

HIGH TIBIAL OSTEOTOMY IN PATIENTS WITH KNEE ARTHROSIS

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SUMMARY

Purpose: To assess medial gonarthrosis treatment with wedge-like side-closed tibial osteotomy combined with proximal tibial-fibular joint release. **Methods:** we employed this technique combined with proximal tibial-fibular joint release in the treatment of medial gonarthrosis in 36 patients (41 knees), from January 1995 to April 2003, with mean age of 53.4 years, followed-up for 51.6 months (in average). **Results:** In the assessment, we noticed that wedge-like side-closed tibial osteotomies allow for a satisfactory repair of the femorotibial deformity, with end

femorotibial angle of about 7° valgus; the mechanical axis was dislocated from the medial region of the tibia (position: 1.2%) to knee center (position: 50.5%); the 9.8° tibial bent at preoperative lateral plane was fixed to 6.5° (mean); joint motion showed 2.3° loss at extension (mean). **Conclusion:** This technique allows for a satisfactory repair of femorotibial varus deformity, but is not free of complications (14.6%). The level of patient satisfaction (Lysholm) grew from 27.3 to 89. Thus it constitutes an essential part of the gonarthrosis treatment arsenal.

Keywords: Osteotomy; Osteoarthritis; Tibia.

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INTRODUCTION

The important incidence of degenerative arthrosis on medial femorotibial compartment of knee joint among the population in the age group of approximately 50 years old has been targeted by a number of studies for therapeutic purposes, having used lower limb's load axis reorientation as a principle in order to decompress the area of the affected knee compartment thus allowing symptoms improvement. Thus, lower limbs realignment aims to better distribute these pressures in order to provide joint cartilage regeneration, with improvement of symptoms and knee joint function, and to enable usual daily life activities consistent to each life style.

Among the several techniques aimed to provide repair of the lower limbs load axis, the proximal tibial osteotomy with lateral closing wedge is often mentioned in literature, which was the selected alternative here for 41 knees diagnosed with medial gonarthrosis, using as a fixation method large-fragment screws and lateral tie with 8-shaped cerclage, combined with proximal tibiofibular joint release after wedge-like resection of the tibial bone. Frequent complications are associated to this technique, with gradual return of deformity and symptoms, back to preoperative deformity, emergence of associated injuries, arthrosis worsening and repair failure, with limited effectiveness of the procedure, among others.

MATERIAL AND METHODS

At the Department of Orthopaedics and Traumatology of Santa Casa de São Paulo's Central Hospital – "Pavilhão Fernandinho Simonsen", between July 1994 and August 2003, 60 patients were submitted to valgusing supratuberosus proximal tibial osteotomy with closing lateral bone wedge⁽¹⁾, fixated with two large spongy fragment screws at the proximal portion and two cortical screws at the distal portion from the osteotomy with washer and 8-shaped single or double tie. Of these 60 patients, 31 medical files were reassessed and included for having the required data and parameters for the evaluation. These included 41 knees (5 bilateral, 18 right knees and 23 left knees), of 22 women and nine men (Table 1). Age ranged from 33 to 68 years old (mean: 54.3), diagnosed with primary or secondary gonarthrosis. The study was approved by the committee on hospital ethics.

Inclusion criteria were the following: primary or secondary gonarthrosis, age preferably lower than 60 years, range of motion degree of knee joint of at least 90°, early stage of arthrosis⁽²⁾, medial femorotibial unicompartamental, preferably without symptomatic femoropatellar joint and hip and ankle joints involvement. The exclusion criteria were the following: involvement of multiple joints, systemic conditions, arthrosis on two or more compartments, Ahlback's medial arthrosis grade-4 or above,

Study conducted at the Department of Orthopaedics and Traumatology, Medical Sciences School, Santa Casa de São Paulo - SP - Brazil (DOT-FCMSSP).

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	Number of Patients (n)	Percent of Patients (%)
Male	14	65.85%
Female	27	34.15%
Total	41	100%

Source: Medical files service, Santa Casa de São Paulo.

