Correction of moderate to severe varus deformity in osteoarthritic knee during total knee replacement using soft tissue release technique

Mahmoud Abd Allah Zayed; Mahmoud Mabrouk Said; Yasser Ali Elbatrawy; Abd Elhamid Abd Elaziz Attallah; Yaser Elsayed Hassan and Ibrahim Mohamed Ibrahim

Department of Orthopaedic Surgery, Faculty of Medicine for Girls, Al-Azhar University, Egypt.
drhimo80@yahoo.com

Abstract: In the period between junuary, 2013 and september, 2016, this study was conducted on 20 patients with 23 knees who underwent primary total knee arthroplasty due to varus osteoarthritis with tibio- femoral angle 10˚ or more. The group of patients included 8 males (40%) and 12 (60%) females with mean age at the time of surgery of (59.39) years old (range from 55 to 75 years), 8 patients had the right knee replaced, 9 patients had the left one, while 3 patients had bilateral total knee replacement, all prostheses used in this study were cemented, fixed bearing and posterior stabilized. The average knee society score improved from (10.17) preoperatively to (86.52) postoperatively and improvement of the functional knee score from (24.35) preoperatively to (73.26) postoperatively.

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Key words: Varus deformity**,** knee**,** osteophyte, Tibio- femoral angle.

1. Introduction

Varus deformity of the knee is the most common deformities encountered during total knee replacement, usually there is associated erosion of medial tibial platue, osteophyte formation, and contractures structures, also flexion contracture may coexist, due to contracture of both posterior capsule and posterior cruciate ligament[7].

Successful, durable knee arthroplasty depends partially on achieving proper limb alignment through soft tissue releases aiming at balancing the collateral ligaments, femoral component should be 7 ± 2 degrees of valgus angulation, whereas tibial component should be 90 ± 2 degrees relative to the longitudinal axis of the tibia. [7]

Inproper alignment is associated with medially overloaded components which may result in failure of implant through early component loosening or accelerated wear.[2]

2. Patient and Methods

This study took place between January 2013 and january 2016 in Al Zahraa University hospital, during this period we operated up on (23) knees in (20) patients, (8) were males and (12) were females, all patients had severe knee osteoarthritis associated with varus deformity of 15 degree or more (tibiofemoral angle 10 degree of varus) as measured on weight-bearing films using (surgimap program). The Knee Society clinical and function scores were documented for all cases preopratively., mean age (59.39) years range from (55 to 75) years old, 8 patients had the right knee replaced, 9 patients had the left one, while 3 patents had bilateral total knee replacement.

The mean tibiofemoral varus was (15.57°) (range from 10° to 30° varus). Table () shows the distribution of the angular deformity in the coronal plane. The deformity was essentially intra-articular.

Twenty two knees (86.96 %) had moderate deformity (10˚-20˚) while three knees (13.04%) had severe deformity (more than 20˚). Therteen knees had flexion deformity, seven knees had mild flexion deformity (less than 15˚) while 6 knees had moderate flexion deformity (15˚-30˚).

Inclusions criteria: patients with primary knee osteoarthritis associated with varus deformity in whom tbiofemoral angle equal 10 degree varus or more.

Exclusion criteria: osteoarthritis associated with valgus deformity, secondary osteoarthritis or post infection. All knees were replaced with cemented fixed bearing, posterior stabilized prosthesis, the patella was not resurfaced in any case.

We are aiming to evaluate efficacy of soft tissue release in restoring mechanical axis and component alignment, and the effect of that on clinical improvement of the patient using the knee society score system and knee function score this study is short term study depends on post operative radiographic parameters, every patient was informed about the surgery and a signed consent was received.

Table (1) Tibio- femoral angle

Tibio- femoral angle	No.	%	Flexion deformity	No.	%
Moderate varus	20	86.96	No	11	47.8
Severe varus	3	13.04	Mild	7	30.4
Total	23	100.00	Moderate	5	21.7

Surgical Technique

After loint arthrotomy the medial side of the knee was entered by subperiosteal dissection of medial capsule and deep meadial collateral ligament (MCL) up to the posteromedial corner of the tibia according to the severity of the case. Fat pad was removed from under surface of the patellar ligament and the patella was everted and retracted laterally by curved Homman retractor. Distal femor was cut at 6 degrees valgus in all cases through intramedullary femoral guide, we cut about 9 mm of distal femur our refrence was the lateral femoral condyle, but in 2 cases we cut 2mm more from the distal femur to increase extension gap to correct the flexion deformity.

