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TIBIAL OSTEOTOMY FOR GENU VARUM

Indications, Preoperative Planning, and Technique

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Valgus osteotomy of the proximal tibia remains the treatment of choice for the young active patient with a progressively symptomatic varus knee and mild to moderate secondary osteoarthritis.[1,2,3,4,7-10,14,16] Although the natural history of the varus knee is not well established, it is widely accepted that patients with varus malalignment who develop meniscal injuries or progressive cartilage wear will inevitably develop more severe medial compartment osteoarthritis unless the abnormal mechanics of the knee are corrected.

The ideal candidate for a valgus osteotomy of the tibia is the younger, more active patient with a varus knee owing to a deformity of the proximal tibia who has progressive symptoms, more than 90 degrees of motion, intact collateral and cruciate ligaments, no subluxation, and only early degenerative change. However, although patients with mild subluxation, anterior cruciate ligament (ACL) insufficiency, more limited motion, more advanced medial compartment osteoarthritis (OA), or medial collateral ligament (MCL) laxity are less ideal candidates, tibial osteotomy may still be the most suitable option when one is faced with extreme circumstances.

PREOPERATIVE PLANNING

Early failure of tibial osteotomy is usually a failure of patient selection or a failure to achieve and maintain appropriate overcorrection until union.[5,11,18] Ideal alignment following osteotomy produces a mechanical axis that passes through the mid third of the lateral compartment of the knee.[6] Therefore, preoperative planning should be based, in part, on full-length standing films of the entire leg so that the preoperative mechanical axis can be defined. There is no ideal postoperative femorotibial angle, because shorter patients generally require more genu valgum and taller patients require less genu valgum to produce the same mechanical axis through the knee. In addition to the long leg standing roentgenogram, a valgus stress radiograph is helpful to determine the change that occurs when the MCL is placed under tension. Most varus knees correct a few degrees when a valgus stress is applied, and this amount of additional correction should be anticipated following osteotomy when the mechanical axis is shifted from medial to lateral. If this intraarticular angular shift[11] is large, the angle of the planned osteotomy should be de-

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Figure 1. The presence of tibial collateral ligament laxity should always be noted when plans are made for correction of varus malalignment. *A–C,* A case of post-traumatic varus deformity is illustrated. Because the tibial collateral ligament was lax as seen on the valgus stress view, a medial opening wedge osteotomy was used to correct the malalignment and medial laxity simultaneously. A lateral closing wedge osteotomy would have resulted in gross overcorrection and exacerbated the uncorrected medial instability. The lines in *A* and *C* represent the preoperative and postoperative mechanical axes, respectively.

creased by the same amount to prevent excessive overcorrection. In addition, if the MCL is truly lax, a medial opening wedge osteotomy should be considered to tighten the MCL instead of the usual lateral closing wedge osteotomy (Fig. 1*A* to *C*). A preoperative assessment of the ideal tibial osteotomy angle has been best described by Miniaci et al.[13] With the use of their method, the preoperative mechanical axis and the proposed postoperative mechanical axis (passing through the mid third of the lateral compartment) are drawn (Fig. 2). Next, one line is drawn from the apex of the proposed osteotomy to the center of the ankle. A second line is drawn from the apex of the osteotomy to where the center of the ankle should be postoperatively (*see* Fig. 2). The angle (theta) between these two lines is the angle of correction.

LEVEL OF THE OSTEOTOMY

Tibial osteotomy may to be performed above, behind, or below the tibial tubercle. In the United States, the most popular method of tibial osteotomy is performed above the tibial tubercle.[3,4] This level of osteotomy has the advantage of high healing rates. Osteotomy above the tubercle also has many disadvantages, particularly when a closing wedge osteotomy is performed. These disadvantages include limited degrees of correction, the potential for tibial plateau necrosis, elevation of the tibial tubercle, which compromises subsequent exposure for total knee replacement,[12,15] iatrogenic patella alta, increased Q-angle, and limited bone stock for rigid internal fixation.

Osteotomy below the tubercle[17] has a greater range of correction and more bone stock for rigid fixation. This is the only appropriate osteotomy in patients with open growth plates. Osteotomy below the tubercle has the disadvantage of involving cortical bone with its associated slower and lower healing rates. Lower osteotomies also sometimes correct the alignment below the level of deformity, creating a zig-zag tibia.

