the knee and allow optimum knee kinematics. Several structures may be addressed during correction of severe varus deformity: (1) removal of osteophytes, (2) increase in the pes anserine complex release, (3) release of the tibial insertion of the deep head of the medial collateral ligament (MCL), (4) posteromedial capsule complex, (5) resection of the posterior cruciate ligament (PCL), and (6) release of the superficial MCL medially and posteriorly.[1–3] In varus knees, most surgeons prefer to release or elevate the soft tissues of the tibial insertion site by either sharp or blunt techniques. However, the intrinsic risk of this maneuver is the potential for excessive release and early or late iatrogenic instability.[4,5] In moderate-to-severe varus knees, pie crusting of the MCL midsubstance can be a solution.[6] Although most varus knees can be treated with these procedures, inadvertent over-release of the medial structures, especially the superficial MCL, can occur during the procedure in knees suffering from severe varus deformity.[7,8]

Engh and Ammeen[9] introduced a balancing procedure to release the MCL from the femur by performing a medial epicondylar osteotomy. A medial epicondylar osteotomy can prevent medial instability by complete conventional MCL stripping.[9] Here, we compare the clinical results of patients with severe bilateral varus deformity who had undergone epicondylar osteotomy in the one side and extensive release in the other side. In addition, we describe our technical experiences in the epicondylar osteotomy fixation method.

Materials and Methods

Fourteen female patients with bilateral knee osteoarthritis gave their informed consent to participate in this study. All patients underwent an operation with similar fixed-bearing posterior stabilized (Zimmer company or Smith and Nephew) prosthesis and the surgeries were performed by the same surgeon. The inclusion criteria included primary bilateral knee osteoarthritis with bilateral varus deformity greater than 15. The exclusion criteria included traumatic osteoarthritis, body mass index of > 30, neuromuscular disease, and congenital deformity. For all patients, a preoperative standing, long-leg alignment view radiograph was obtained. For each patient, the first knee was managed with an epicondylar osteotomy and the second knee replacement was approached with an MCL release. Intervals between arthroplasties were 6 to 12 months. The medial epicondylar osteotomy was performed in one side when the mediolateral release was not achievable despite that all the medial and posteromedial structures were released with the exception of superficial MCL. We considered more than 4 mm of medial–lateral imbalance as an indication of the epicondylar osteotomy. In addition, medial epicondylar osteotomy would be performed if we could not handle the minimum possible insertion due to the tightness of the medial side. In the contralateral side, extensive medial release of pie-crusting technique was done and if the MCL still prevented the balance, we released the superficial MCL subperiosteally by pie-crusting technique.

A Common Preliminary Medial Release

First, a femoral distal cut was done. Then, the proximal tibia cut was created perpendicular to the mechanical axis of the tibia using a spacer in place. The preliminary estimations for stability and tightness in extension were performed. Medial side osteophytes were excised and deep MCL was elevated in all cases. If the medial side still was tight in extension, medial and posteromedial capsule and soft tissue including the semimembranosus were released. If the correction was made, the anterior–posterior and chamfers cuts were performed, PCL was removed, and the femoral trial was created with an appropriate insertion in the extension. In addition, if the tibial augment was necessary, the corresponding cuts were applied and stability tests were done again. In cases where the medial side was tight in flexion, a small segment of the posteromedial edge of tibial plateau was excised according to the technique described by Mullaji and Shetty.[2] If, however, it was still impossible to insert the trial into the flexion space, the only option was the full release of the MCL. Then, we decided to do medial epicondylar osteotomy.

Osteotomy Technique

The osteotomy of the medial femoral epicondyle was done in the dimension of $4 \times 4 \times 1$ cm^3. The osteotomy was performed using a narrow saw, and 85% of the epicondylar cross-section was cut (►**Fig. 1**). Proximal and posterior soft tissue attachments were left intact. To put the insert trial in place, cracks were made in the osteotomized segment with a narrow osteotome to displace the epicondylar segment distally and posteriorly. After putting the insert trial in place, the knee was