Sizing of the distal femur was done, depending on the posterior condyles as a reference guides, also we consider the trans-epicondylar axis and the whiteside line as a refrence lines because in cases with high degrees of varus, femoral condyles may be hypoplastic or torn out. In two cases there were cavitary condylar deficiency in distal femur that was managed by morcelized bone grafting taken from the osteotomizd pieces without fixation.

To make the tibial cut perpendicular to the mechanical axis of the tibia, we used an extramedullary guide projecting from the tibial cutting jig and adjusted to point to 2nd metatarsal parallel to the chin of the tibia. Combined intramedullary and extramedullary guide were used in one case with severe deformity.

Tibial trey was adjusted to rest on the cortical bone avoiding hanging, making the centre of the anterior aspect of the tibial trey at the junction between medial one third and lateral two thirds of the tibial tuberosity. It is acommonly to find tibial defect in cases with varus deformity the defect in medial tibial platue was managed according to the size of the defect.

- No reconstruction: when the defect disappear by tibial cut or in defects < 5 ml which was filled with cement after making many small drill holes in the floor of the defect to make good anchorage, done in 11 cases.
- bone grafting: in defects 5- 10 mm (done in 3 cases), we prepared the tibial plateau including the defect then make drilling of the sclerotic surface of the defect, the graft was taken from femoral cuts, we did reshaping of the graft to fit the defect, then we impacted the graft in the defect and fixation by short threaded 4mm cancellous screw. In all the cases the graft has shown complete incorporation at 9 to 12 months postoperatively.

After those trials was done to check alignment and to assess flexion and extension and the extent of medial contracture subsequently the degree of soft tissue release.

Medial release:

- Medial osteophytectomy, coronary ligament release, deep medial collateral and PCL removal were done routinely in all the cases.
- Superficial medial collateral ligament: in all the cases with different degrees according to the severity of the varus deformity using osteotome to form subperiosteal flap to permit later healing.
- Postero-medial capsule: Using curved periosteal elevator, done in 2 cases.
- Semimembranouses release: the knee was flexed 30 degrees and externally rotated the the semimembranouses was released by cautery done in 14 case.

Management of associated flexion deformity:

The PCL was already sacrificed in all cases in the study, in cases with mild flexion deformity, release of the posterior capsule and removal of osteophytes were done. In two case with moderate flexion deformity, we increased extension gap by cut 2mm more from the distal femur and

Patella:

Patella was prepared by removal of osteophytes, we did not use patellar resurfacing, patellar tracking was assessed using no thumb technique before and after release of the tourniquet patellar maltracking was present in two case and partial lateral release was done.