Table 1 – Distribution of patients according to gender.

range of motion deficit below 90° or extension restraint above ten degrees. Patients with incomplete medical files have been excluded from the study.

From long panoramic X-ray images of the lower limbs ranging from femoral head to the ankle, with bipodal support, at antero-posterior extension plane, anteroposterior localized plane, and lateral at 30° of flexion and patellar axial, bone deformity was assessed (anatomical and mechanical axis), calculating the resection of a lateral-base bone wedge⁽¹⁾, with the objective of maintaining the lower limb's load axis neutral, associated to hypercorrection at about two to five degrees of valgus, thus dislocating the mechanical axis to approximately 62% at tibial condyle (slightly lateral to the lateral intercondylar protuberance).

Medical files data were retrospectively assessed. Objective criteria such as anteroposterior X-ray images of the femorotibial axis angle at preoperative, early postoperative and current (last evaluation) phases, preoperative and current (last evaluation) mechanical axis, preoperative, early postoperative and current (last evaluation) tibial condyle-shaft surface axis angle, preoperative, early postoperative and current (last evaluation) anatomical axis angle, preoperative and current (last evaluation) X-ray images at lateral plane for assessing posterior tibial joint bending (recurvation), preoperative and current (last evaluation) location (in %) of the load axis pathway at the tibial condyle, and clinical criteria such as personal satisfaction based on preoperative and current (last evaluation) subjective Lysholm scale, comparative preoperative and current (last evaluation) range of motion at the operated side, current (last) evaluation of pain location at joint interline (anterior, medial and lateral), severity (mild, moderate or severe) of current femoropatellar joint crepitation (last evaluation).

By assessing the pre-determined parameters, preoperative femorotibial anatomical axis ranged from 21° of varus to three degrees of valgus (average: 5.5 degrees of varusing), showing an important bone deformity.

Preoperative tibial condyle-shaft axis ranged from 14° of varus to four degrees of valgus (average: six degrees of varus) at anteroposterior X-ray plane and, at lateral plane, the mean preoperative tibial recurvation was ten degrees (two at 17°).

Preoperative mechanical axis angle ranged from 23° of varus to two degrees of valgus (average: 11.5° of varus), with the location percentage of the mechanical axis pathway at preoperative tibial condyle ranging from -44% to 43.3% (average: 1%), considering tibial condyle medial edge as 0% and the lateral edge as 100%.

Patient satisfaction ranged from four to 65 as per preoperative Lysholm scale (average: 27).

Surgical indication consisted on the presence of painful symptoms on knee joint mainly located on the medial joint interline, with the presence of mild or moderate unicompartmental arthrosis according to Ahlback's classification, with no major involvement of the femoropatellar joint and of the knee lateral compartment that could give rise to symptoms.

The surgical procedure consisted of the employment of the previously described osteotomy technique with general or rachimedullary anesthesia, with the patient in horizontal supine position, using a manual tourniquet after compressive blood draining, with an access transverse port being provided on the knee from the posterolateral edge of the anterior tibial tuberosity to the anterior edge of the fibular head, of approximately 5 cm long, isolating the anterolateral tibial bone crest, and with the foot and ankle dorsiflexor musculature partially disinserted distally, leaving the proximal tibiofibular joint, the patellar ligament (lateral and lower portions), and approximately 2cm beneath lateral femorotibial joint interline visible.

The proximal tibiofibular joint was released with the aid of an osteotome, taking care with the fibular nerve on fibular neck, which was isolated and cleared.