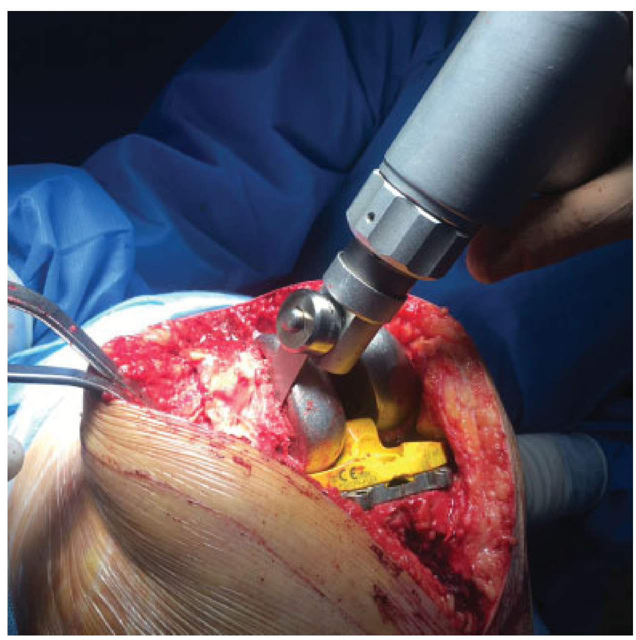

Fig. 1 Intraoperative photo of medial epicondylar osteotomy during total knee replacement.

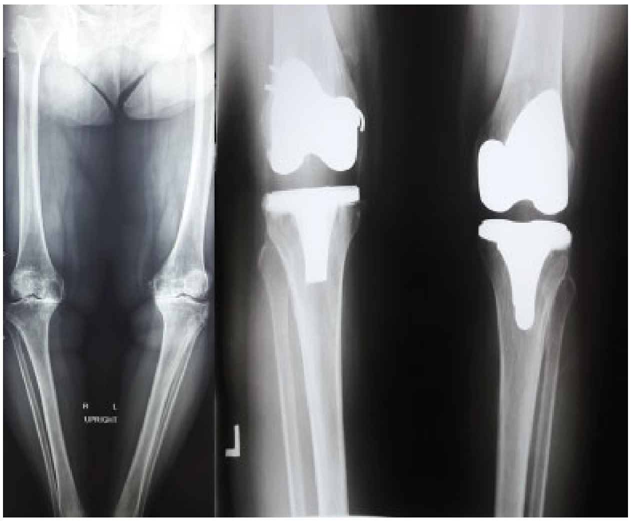

Fig. 2 Preoperative and final follow-up radiography in patients under total knee replacement with medial epicondylar osteotomy and medial soft tissue release technique to correct severe varus malalignment in contralateral side.

brought from flexion to the extension; in this position, the fragment was fixed with two pins from inferomedial to superolateral. If, however, the fragment was impossible to be fixed because of osteoporosis or comminution, the osteotomized fragment was fixed with nonabsorbable sutures. We did not accept any gap in the osteotomy site to avoid cement infiltration and nonunion. When the displacement of the osteotomized fragment was too high in a way that it impinged on the tibia and interfered with tibia motion, the protruded segment was excised. The rest of the procedure was similar to the routines and at the end of the operation, valgus instability was checked using mild valgus force (►**Fig. 2**). In the superficial MCL release, we had done pie-crusting technique very gently. If the medial side was still tight, we do complete subperiosteally MCL release.

Six months after the surgery, the patients were evaluated by an orthopaedic surgeon in terms of knee range of motion (ROM), flexion contracture, and valgus stress test. WOMAC [Western Ontario and McMaster Universities Osteoarthritis Index] and Oxford questionnaires were used for clinical scoring. We asked the patients to answer which one of their knees were they more satisfied with. Union quality and time were evaluated by a radiologist and recorded in a checklist. Pain intensity was graded based on the visual analog scale, in which 0 showed no pain and 100 indicated the worst imaginable pain. All patients were followed up for 12 months.

The research was approved by the ethics committee of Urmia University of Medical Sciences with the code of **IR. UMSU.REC.1396.329.**

Statistical Methods

Continuous variables were reported as mean ± standard deviation. The normality of the distributions was checked for each variable using the Kolmogorov–Smirnov test. The Mann–Whitney U test was employed to compare the quantitative data. Statistical analyses were performed using SPSS software (Statistical Package for the Social Sciences, version 16.0, SPSS Inc, Chicago, IL). *p*-values of less than 0.05 were considered statistically significant.

