Gap balancing of varus knee in total knee arthroplasty without superficial medial ligament release

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Abstract

Background:
Ligament balancing is considered a pre-requisite for good function and survival in total knee arthroplasty. Medial soft tissue release is required to obtain balanced rectangular flexion and extension gaps in the varus knee. Optimal ligament tension during total knee arthroplasty is still mostly based on the surgeon's feel and personal experience. Over release of the superficial medial collateral ligament may occur resulting in instability.

Aim of the study:
Our study aimed to test the hypothesis that adequate soft-tissue balance can be achieved in primary TKA in patients with varus deformity 15 degrees or more without releasing the superficial MCL.

Patients and methods:
41 total knee arthroplasty were done in 36 patients. All patients were female with a mean age of 59.1 years (range, 51 to 64 years). The inclusion criteria were patients with knee osteoarthritis indicated for primary total knee arthroplasty with varus deformity 15 degrees or more. Soft tissue releasing procedure we followed was the removal of medial osteophytes as the first step, deep medial collateral ligament release as the second step, Excising of scarred tissue in the posteromedial corner, and release of the posteromedial capsule, and the last step was semimembranous insertion release.

Results:
Out of 41 knees, we could balance38 knees without superficial medial ligament release. Three knees needed superficial medial ligament release to had mediolateral gap balance.

Conclusion:
Most TKA with varus deformity 15 degrees or more can be balanced without superficial MCL release but this should not be at the expense of residual lateral laxity as adequate soft tissue balancing and deformity correction are mandatory to obtain good outcomes.

Keywords:
total knee arthroplasty, superficial medial collateral ligament, release, gap balance.

Introduction

A stable knee with an appropriate longitudinal and rotational alignment of the femoral and tibial component has been one of the primary goals of total knee arthroplasty (TKA) because it was supposed to be important for successful clinical outcomes and implant survivorship [1,2].

Varus deformity of the knee is one of the most common deformities seen at the time of TKA, medial soft tissue release is needed to obtain balanced rectangular flexion and extension gaps. The classical medial release consists of osteophyte removal, deep medial collateral ligament (MCL) and posterior oblique ligament (POL) release, semimembranosus release, posterior capsule release, superficial MCL release, and pes anserinus tendon release in a sequential manner. In moderate to severe varus knees, the release of the superficial MCL can be a solution. Although most varus knees can be dealt with these procedures, over the release of the medial structures, especially the superficial MCL, can occur in knees with severe varus deformity[3-5].

The MCL is the primary restraint to the valgus force of the medial side of the knee so conservation of superficial MCL is considered to be critical to maintaining joint stability. Several techniques for soft tissue balancing in the varus knee have been described. They generally include the release of the superficial medial collateral ligament distally on the tibia described by Insall and popularized by Whiteside. Others have

described an osteotomy of the medial collateral ligament insertion on the femur, pie-crusting of superficial MCL, and tibial reduction osteotomy [3,5-8].

Lack of mediolateral symmetry in the flexion or extension gaps or both may lead to instability, poor function, and wear. The immediate consequences of poor ligament balance differ depending on the implantation technique. If the measured resection technique is used poor ligament balance can lead to asymmetric medial and lateral condylar liftoff. If the balanced gap technique is used, the ligament balance in flexion will influence on the rotation of the femoral component. [9,10].

Incorrect gap balancing can lead to aggressive polyethylene wear, which could be a cause of early failure after TKA; thus, osteophyte removal, medial (MCL) release, posterior capsular release, semimembranosus release, and posterior oblique ligament (POL) release have been performed traditionally. Although most varus knees can be managed with these procedures, precise gap balancing using traditional techniques is still challenging, especially for moderate to severe varus deformities, because over the release of the superficial MCL may occur, resulting in catastrophic instability [11,12].

There are many surgical techniques for ligament balancing in TKA and many different devices designed to assist in ligament balancing. These include spacers, tensors, electronic instruments, and computer navigation. Gap balance in TKA is determined almost exclusively by the subjectivity of each surgeon. At least 20% of early revision was related to postoperative instability [1,13-15].

Our study aimed to test the hypothesis that adequate soft-tissue balance can be achieved in primary TKA in patients with varus deformity 15 degrees or more without releasing the superficial MCL.