Approximately 2.0 cm beneath the joint interline, the tibial bone was proximally cut – parallel to the joint interline – with the aid of an image enhancer, progressing from lateral to medial up to 5 mm of the tibial medial bone cortical, taking care to keep it intact, with the remaining completed with 4.5-mm burr and drill. Then a distal bone cut of the tibial osteotomy was provided, with proximally-oriented oblique position, keeping medial bone cortical intact, then removing the previously planned bone wedge for achieving optimal correction, applying efforts in valgus for closing the space initially occupied by the bone wedge, keeping partial integrity of the medial bone cortical of the tibia and periosteum, thus preserving medial stability (Figure 1). The osteotomy was laterally fixated, with one or two 8-shaped ties anchored on two 32-mm thread, 6.5-mm thick spongy screws with washer, proximally to the bone cut, and two 4.5-mm thick distal corticals with washer (Figure 2). After fixation was provided, intraoperative control X-ray images were taken at anteroposterior and lateral planes, and with the image enhancer at anteroposterior plane, load axis position was assessed from

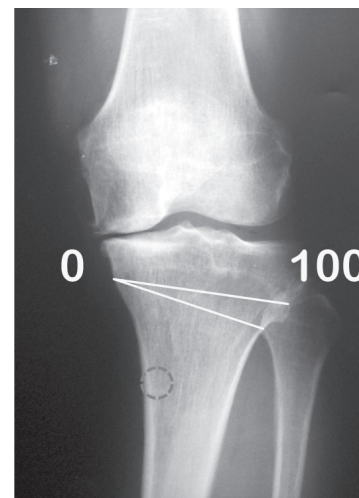


Figure 1 – Preoperative X-ray image at anteroposterior plane showing deformity in varus at the anatomical axis.

the anterosuperior iliac spine to the center of the knee joint optimally between the medial and lateral portion of the lateral condyle (62%) for a correction to be regarded as satisfactory. After X-ray confirmation, the tourniquet was removed and hemostasis was provided, with closing being made by planes and with the dorsiflexor musculature reinsertion into the lateral tibial crest, and inserting the 3.5-mm aspiration drain, which was kept for two days in average, with no postoperative immobilization being required, with restricted load release for approximately six weeks, with the early physical therapy starting upon hospital discharge with careful active and passive mobilization.

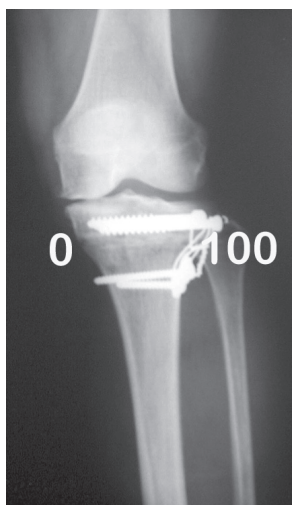


Figure 2 – Postoperative X-ray image at anteroposterior plane showing alignment on the anatomical axis and fixation with screws and “eight-shaped” ties.

RESULTS

In the assessment of the previously mentioned parameters, the early postoperative anatomical femorotibial axis ranged from 0° to 20° of valgus (mean valgus angle: 11.1°) and current 10° varus to 19° valgus (average: 7° valgus) (Table 2).

	Mean
Preoperative	5.5° (varus)
Early Postoperative	11.1° (valgus)
Current	7° (valgus)

Source: Medical files service, Santa Casa de São Paulo

Table 2 – Mean variation of the femorotibial anatomical axis.

The early postoperative condyle surface – tibial shaft axis ranged from 2° varus to 16° valgus (average: 7.19° valgus) and current from 8° varus to 14° valgus (average: 4.1° valgus) (Table 3).

	Mean
Preoperative	6° (varus)
Early Postoperative	7.19° (valgus)
Current	4.1° (valgus)

Source: Medical files service, Santa Casa de São Paulo

Table 3 – Mean variation of the condyle surface – tibial shaft axis

The mechanical axis angle ranged from 11.5° varus preoperatively to 0° postoperatively (last evaluation) (Table 4).

	Mean
Preoperative	11.5° (varus)
Current	0°

Source: Medical files service, Santa Casa de São Paulo

Table 4 – Mean variation of pre- and postoperative mechanical axis angle.