Osteotomy behind the tibial tubercle as advocated by Jacob and Murphy[11] (Fig. 3*A* and *B*) retains the advantage of high healing rates with

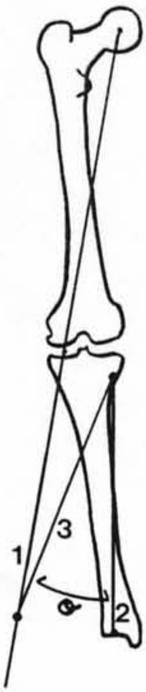

Figure 2. The precise angle of correction for valgus osteotomy is best determined on a long-leg radiograph. A line (1) drawn from the center of the hip through the center of the lateral compartment defines the desired postoperative mechanical axis. A second line (2) is drawn from the apex of the proposed osteotomy to the current ankle center. A third line (3) is drawn from the apex of the proposed osteotomy to the point where the ankle will intersect the proposed long axis when the osteotomy is performed (lines 2 and 3 are the same length). The angle between lines 2 and 3 is the angle of the osteotomy (θ): the angle of correction required to place the long axis through the center of the lateral compartment.[11,13]

the additional advantages of greater range of correction and more proximal bone stock for rigid internal fixation. Osteotomy behind the tubercle also avoids raising the tubercle, which compromises exposure for a subsequent total knee replacement and increases the Q-angle.

Overall, although osteotomy above, behind, or below the tubercle may be preferred in specific circumstances, osteotomy behind the tubercle is currently our preferred method under most circumstances because the tubercle height, patellar height, and Q-angle all remain unchanged.

METHODS OF FIXATION

Methods of fixation of tibial osteotomies have varied widely. Cast immobilization is imprecise and causes muscle atrophy and knee stiffness. Limited internal fixation laterally, such as staples or a short plate with screws, provides adequate fixation provided the medial cortex remains intact. If the medial cortex is broken, as is required with large, biplane or triplane corrections, these methods do not provide adequate fixation in varus/valgus alignment, and the postoperative correction frequently shifts into malalignment. Internal fixation using blade plates provides much more stability in varus/valgus, flexion/extension, and rotation even in the absence of an intact medial cortex. Suitable blade plates for tibial osteotomy include the adolescent T-shaped 90-degree hip osteotomy blade plate, the adolescent T-shaped 95-degree condylar blade plate, or specially designed plates. Rigid fixation with a blade plate combined with a retrotubercle level of osteotomy is currently our preferred choice under most circumstances.

External fixation confers the added advantage of allowing gradual correction through distraction callotasis and fine adjustment of the mechanical axis on an outpatient basis. The major disadvantage of external fixation includes wire and pin-tract infections, which greatly complicate subsequent total knee replacement or can necessitate pin removal before adequate correction and healing have been achieved. Furthermore, the use of ring external fixators around the proximal tibia prevents full knee flexion postoperatively.

In summary, many methods of realigning the proximal tibia in the prevention and treatment of medial compartment osteoarthritis are acceptable provided that appropriate overcorrection is achieved and maintained until union while allowing unrestricted knee motion. Many methods of achieving and maintaining correction are reasonable provided that patients are carefully selected and that the surgery is precisely planned and executed.

TECHNIQUE OF VALGUS CLOSING-WEDGE RETROTUBERCLE OSTEOTOMY WITH BLADE-PLATE FIXATION FOR GENU VARUM

Position, Prep, and Drape

Because the mechanical axis of the leg is measured from the center of the hip to the

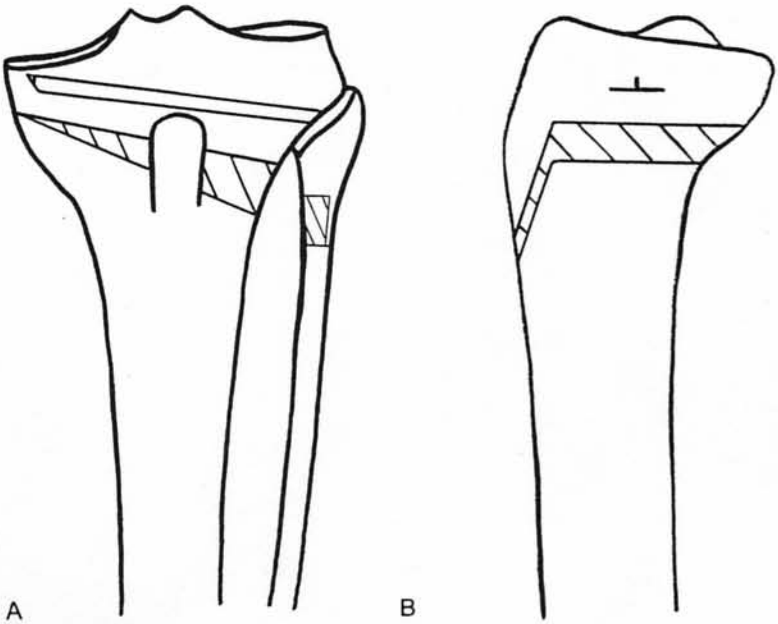

Figure 3. *A* and *B*, Anteroposterior and lateral views of the retrotubercle osteotomy. Osteotomy behind the tibial tubercle avoids raising the tubercle and increasing the Q-angle, both of which occur with osteotomy above the tubercle. The upside down "T" in *B* marks the typical location of insertion of a blade plate. The shaded area shows the lateral side of the bone wedge. If the bridge between the tubercle and the plateau is thin or cracked, it should be reinforced with a screw or tension band suture.