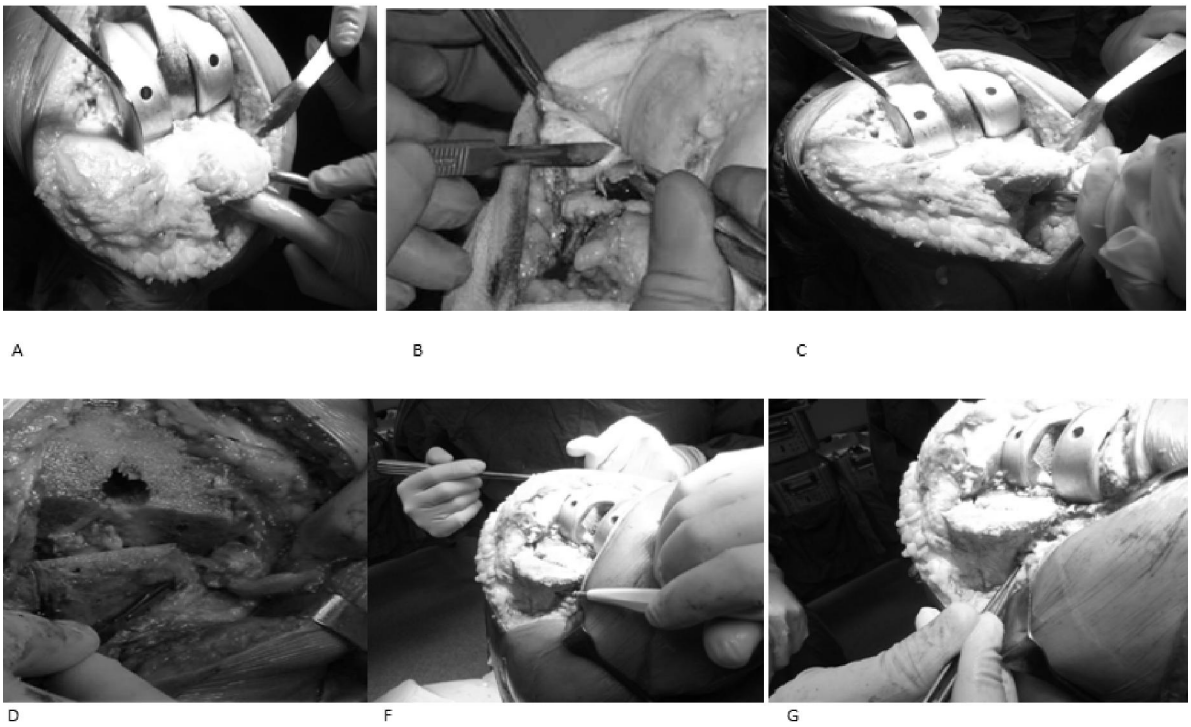


Fig.(1): A osteophyte removal, B deep medial collateral release, C superficial medial collateral release, d & f semimembranosus release, G posteromedial corner release

Postoperative care:

Patient's recieved prophylactic dose of low molecular weight heparin subcutaneously 12hours postoperativelty and then every 24 hours, intravenous antibiotic every 12hours for 10 days. The patients started static quadriceps and hamstring exercises, straight leg raising, flexion and extension from day one. Walking with walker in the second postoperative day or 6 weeks later if bone grafting was used.

Follow up:

Follow up of patients clinically according to items of the knee society score and radiologically for assessment of limb alignment, component position, radiolucent lines and signs of infection patients at 6 weeks, 3 months, and 6 months.

[A]Clinical results:

(1) Knee society score:

At last follow up, there was highly statistically significant improvement the average knee society score was (86.52) (range from 75 to 96) compared with average preoperative KSS of (10.17) (range from 0 to 29), Fifteen (65.2%) knees had excellent results (85 to 100 points), eight (34.8%) had good results (70 to 84 points), no knees had fair results (range 60 to 69 points) or poor results (<60 points).

(2) Knee function score:

The average knee function score was (73.26) range from (55 to 90) compared with average preoperative knee function score of (24.35) range from (zero to 45) which is highly statistically significant, two knees (6.25%) had excellent results (85 to 100 points), fifteen knees (65.21%) had good results (70 to 84 points), three knees (13.04%) had fair results (range 60 to 69 points) and three knees (13.04%) had poor result (less than 60).

Table (2)

Knee society score	Mean±SD	Mean Diff.	t-test	p-value	Knee function score	Mean±SD	Mean Diff.	t-test	p-value
Pre-oprative	10.17±8.07	76.35	37.32	**<0.001**	Pre	24.35±19.09	48.91	10.82	**<0.001**
Post-oprative	86.52±5.58				Post	73.26±10.29			