Patients and methods:

Between Mars 2017 and June 2018, 41 TKA was done in 36 patients at our Mansoura university hospital. All patients were female with a mean age of 59.1 years (range, 51 to 64 years). The inclusion criteria were patients with knee osteoarthritis indicated for primary TKA with varus deformity 15 degrees or more. In this study, the deformity ranged from 15 to 25 degrees varus and from 5 to 15 degrees flexion deformity. The exclusion criteria were rheumatoid arthritis, valgus knee, bony defect requiring bone graft or metal augments, previous knee surgery, extra-articular deformity requiring osteotomy, and severe preoperative ligament instability that needed to be constrained TKA. All surgeries were performed by the same surgeon. Fixed-bearing, posterior stabilized implants were used in all patients. Thorough preoperative clinical and radiographic assessments were done including a full-length, weight-bearing, hip-knee-ankle radiograph. Full-length radiographs will identify extraarticular deformities of the femoral or tibial shaft which would otherwise be missed on a short anteroposterior radiograph of the knee. Furthermore, short films may underestimate the degree or severity of the deformity.

Surgical technique

All the cases were done under spinal anesthesia and a tourniquet was used. All knees were operated through a standard midline incision and a medial parapatellar arthrotomy. The posterior cruciate was sacrificed in all knees. The medial osteophytes of the femur and tibia are removed in all knees. Next, femoral and proximal tibial resections were performed and posterior osteophytes were removed after completion of femoral cuts, measured resection technique which involves resecting the amount of bone from the distal and posterior femur and the proximal tibia that will be replaced by the prosthetic components was used in all patients. The valgus angle of the femoral component was set as measured on preoperative standing hip–knee–ankle radiograph as the angle between the mechanical and anatomical axis of the femur. The femoral component rotation was established by combining information from the Whiteside's line, the transepicondylar axis, and the posterior condylar axis.

The soft tissue releasing procedure was divided into 4 steps as follow:

1- Removing medial osteophytes of the tibia and femur with a rongeur. This procedure permits to a reduction of the bowstring effect on the medial collateral ligament and opens the gap medially reducing the deformity.
2- Deep medial collateral ligament release 3 to 6 mm below the medial joint line paying attention to avoid release of the superficial medial collateral ligament which is attached more distally.
3- Excising of scarred tissue in the posteromedial corner and release the posteromedial capsule.
4- Releasing the semimembranous insertion.

After complete bone resection and osteophytes removal, preliminary gap assessment was done using a gap spacer block. Both flexion-extension gap balance and mediolateral gap differences are

evaluated with the spacer block inserted into the flexion and extension gaps. The flexion and extension gaps were considered as balanced when the mediolateral gap difference was 1 to 3 mm and the difference between the flexion and extension gaps ≤ 3 mm under manual stress. . When the gaps are balanced at this step there was no need to carry on the other steps; And if there was relative medial tightness compared to the lateral gap, further step by step medial soft tissue release in the same order described above was performed until mediolateral flexion and extension gaps are balanced.

The clinical outcome including the mediolateral stability was evaluated according to the Knee Society Rating System [KSS]. All patients were evaluated preoperatively and at 3 months, 6 months, and 12 months postoperative [16].

Results

Our study included 41 total knee arthroplasty in 36 patients. The varus deformity ranged from 15 to 25 degrees (mean 19.9 degrees), with 13 knees (31.7%) > 20 degrees. All cases had flexion deformity ranged from 5 to 15 degrees (mean 7.5 degrees).

In our study 38 knees (92.7 %) was balanced without superficial medial collateral ligament release (mediolateral gap difference was ≤ 3 mm, the difference between the flexion and extension gaps ≤ 3 mm) as follows (fig 1 &2):

1- In 6 knees, the first 2 steps were done (removing osteophytes, deep medial collateral ligament release).
2- 22 knees were balanced with the first 3 steps (removing osteophytes, deep medial collateral ligament release, and release the posteromedial capsule).
3- 10 knees needed the 4th step (semimembranous insertion) in addition to the first 3 steps.