The mechanical axis position (percentage) at tibial plateau ranged from -13% to 98% (average: 51%) in current evaluation with the majority showing arthrosis grades 2 and 3 on medial tibiofemoral compartment at the time of surgery with subtle symptoms on patellofemoral joint (Table 5). It ranged, preoperatively, from 1.21% (medial edge of the knee medial condyle) to 50.56% (center of knee joint) postoperatively.

	Mean
Preoperative	1%
Current	51%

Source: Medical files service, Santa Casa de São Paulo

Table 5 – Position (%) of the mechanical axis passing through condyle-tibia surface.

Concerning joint mobility, we found a range of 90° - 140° flexion (average: 122°), range of -10° - 0° extension (average: -4°) on the operated side on the current evaluation. Flexion range of motion ranged from 120° preoperatively to 122° postoperatively, and extension ranged from -1° to -4° (Table 6).

	Preoperative	Postoperative
Flexion	120°	122°
Extension	-1°	-4°

Source: Medical files service, Santa Casa de São Paulo

Table 6 – Mean variation of joint range of motion at maximum flexion and extension, pre- and postoperatively.

For the current Lysholm scale rate assessment, the scores ranged from 39 to 100 (average: 89), while the preoperative average was 27.3 (Table 7).

Regarding palpable crepitation on the patellofemoral joint during knee range of motion, this was mild in 6 patients (19.35%), moderate in 23 (74.19%) and severe in 2 (6.4%), however, only one patient presented painful clinical symptoms.

	Lysholm scale score
Preoperative	27.3
Current	89

Source: Medical files service, Santa Casa de São Paulo.

Table 7 – Variation of pre- and postoperative satisfaction degrees (Lysholm).

DISCUSSION

The good early outcomes achieved with the use of valgusing tibial proximal osteotomies for treating osteoarthritis cases on knee joint led several orthopaedic surgeons to perform this kind of surgery⁽¹⁾ intending to relieve pain, non-physiological loads and secondary arthrosic degenerative changes of medial femorotibial compartment for correcting deformities in varus. At the same time, pulled ligaments, surrounding soft tissues and capsule are relaxed and load is reduced when the medial compartment is involved, as shown by Ahlback et al.⁽²⁾ We agree with these reports, and, by using the technique of lateral wedge closing, we noticed an improvement of symptoms at the medial knee compartment.

This treatment approach is widely validated by literature⁽³⁾, especially for the outcomes seen on the early phases of therapy, with 77% - 80% good outcomes within up to five years of follow-up. In the present study, we found 73% satisfactory results (Lysholm) after a mean follow-up time of four years (up to eight years and 11 months), which is consistent to literature.

Aglietti et al.⁽⁴⁾ showed good outcomes in 64% of the patients after 10 years of follow-up, with 88% good outcomes for osteotomies with wedge-like lateral closing after four years of follow-up, with proximal tibiofibular joint release, outlining this method as simple, safe and technically accurate with limited surgical approach and low complications rate. We employed this technique with similar results, with a satisfaction rate of 73.1% within 51.6 months of follow-up.

Holden et al.⁽⁵⁾ showed that, after ten years of follow-up, the wedge-like lateral closing osteotomy provided 70% good and excellent outcomes, highlighting the early functional clinical evaluation of the knee (HSS) more than the X-ray arthrosis as a predictor of the disease progression. In our study, all patients, except for one, had a satisfaction rate below 65 points preoperatively (Lysholm), achieving a significant improvement after surgery. Although they are different evaluation methods, the patients had an important improvement, apparently unrelated to their preoperative status.

Some of those studies show that such good outcomes may last for up to ten years or longer^(6,7), and the best outcomes are associated to a subtle hypercorrection, as well as a physiological femorotibial alignment. In our study, we found satisfactory outcomes with Lysholm scores above 84 points (reaching 100) in 13 patients with longer follow-up times. The subtle hypercorrection of the mechanical axis ranges in literature at the tibial lateral condyle from the position 30 up to 50% laterally. In our final evaluation, this is found at the center of knee joint, after a loss of approximately four degrees at femorotibial axis.