Results

Fourteen female patients with a mean age 67.8 ± 8.4 years were enrolled in the study. Before surgery, their mean varus angle was 22.6 ± 4.7 degrees in the osteotomized side, which was corrected to 8.6 ± 2.9 degrees after the operation. The mean varus angle of the contralateral side was 21.6 ± 4.7 degrees before surgery, which was corrected to 7.5 ± 2.3 degrees after the operation ($p = 0.1$). In 12 patients, the epicondylar osteotomy was performed on the left side, while two of them had it on their right side. In 10 cases, epicondylar fragments were fixed with pins, whereas this procedure was performed by nonabsorbable sutures in four cases.

Medial joint line opening in valgus stress test was 2.7 ± 0.42 mm in the osteotomized side and 3.5 ± 0.9 mm in the contralateral side based on the physical examination. Patients' follow-up findings showed no significant difference, as shown in ►**Table 1**.

The mean flexion contracture of patients was 4.29 ± 1.3 (0–10) degrees in the osteotomized side and 1.43 ± 0.92 (0–5) degrees in the contralateral side ($p = 0.1$). The mean scores of WOMAC and Oxford questionnaires were not significantly different between the two techniques ($p = 0.1$, $p = 0.4$; ►**Table 1**). Mean ROM for the osteotomized side was 97.86 ± 4.34 degrees, while the contralateral side showed mean ROM of 100.71 ± 2.76 degrees ($p = 0.69$).

One case showed nonunion of the osteotomized fragment (►**Fig. 3**). The mean scores of Oxford and WOMAC, in this case, were 60 and 23, respectively. There were no cases of infection, fracture, or any other major complications.

Discussion

In this study, the short-term results of medial epicondylar osteotomy in one knee were compared with the results of the

Table 1 Comparison of functional outcome and follow-up finding between two sides of arthroplasty with medial epicondylar osteotomy versus medial extensive soft tissue release

Variables	Medial epicondylar osteotomy $n = 14$	Medial extensive soft tissue $n = 14$	*p*-Value
ROM degree	98.9 ± 9.4	100.7 ± 2.8	0.1
WOMAC	39.8 ± 9.4	37.4 ± 2.3	0.1
Oxford	88.3 ± 8.2	84.3 ± 4.3	0.4
Flexion contracture	3.4 ± 1.2	4.1 ± 2.3	0.2
VAS pain scoring	39.5 ± 10.2	44.2 ± 11.3	0.3

Abbreviations: ROM, range of motion; VAS, visual analog score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