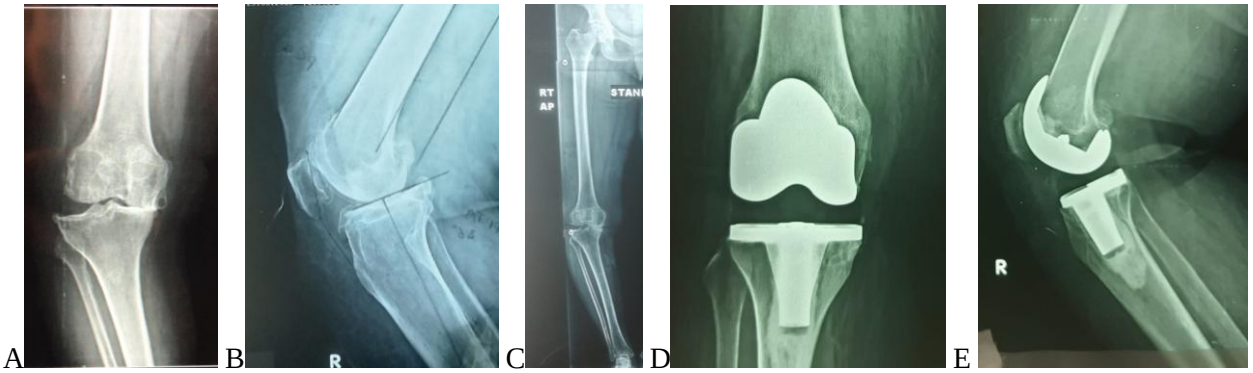

Figure 1(A-E): preoperative and 1 year follow up X-ray of a female patient with 20° varus and 10° flexion deformity, gap balance achieved with the 4 steps of release and no release of superficial MCL

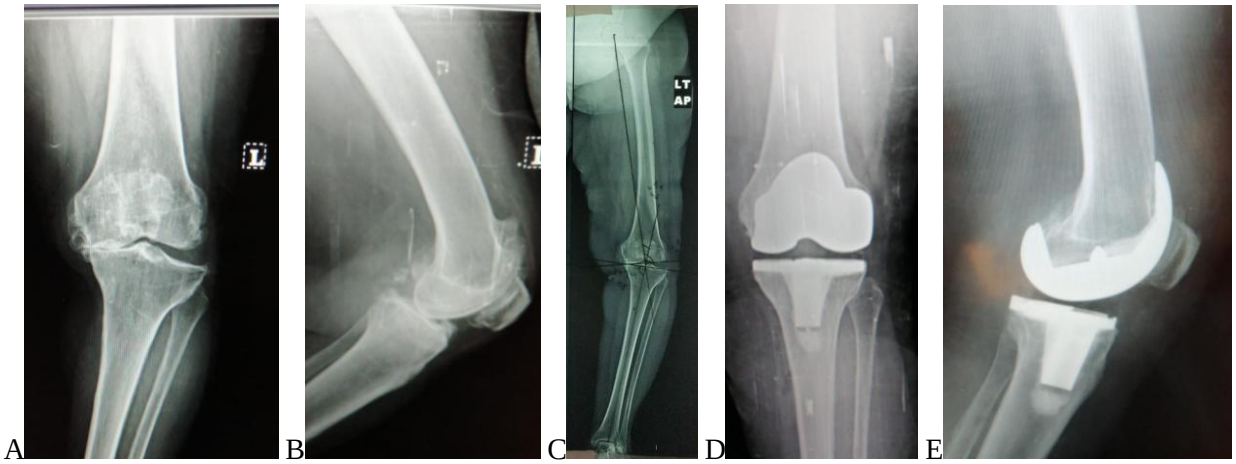

Figure 2(A-E): preoperative and 1 year follow up X-ray female patient, 15° varus and 10 ° flexion deformity, gap balance achieved with the first 3 steps of release and no release of superficial MCL

The tibial insert used ranged from 9 to 14 mm (9 mm in 6 knees, 10 mm in 23 knees, 12 mm in 6 knees, and 14 mm in 3 knees).

We had 3 knees (7.3 %) needed additional release of the superficial medial collateral ligament. After the 4 steps of release was done we tested mediolateral balance with gap spacer block (up to size 14 mm), we had residual lateral laxity more than 5 mm so we had to balance the 3 knees with the release of the superficial medial collateral ligament and insert 17 mm was used in the 3 knees.

The preoperative KSS knee score was poor in all cases and improved to excellent in 31 knees (75.6 %) and good in 10 knees (24.4%) at 1-year follow-up. The preoperative KSS function score was poor in all cases and improved to excellent in 26 knees (63.4%) and good in 15 knees (36.6%) at 1 year follow up.

The main preoperative knee flexion was 92.8 degrees (range, 75 to 120) and improved at 1 year follow up to 113.2 (range, 100 to 130). The post-operative alignment ranged from 5 to 9 degrees of valgus with no cases of postoperative malalignment. We did not have knee instability or flexion deformity in any case.

One knee had acute postoperative infection managed by debridement and insert change with no further complications and in 1 knee intraoperative partial avulsion of the femoral attachment of superficial MCL occurred. This knee was osteoporotic and after the 4 steps of release and trial with 14 mm gap spacer, the medial gap was good but the lateral gap was lax by more than 5 mm so we tried 17 mm spacer and the medial gap was so tight and partial avulsion occurred. We managed the avulsion and release of the superficial MCL were done.

Discussion

Varus osteoarthritis of the knee is the most common indication for TKA, which is accompanied by contracture of the medial soft tissue structures. Correction of a varus deformity using adequate soft tissue release is essential to knee stability and clinical outcome [17].