Majima et al.⁽⁸⁾ after 10-15 years of follow-up of wedge-like lateral closing osteotomies notice that medial and lateral arthrosis progress, with medial depending on an optimal correction (between 12 and 16° valgus), i.e., it progresses more quickly than in hypercorrected cases. Lateral arthrosis is not correlated with hypercorrection. The procedure acts on biomechanical factors and not on biological factors such as age-related degeneration, with arthrosis not progressing more than two degrees in the classification, with better clinical results in hypercorrected cases.

Billings et al.⁽⁹⁾ in a follow-up time of up to eight years assessing preoperative tibial anteroposterior angle around four degrees

of varus deformity, surgical correction to five degrees of valgus, and four degrees of valgus at follow-up. At the lateral plane (recurvate), it has nine degrees, with a six-degree angle being obtained after wedge-like lateral closing. It shows 1.8° lost anteroposterior femorotibial alignment, with anteroposterior tibial lost alignment of 0.7° contributing to approximately 40% of the final alignment loss. Thus, anteroposterior tibial alignment loss is noticed, as well as a reduced posterior slope after lateral wedge-like closing. In our assessment, we also noticed that loss, of approximately three degrees at anteroposterior and lateral planes. This 3-degree tibial slope loss may have contributed to femorotibial alignment loss of about four degrees in the follow-up.

Takahashi et al.⁽¹⁰⁾ showed the follow-up of 55 high tibial valgusing osteotomies with wedge-like lateral closing, reporting a reduction of the subchondral bone sclerosis at medial femorotibial compartment within up to three years after surgical procedure, maintaining this pattern as long as after seven years of the osteotomy, correlating the best clinical and X-ray outcomes with hypercorrection to 12° on the anatomical axis, evidencing a clinical improvement after the procedure. Koshino et al.⁽⁷⁾ reported 75 knees with mean follow-up time of 19 years in a sample with ages around 59 years. They targeted an anatomical femorotibial angle of 10° valgus, with this initial axis of 6° varus being corrected to 9° valgus in the last evaluation, showing a satisfaction rate of 98%. In the present assessment, we found 73.1% of satisfied patients after 51 months of follow-up, with correction to 7° of anatomical valgus.

Kesmezacar et al.⁽¹¹⁾ report an evaluation of the patellar height in 85 knees after high tibial osteotomy with wedge-like lateral closing, reporting that after 85 months of follow-up in average, a reduction of the patellar height occurs according to three evaluation methods (Insall-Salvati, Blackburne-Peel and Caton), with patella-femur distance parameter being assessed, noticing patellar elevation compared to femur following osteotomy. They show that patellar height is influenced by factors such as tibial slope and anteroposterior translation of the proximal fragment. We didn't assess patellar height, but we believe that it is reduced after osteotomy.

Briem et al.⁽¹²⁾ report the assessment of 16 patients with primary osteoarthritis submitted to valgusing tibial osteotomy with medial wedge-like opening, noticing that, after one year, the best results were associated to 5° mechanical axis hypercorrection, with hypo or hypercorrection being associated to worse clinical outcomes, high adductor moment and osteoarthritis progression.

The use of internal osteosynthesis is described with agraffes⁽¹³⁾, which allows a small but sufficient stability if the medial cortical remains intact. Internal fixation enables a swift return to daily activities, provides more effective correction maintenance, and reduces the prevalence of other complications such as delayed or absence of union. With the use of the internal osteosynthesis with ties and screws we can provide patients with sufficient postoperative stability for an early rehabilitation with muscle and joint structures stimulation, thus avoiding a number of complications resulting from immobilization.

Releasing proximal tibiofibular joint is recommended in literature; however, this can lead to fibular proximal migration, ultimately worsening any previous fibular collateral ligament laxity or causing a new one. In the present case series, we assume

that a contraction of the soft tissues at the lateral portion occurs postoperatively, including the ligaments of the knee joint lateral complex. In the last follow-up visit, 22% of the patients showed presence of effort test in varus, but no clinical complaints of instability. By releasing the proximal tibiofibular joint, the requirement of fibular osteotomy was avoided, thus reducing the incidence of fibular nerve palsy (2.4%).