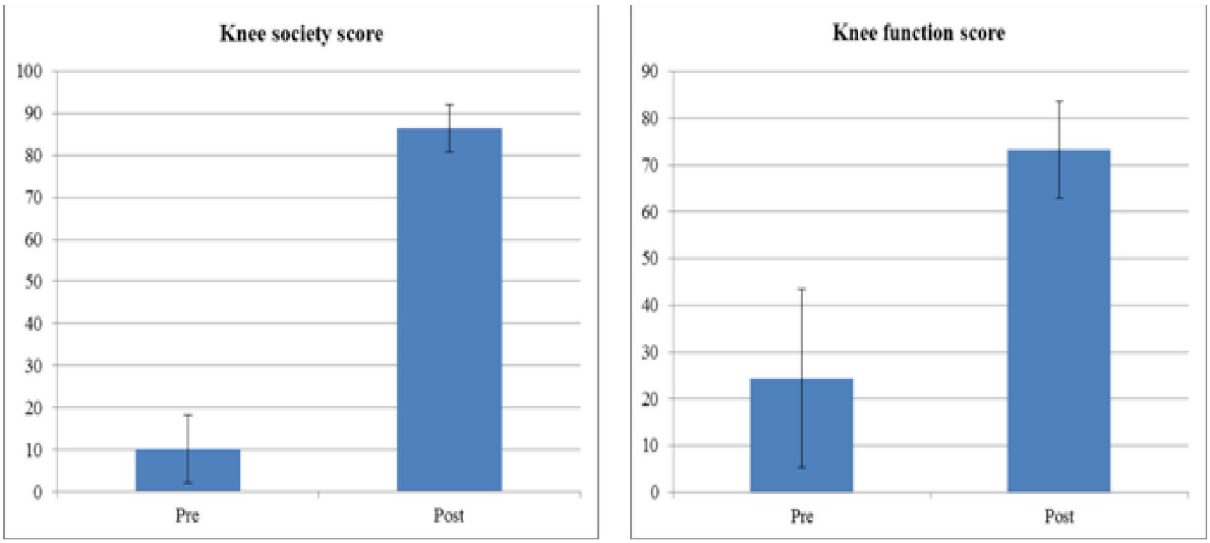


Figure (2)

[B] Radiological results:

Standing anterposterior and lateral views were done directly in the second day postoperatively and long standing films were done six weeks postoperatively, we collected digital photos of these X-rays and we measured it by computer soft ware (surgi map).

The average post operative tibio-femoral valgus angle was (3.87°) valgus (range from 0° to 7° valgus), compared with average pre-operative tibio-femoral varus angle of (15.57°) (range from 10° to 30° varus). As regards Post operative lateral ligament laxity Post operative one knee (4.3%) had mild Lateral laxity (6-9º medial opening), in comparison to the pre-operative, 8 knees (34.8%) had mild lateral laxity, and 12 knees (52.2%) had moderate lateral laxity while 3 knees (13%) had severe lateral laxity.

Although there was no statistically difference in the mean KSS and FKSS post operatively between degree of varus deformity, the patients with moderate varus deformity (10°- 20°) showed improvement in the mean scores than the patients with severe deformity (Negative correlation by Pearson correlation coefficient test). On other hand there was statistically difference in the mean KSS and FKSS post operatively between degrees of varus correction, patient with more valgus had better score in KSS and FKSS, significant positive correlation.

The mean proximal medial femoral (α) angle was 95.91° (range between 93-97°), the Mean proximal medial tibial (β) angle was 86.78° (ranges from 84-90°), the mean posterior tibial slope (σ) angle was 84.61°range from (1 to 9°).

[C] Complications:

Inflamed stitches in two cases (8.69%) treated with antibiotic and local antiseptic solution, Intra operative patellar mal tracking corrected intra operative by lateral release.

4. Discussion

Knee varus deformity is the commonest deformity facining surgeons during total knee arthroplasty, uncorrected varus deformity may compromise the outcome of the joint replacement.[1] Obtaining a well positioned and stable prosthesis with restoration mechanical axes of the limb and joint line have an important effect on the final outcome of knee replacement. Proper soft tissue balancing during TKA is the corner stone in the mechanical balance of the knee joint and medial soft tissue contracture must be corrected by surgeons.[6]

The aim of the this study is to evaluate patients with moderat to severe varus osteoarthritis, their pre-operative planning, methods for bony and soft tissue reconstruction and the final outcome of the replacement in these patients. In the present study, 20 patients with 23 knees with primary varus osteoarthritis with a mean preoperative anatomical tibio-femoral angle of 15.57º varus (range from range from 10 to 30º varus). Twenty knees (86.96%) had moderate deformity of (10˚ - 20˚) while three knees (13.04%) had severe deformity of (more than 20˚).