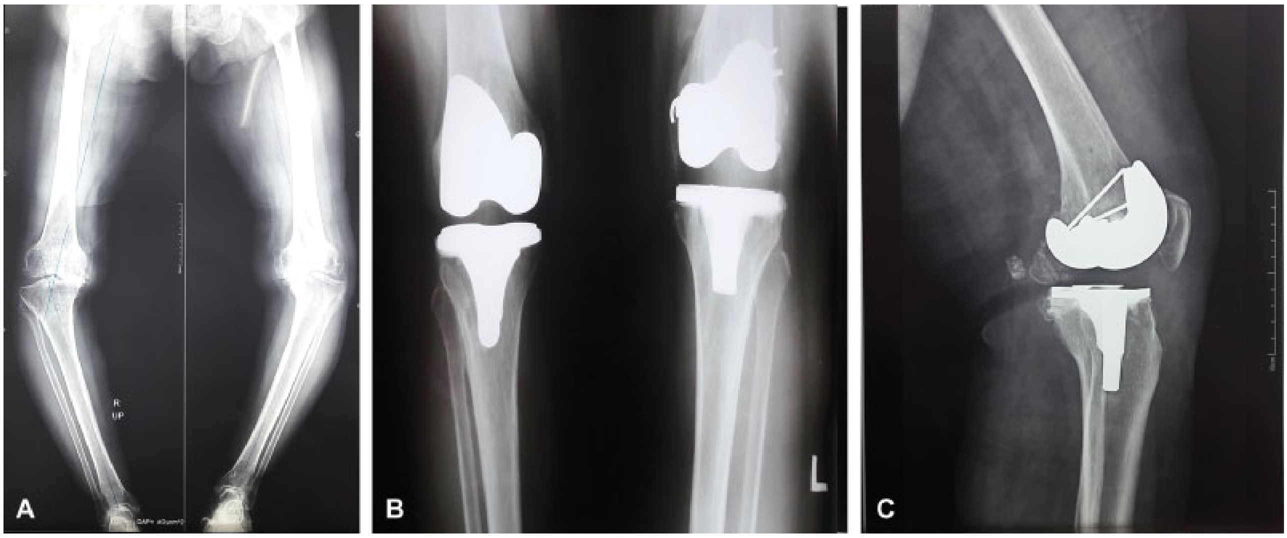

Fig. 3 A case of nonunion occurring in the osteotomized side. (**A**) Preoperative alignment view. (**B**) Postoperative view. (**C**) Lateral view in the last follow-up with nonunion in osteotomy site.

medial release in the contralateral knee. No significant difference was recorded between the clinical scores of the two techniques. The number of epicondylar nonunions did not affect the final results. Medial epicondylar osteotomy showed similar effects on both flexion and extension gap; the most severe flexion contractures were corrected in this osteotomy.

Varus malalignment is a common angular contracture in patients awaiting primary TKA.[10] Varus deformity can be usually treated with medial ligament release. Medial soft tissue balancing with the traditional subperiosteal release of the superficial MCL could be technically demanding and may lead to over-release.[11,12] Another option for the knee with severe varus deformity involves the resection of the bone along the medial tibial plateau, with downsizing and relative lateralization of the tibial baseplate. Downsizing the tibial baseplate and performing a medial tibial reduction osteotomy may also be effective for relaxing the soft tissue envelope. However, this may have negative impact on long-term durability for the TKA.[2,4] With these limitations to the medial release, the medial epicondylar osteotomy seems to be a good alternative for knee balance in TKA. Our results confirmed that epicondylar osteotomy in one knee resulted in outcomes similar to those of the contralateral side with a good medial release.

The superficial MCL is an important stabilizer against valgus and rotational forces after TKA. When other structures have been released and have not effectively provided soft tissue balance, caution should be used during superficial MCL release to avoid over-release of the superficial MCL that could have severe adverse impact on TKA stability. The MCL affects both the flexion and the extension gap; however, the release of only the anterior portion affects the flexion gap more than the extension gap. Keeping in mind that both anterior and posterior fibers of superficial MCL directly originate from medial epicondyle, its osteotomy would affect flexion and extension to a certain extent.

Epicondylar osteotomy has been also reported to aid in balancing and providing the exposure of the varus knee with flexion contracture.[13] In addition to superficial MCL, posterior oblique ligament and posteromedial capsule also have direct attachments to medial epicondyle and could play a significant role in the development of the flexion contracture. In our series, the medial epicondylar osteotomy was useful in correcting the varus deformity in the coronal plane, as well as flexion contracture in the sagittal plane. Even the most severe flexion contractures were corrected easily by this technique.

We think that there is no universally accepted special measurement for evaluating the effect of ligament release and balancing during operation. Medial epicondylar osteotomy benefits from the complete removal of tension in the medial side. This could be achieved in soft tissue releasing techniques only by complete MCL release. Complete MCL release could be associated with medial instability. In our series, one of our patients had medial instability using medial soft tissue releasing technique. In one patient with epicondylar osteotomy and fibrous union, there was still no significant instability.

Femoral condylar lift-off may contribute to eccentric polyethylene wear, particularly in designs of TKA that have flatter condyles.[14] Since the medial epicondylar osteotomy is effective in flexion gap unloading, lift-off was immediately corrected after osteotomy. This correction could not be completely achieved in some of our patients with soft tissue release alone.

One of the advantages of epicondylar osteotomy is the possibility of minimally invasive approaches for severe varus cases. Although we did not conduct a minimally invasive approach in our cases, we still believe that it could be possible to do epicondylar osteotomy from the beginning without any medial releases.

In 10 of our cases, we fixed the epicondyle with pins. In one of them occurred nonunion. This case had comminution of epicondyle due to severe osteoporosis. Despite nonunion, patient's clinical scores were not significantly decreased and in the valgus stress test, the joint was opened 3 to 4 mm. Literature review shows challenges in methods of fixation in the epicondylar osteotomy. Mullaji et al did a sliding osteotomy and fixed the osteotomy site with a cancellous screw.[13] Sim et al fixed the osteotomy site with pins, while Jae Ang Sim sutured and fixed the fragment with Ethibond No. 5.[15] It is important to note that the major stabilizer of the epicondylar fragment after osteotomy would be the Adductor Magnus that is tight in extension. For this reason, all of the fixation methods should be done in full extension.