The medial release should be performed sequentially depending on the degree of varus deformity. The anatomical structures released in a tight medial gap include the deep MCL, superficial MCL, posterior oblique ligament, posterior medial capsule, semimembranosus, and pes anserinus [5,18].

The stability of the knee is a complex issue and involves ligaments that behave differently on the medial and lateral side. Correct positioning of the components and adequate soft tissue balancing are critical steps in successful TKA. Insufficient soft tissue release is usually associated with tight TKA and may cause a limited range of motion, pain, and compromise patient satisfaction while over release may produce a TKA that is unstable. Mediolateral instability is the most common type of instability and may result from incompetent collateral ligaments especially over release the superficial MCL, incomplete correction of a preoperative deformity, or incorrect bone cuts. Instability is a leading cause of early clinical failure of a primary TKA (21% to 29%), resulting in revision within the first three to five years [8,19-21].

Rectangular gaps are difficult to achieve in TKA. A mediolateral difference of ≤1 mm only achieved in 47% to 57% of TKAs. Slightly greater laxity in the lateral than medial side may be acceptable, even normal knees have unbalanced soft tissue tension. In severely deformed knees, equality of the flexion and extension gaps is more difficult to obtain. The difference between the flexion and extension gaps should not exceed 3 mm [22-24].

Superficial MCL is considered to be critical to maintaining the joint stability and releasing or pie crusting may end with instability and the use of constrained prosthesis. Verdonk et al. reported that pie crusting of the superficial MCL in varus knees was safe and effective, however, Min Woo et al. in their practice founded that it was difficult to control the depth and size of each puncture of the pie crusting with a knife blade and experienced some cases of over release with the pie crusting [8,20].

Meneghini et al. [25] in their cadaver study was comparing the superficial MCL pie crusting technique using a size 15 blade and the traditional technique which elevates anterior fibers of the superficial MCL subperiosteally and found that the pie crusting group caused a characteristic to stair-step failure mode at the joint line whereas the traditional technique group failed elastically at the tibial insertion.

Our study included 41 TKA with varus deformity ranged from 15 to 25 degrees and from 5 to 15 degrees flexion deformity. We follow a sequential soft-tissue releasing procedure consisting of 4 steps to balance the knee (removing medial osteophytes as a first step, 2nd step deep MCL release, 3rd step excising of scarred tissue in the posteromedial corner and release the posteromedial capsule and 4th step releasing the semimembranous insertion.

Thirty-eight knees (92.7 %) were balanced in our study without superficial MCL release with 6

knees needed the first 2 steps, 22 knees needed the first 3 steps and 10 knees needed the 4 steps. Three knees (7.3 %) needed additional procedures to achieve a balanced mediolateral gap. The 3 knees had residual lateral laxity more than 5 mm so we had to balance the 3 knees by releasing the superficial MCL.

The tibial insert used in our study ranged from 9 to 14 mm in knees without the superficial MCL release. The maximum insert we could use without superficial MCL was 14 mm. We had 3 knees with residual lateral laxity with insert 14 and we tried to use 17 mm but the medial gap was too tight (in 1 of the 3 knees partial femoral avulsion of superficial MCL occurred) so we had to release the superficial MCL in the 3 cases.

Mina et al. [26] in their study concluded that correcting severe varus deformities with extensive medial soft tissue release largely did not alter knee kinematics or clinical outcome scores compared to those with minimal soft tissue release with a minimum of 1 year follow up.

Tadashi and Yoshikazu [27] in their study of 28 knees and 9.7 months follow up founded that spontaneous soft tissue correction occurs after TKA. They concluded that surgeons don't need to perform the medial soft tissue release until the soft tissue tension is equalized on both the medial and lateral sides which has the risk of excessive release leading to instability. In situations where the surgeon is confronted with a knee that becomes too tight or too loose depending on the insert thickness, it is recommended to choose the thicker insert with the understanding that the knee will initially have a slightly tighter medial compartment that will loosen over time.

In this study, we aimed to achieve adequate soft tissue balance in primary TKA in patients with varus deformity 15 degrees or more without releasing the superficial MCL. We achieved adequate soft tissue balance in more than 90 % of knees and with no cases of instability or malalignment at follow up. Our study has some limitations as manual stress testing was performed to assess mediolateral laxity and, despite all knees having been performed by the same surgeon, some degree of variability in the forces exerted during testing can not be excluded.

Conclusion

Most TKA with varus deformity 15 degrees or more can be balanced without superficial MCL release but this should not be at the expense of residual lateral laxity as adequate soft tissue balancing and deformity correction are mandatory to obtain good outcomes.

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