There were (12) knees with flexion deformity, (7) knees had mild flexion deformity (less than 15˚) while 5 knees had moderate flexion deformity (15˚ - 30˚). All knees were replaced by fixed bearing, posterior stabilized prosthesis.

Mullaji et al[5] evaluated 173 knees in 117 patients with varus deformity of more than 20º with a

mean preoperative anatomic tibio-femoral angle of 22.7º (range from 15º to 62º). The diagnosis was primary osteoarthritis in 155 knees (as in the current study) and rheumatoid arthritis in 18 knees (rheumatoid excluded In current study knees.

Teeny et al[8] compared 27 knees (20 patients) with a mean tibio-femoral angle 25º (range 20 º -38 º) pre-operatively to a non deformed group with varus less than 5 ˚ in 40 knees (31) patients. The primary diagnosis was osteoarthritis in 17 knees (as in the current study), rheumatoid arthritis in 2 knees and one case with post avascular necrosis arthritis (not matched to the present study).

Laskin [4] evaluated 161 knees with a mean tibiofemoral angle 18 º (range 15º - 34 º). In this study we used autogenous bone graft fixed by screws, this technique was used in 3 cases in with medial tibial defect 5-10mm. complete incorporation and healing of the graft was noticed after 9 to 12 months. The remaining tibial defect after cut of less than 5 millimeter was filled by bone cement only without screw after drilling of the sclerosed surface.

After removal of sclerotic and avascular bone from the floor and side wall of the defect, autologus resected bone from femoral condyles is prepared by removal of the covering artcular cartilage using cutting saw, then it is fashioned to fit the defect then temporary k-wires is used to held the graft till fixation by cancellous screw. The femoral bone defect met in this study all were contained defects in the femoral condyle and were treated by morcelizd bone graft taken from tibial or femoral cuts.

Mullaji et al [5] managed bone defects in the same way as in the present study but he made the horizontal floor of the defects gently sloping downwards to the lateral side to lock the graft in its place, so that when the tibial component was placed on it, the sloping floor ensures that the graft is locked in place, that made him not in need for fixation of the graft in 20 knees out of 30 knees needed reconstruction. In eight knees k-wires were used to secure graft, in 1 knee they used a cancellous screw as in current study. On the other hand only one case used metal augment to reconstruct the more deep tibial defect. Graft incorporation was seen in 28 of the 30 knees. In 2 cases there was incomplete correction of the varus deformity. In comparison to the current study 3 cases in which bone graft was used complete incorporation was seen which better result but it may be because the study of Mullaji et al[5] included much more number of cases that needed bone grafting, also we did not meet tibial defect of more than 10 millimeter that may need metal augment.

The challenge of total knee arthroplasty in varus deformities is obtaining soft tissue stability and ligamentous balance to obtain good bony alignment. Numerous methods for varus correction have been described either soft tissue or bony procedures.

We used the sequential medial release in all cases, we also sacrificed the PCL in all the cases because the PCL was a major deforming force that tethers the soft tissue preventing balancing of the gaps especially if accompanied by flexion deformity. After initial dissection of the soft tissues along the medial joint line, including the deep medial collateral ligament, osteophytes were removed from the medial distal femur and proximal tibia, then proximal tibial cut was done. Tensioning stress examination of joint space was performed to assess obtained space. If still unequal rectangular space found, then further subperiosteal release of the medial and posteromedial soft tissues of proximal tibia including release of the superficial medial collateral ligament were done. When flexion contracture was present, release of the semimmembranosis and posteromedial capsule was done.

The procedure in this study was similar to teeny et al in the sequential progressive release but in the study of Tenny et al [8] the PCL was sacrificed in less than half of their study and they occasionally, released pes tendons. In two cases they had to do lateral collateral ligament advancement, in one case this was done by resection of a segment of proximal fibula and then reattaching the fibular head by means of intramedullary screw, thereby tightening of the ligament. In the other case, the origin of the lateral collateral ligament was advanced proximally on the distal femur. In the present study we do believe that PCL has a major tethering force so that it should be sacrificed in all cases with high degrees of varus especially if associated with flexion contracture, lack of this concept in Tenny et al [8] may be the cause that made them in need for attacking the lateral side to correct the deformity, correcting residual varus by either lateral ligament advancement or fibular osteotomy add more time to the operation and make it susceptible for more complications.