In our study, there were several limitations. Our study population only included female patients, and this may impact the generalizability of our study findings. In addition, there were bone quality differences between women and men that could affect patients' outcome under epicondylar osteotomies. The small number of enrolled cases and short follow-up duration can be mentioned as other limitations of this study.

Our study findings support the use of either distal femoral osteotomy or extensive superficial MCL release in the treatment of severe varus deformity during TKA has the same clinical outcomes. Distal femoral osteotomy is a suitable and good alternative technique in the management of sever varus knee deformity during TKA.

Note

The study was confirmed by the ethics committee of Urmia University of Medical Sciences.

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Conflict of Interest

None declared.

References

1 Mihalko WM, Saleh KJ, Krackow KA, Whiteside LA. Soft-tissue balancing during total knee arthroplasty in the varus knee. J Am Acad Orthop Surg 2009;17(12):766–774

2 Mullaji AB, Shetty GM. Surgical technique: computer-assisted sliding medial condylar osteotomy to achieve gap balance in varus knees during TKA. Clin Orthop Relat Res 2013;471(05):1484–1491

3 Verdonk PC, Pernin J, Pinaroli A, Ait Si Selmi T, Neyret P. Soft tissue balancing in varus total knee arthroplasty: an algorithmic approach. Knee Surg Sports Traumatol Arthrosc 2009;17(06):660–666

4 Tang Q, Yu HC, Shang P, et al. Selective medial soft tissue release combined with tibial reduction osteotomy in total knee arthroplasty. J Orthop Surg Res 2017;12(01):174

5 Bellemans J, Vandenneucker H, Van Lauwe J, Victor J. A new surgical technique for medial collateral ligament balancing: multiple needle puncturing. J Arthroplasty 2010;25(07):1151–1156

6 Bellemans J. Multiple needle puncturing: balancing the varus knee. Orthopedics 2011;34(09):e510–e512

7 Chang MJ, Lim H, Lee NR, Moon YW. Diagnosis, causes and treatments of instability following total knee arthroplasty. Knee Surg Relat Res 2014;26(02):61–67

8 Heesterbeek PJ, Wymenga AB. Correction of axial and rotational alignment after medial and lateral releases during balanced gap TKA. A clinical study of 54 patients. Acta Orthop 2010;81(03):347–353

9 Engh GA, Ammeen D. Results of total knee arthroplasty with medial epicondylar osteotomy to correct varus deformity. Clin Orthop Relat Res 1999;(367):141–148

10 Verdonk PC, Pernin J, Pinaroli A, Ait Si Selmi T, Neyret P. Soft tissue balancing in varus total knee arthroplasty: an algorithmic approach. Knee Surg Sports Traumatol Arthrosc 2009;17(06):660–666

11 Matsumoto T, Kuroda R, Kubo S, Muratsu H, Mizuno K, Kurosaka M. The intra-operative joint gap in cruciate-retaining compared with posterior-stabilised total knee replacement. J Bone Joint Surg Br 2009;91(04):475–480

12 D'Lima DD, Patil S, Steklov N, Colwell CW Jr. An ABJS best paper: dynamic intraoperative ligament balancing for total knee arthroplasty. Clin Orthop Relat Res 2007;463(463):208–212

13 Mullaji AB, Shetty GM. Surgical technique: computer-assisted sliding medial condylar osteotomy to achieve gap balance in varus knees during TKA. Clin Orthop Relat Res 2013;471(05):1484–1491

14 Dennis DA, Komistek RD, Walker SA, Cheal EJ, Stiehl JB. Femoral condylar lift-off in vivo in total knee arthroplasty. J Bone Joint Surg Br 2001;83(01):33–39

15 Sim JA, Lee YS, Kwak JH, Yang SH, Kim KH, Lee BK. Comparison of complete distal release of the medial collateral ligament and medial epicondylar osteotomy during ligament balancing in varus knee total knee arthroplasty. Clin Orthop Surg 2013;5(04):287–291