In the current study, we have made a preoperative plan with bipodal support, since unipodal support can lead to excessive hypercorrection. Correction was provided by targeting hypercorrection to approximately 62% of the lateral femorotibial surface (slightly laterally to the lateral intercondylar protuberance)⁽¹⁴⁾, having achieved a satisfactory outcome in the early alignment, with 11.1° valgus anatomical axis, and about 7° femorotibial valgus in the last evaluation, with 4 degrees lost throughout follow-up, but still satisfactory, with final mean correction of 12.5° over preoperative deformity. The initial mechanical axis at the farthest position of femorotibial joint medial edge (0.6% in average) reflecting a deformity of 11.5° in varus, was corrected and so remained until the last evaluation at position 49.6% of the joint, reflecting zero degree of femorotibial anatomical alignment (center of the knee), after the previously mentioned correction loss, which reflects an effective alignment, consistent to literature reports.

In our postoperative evaluation, 12 (29.2%) knees had a femorotibial alignment inferior to six degrees of valgus, with mean loss of four degrees occurring during the anatomical axis follow-up, with 3 degrees of tibial slope. We don't know why this loss of femorotibial angle in varus occurred in the follow-up.

We found, as previously mentioned, a trend to symptoms recurrence with gradual return after osteotomy, associated to some loss of the correction achieved with surgery, and this may be an important correlated factor.

The amount of optimal valgus correction for femorotibial angle is a controversial topic in literature, ranging from five to 17°^(3,6). In our evaluation, osteotomy was performed targeting subtle hypercorrection. We did not assess cartilage recovery parameters, which we believe should occur after a satisfactory correction. As complications reported in literature, we have: anterior tibial artery injury, aseptic necrosis, tibial condyle fracture (distance between joint interline and osteotomy shorter than two cm), union delay, non-union, lost correction, fibular nerve palsy (direct injury, edema, compression), deep venous thrombosis, infection, compartmental syndrome, inappropriate fixation. In

our study, we found complications in six cases (14,6%), ranging from transient fibular neuropraxis (after synthesis removal), synthesis failure or loosening, and superficial infection, all of these treated and improved. In one case, idiopathic pain occurred after osteotomy, requiring total arthroplasty one year after the first surgery, resulting in symptoms relief.

In our study, we aimed to provide hypercorrection in order to align the mechanical axis to the position 62.5% of the lateral femorotibial joint surface, finding, after a follow-up period of 51.6 months, 73.1% of excellent and good outcomes (Lysholm subjective assessment). We did not evaluate adductor moment because no gait laboratory was available.

Some authors report that a worsening of good and excellent outcomes with time most often shows an unavoidable progression of the disease, and not procedure failure⁽⁵⁾, a fact with which we agree, since in many patients, several parameters such as alignment, range of motion and satisfaction level are appropriate, but symptoms are gradually back as it evolves.

CONCLUSION

1. Tibial upper-tuberosity osteotomy with lateral wedge-like closing stabilized with lateral single or double 8-shaped ties and cortical and spongy screws of big fragments enables the correction of lower limbs' femorotibial deformities in varus in a mid-term follow-up.
2. The mechanical axis was aligned from the medial edge of the medial tibial condyle (position 1.2%) to the region slightly laterally to the center of the knee (position 50.5%).
3. Tibial slope at anteroposterior plane of a initial deformity in varus was corrected to 4.1° valgus (correction of 9.8°). Tibial slope at lateral plane showed reduction to 6.5° (average) after wedge resection.
4. The technique enables a satisfactory correction of a femorotibial deformity in varus, although not complications-free
5. Patients satisfaction, according to the Lysholm subjective scale had a significant increment, from 27.3 (preoperative average) to 88.7 (follow-up average).
6. Satisfactory fixation with simple and low relative cost synthesis material, available in the orthopaedic surgical arsenal.

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