Insall et al [3] followed the same technique in the medial release as followed in the current study but they recommended complete correction of the deformity before completing final bone cuts. They firist undergo dissection around the medial and posterior aspect of the tibia to provide exposure, then making a high initial tibial cut and then the usual distal femoral cut, this technique in their adoption facilitates evaluation of the geometry of the flexion and extension gaps. Further soft tissue balancing can then be completed, and a lower tibial cut be made if necessary. On the other hand they used to excise the PCL and use PCL sudstituting prosthesis from the start as preferred to be done in this study.

In contrary to that we do believe that making osteotomy initially after development of medial subperiosteal sleeve then soft tissue release to obtain equal reqtangular gaps is effective and time saving.

Laskin[4] evaluated a group of patients with varus contracture of at least 15˚ underwent TKR with retention of the PCL (not matched with our procedure). Their results were compared with a group of patients with similar contractures in whom a posterior stabilized implant was used (matched with our procedure) and to another group with no contracture (not matched with our procedure). They found an increased incidence of pain, an increased incidence of bone cement radiolucencies, and a decrease in flexion rang subsequently an increased revision rate and a decreased survivorship among the firist group. Based on that they concluded that in patients with contractures, the posterior cruciate ligament is a part of the deformity and it should be released and a posterior stabilized type of implant should be used.

In our study, all the patients received a posterior stabilized prosthesis as the contracture group in which PCL was sacrificed by Lsakin et al[4], so that we avoided the prpbablity of complications which happened in the deforme non-sacrificed group. So that there were no increased incidence of pain, no incidence of bone cement radiolucencies, and no decrease in the eventual flexion range, however long term follow up of patient is needed to confirm this results.

Mullaji et al[5] when they sub-periosteally strip the superficial MCL from the upper surface of the tibia for correction of rigid varus, they found this maneuver difficult to titrate and liable for over release that leads to excess medial laxity. They had over release in two cases which were treated by suturing the medial collateral ligament to the pes insertion and had protected the repair in a cylindrical cast. so that they adobt preservation of the continuity of the superficial MCL by reduction osteotomy of proximal tibia. If there was medial tightness in extension, the smallest tibial tray that was compatible with the selected femoral component was placed as lateral as possible with even overhanging 1mm. this allowed additional bone to be resected from the medial proximal tibia thus indirect release occurs on the MCL by relieving the tenting over the flare of tibia.

In current study sequential release of the medial structures was done including stripping the superficial MCL and in every step of release the gaps were checked to avoid over release. The medial soft tissue sleeve was preserved and none of the 23 knees developed significant laxity post operatively, this technique is better than reduction osteotomy done by Mullaji et al[5] as conservative bone cuts were done preserving proximal tibial bone stock and so decrease stresses per unt surface area, this is supposed to decrease loosening complications later on.

In the current study, the average post operative tibiofemoral valgus angle was 3.87 degrees valgus (range from zero to 7 valgus), compared with average pre-operative tibio-femoral valgus angle of 15.57˚ varus (range from 10 to 27 varus). This resuls are comparable to results by Tenny et al[8] studied 27 knees with a mean tibio-femoral angle 25º (range 20º - 38º) pre-operatively. Postoperatively the mean angle was 4˚ (range 2˚-8˚).

Compared to the study of Mullaji et al[5] (who studied 173 knees with mean tibio-femoral varus angle preoperatively 22.7˚ (range 15˚- 62˚ varus). The tibio-femoral angle in their study was restored to a mean of 5.3˚ (range 2˚-10˚). One hundred forty eight knees had a valgus angle between 4˚ and 10˚ and 25 cases (14%) had a valgus angle less than 5˚), our results were slightly inferior in correction of varus deformity but with the advantage of preservation of bone stock.

Laskin[4] evaluated 161 knees with a mean tibio-femoral angle 18º (range 15º - 34 º). The mean postoperative tibio-femoral angle was 6˚, this result was superior to our result, this might be because the study of Laskin[4] included patients with no varus deformity at all.

Whatever patients get improvement from the operation by relief of pain, restoration of knee alignment, improvement of knee motion, and elimination of knee flexion contractures. The present study showed the benefit from total knee arthroplasty for the treatment of varus deformities with marked increase in the knee society score and functional knee score.

As regarding the knee society score, the mean KSS was (86.52) compared to (10.7) preoperative, there were twenty knees (86.9) knees had excellent results, three knees (13.1) had good results and neither knees had fair results nor poor results.

Also the functional scores showed marked improvement in relation to pre operative function, the mean KFS was improved from (24.35) preoperative to (73.26) post operative, two (6.25%) knees had excellent results, fifteen knees (65.21%) had good results, three knees (13.04%) had fair results and three knees (13.04%) had poor result.

Mullaji et al [5] reported in their series improvement of the mean knee society score from 22.8 preoperatively to 99.1 postoperatively and the function knee score from 22.8 to 72.1. Their results were coincided with the present study results.

Tenny et al [8]reported that in their study the mean post operative knee society score was 89. Sixteen knees (59%) in the varus deformity group were excellent and 11 knees (41%) good. There were

no fair or poor results. They reported that there is statistical significance in the deformed group compared to the non deformed group as regarding the KSS.

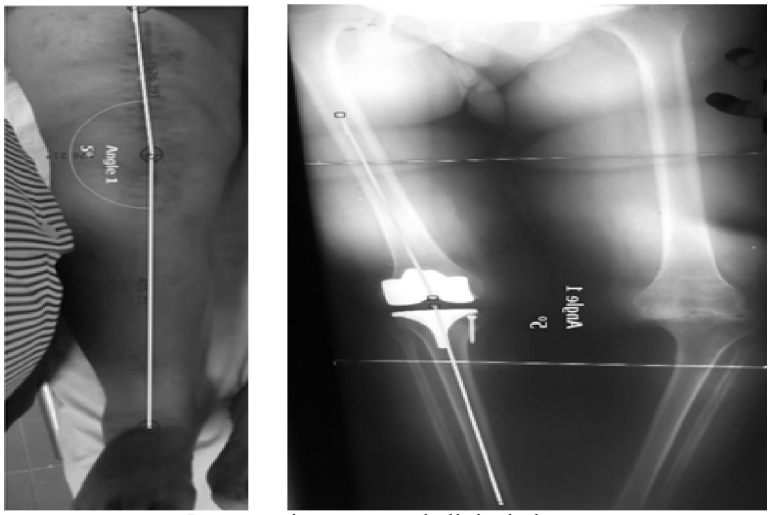
Summary

Well positioned stable prosthesis with restoration of the normal mechanical axes of the limb has an important effect on the final outcome of knee replacement.

Conservative bone cuts and building-up bone defects simplify ligamentous balance and minimize the need for use of more constrained prosthesis. Two options have been proposed to correct ligamentous imbalance, The first is to down size the tibial component and shifting it laterally then making vertical osteotomy for the uncovered medial part of the tibia,. This technique has the drawback of decreasing the weight bearing surface of the tibia thus increasing stresses per unit surface area giving more chance for lossening of the component and increasing wear of polyethelene insert. The other used in this study, is to release the medial soft tissue sleeve in a sequential, titrated manner to provide adequate stability without over releasing.

Knees surgeons can get good results through good pre-operative evaluation, proper planning, measured resection technique from the intact lateral surfaces to preserve bone stock for future revisions and avoiding and sequential titrated medial soft tissue release as a continous sheet to provide adequate stability without over releasing. Also PCL must be released in fixed varus deformity.

Case 1: Preoperative x ray and clinical photo



Preoperative x ray and clinical photo

Table (3)

	Pre-operative	**Post-operative**
Tibio- femoral angle	30º varus	5º valgus
Medio-lateral instability	severe lat laxity	Mild lat laxity
Range of motion	85 degree	115 degree
Flexion deformity	10 degree	Nil
Extension lag	Nil	Nil
Pain score	Zero	50
Stair climbing score	Zero	30
Walking	10	40
Total knee society score	Zero	88
Total function score	5	65

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