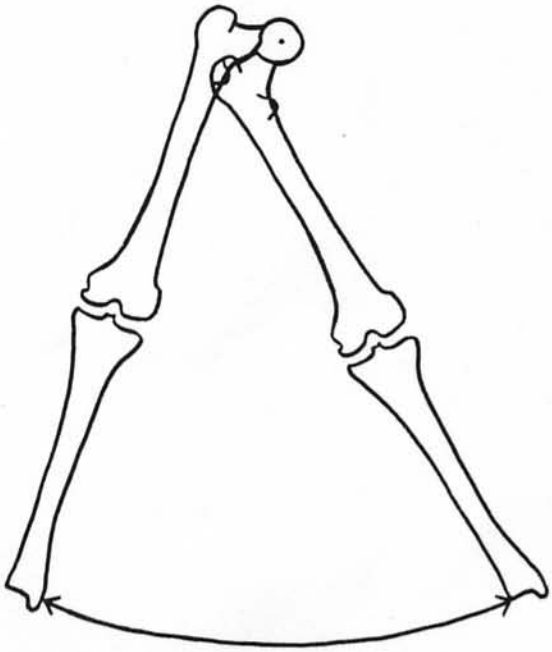

Figure 4. Triangulation to the center of the hip joint is important so that the mechanical axis can be checked intraoperatively. This can be done easily without a radiograph because the center of the hip joint is the only location above the thigh where a line (electrocautery cord) connected to the ankle does not change in length when the leg is adducted and abducted.

center of the ankle, the entire extremity, including the hip joint, is prepped and draped in the supine position. This requires the use of a sterile tourniquet. The precise position of the hip joint center can be determined by triangulation (Fig. 4). This could be done on the operating room table using the electrocautery cord with one end placed at the center of the ankle and the other end over the assumed center of the hip joint. If the cord remains at the same length and tension through arc of hip abduction/adduction, the assumed hip center is correct. If the cord gets tighter in adduction, the hip center is more medial. If the cord gets tighter in abduction, the hip center is more lateral. The hip joint center is then marked with a skin marker. If there is any question about the location of the hip joint center, a single fluroscopic image can be taken for confirmation. Finally, the location of the electrocautery cord as it passes over the knee is compared with the position of the mechanical axis on the full-length radiograph. They should be the same.

Exposure

A longitudinal incision is made just lateral to the midline of the knee so that a total knee replacement could later be performed through the same incision. A subperiosteal flap is developed from the lateral aspect of the tibia to Gerdy's tubercle distally.

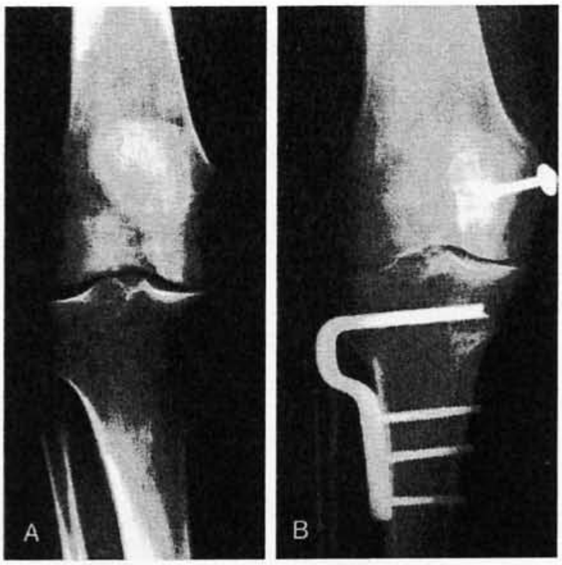

Figure 5. *A* and *B*, Typical correction and fixation technique using a retrotubercle osteotomy and fixation with a blade plate. The medial epicondyle was osteotomized to gain exposure for simultaneous medial meniscal transplantation.

The fibular neck is exposed and an oblique osteotomy of the proximal fibula is made with a small segment of bone removed. Fibular osteotomy and resection are greatly preferred to a tibiofibular joint resection, because this avoids destruction of a normal joint, avoids proximal migration of the fibular head, and avoids increasing the laxity of the lateral collateral ligament.

The proximal surface of the osteotomy is marked by a Kirschner wire (K-wire) placed roughly horizontally and leaving about 2 cm of tibial plateau proximally. A second K-wire is then placed below the first one to identify the distal surface of the osteotomy. The two K-wires should be about 2 mm apart at the medial cortex to allow for saw blade thickness. The angle of the wedge defined by the two K-wires can be measured fluoroscopically. The angle formed between the two K-wires should equal the angle of the proposed osteotomy. Although many jigs have been designed to accurately define the angle of an osteotomy wedge, any method is acceptable provided the proper wedge angle is defined.

The T-chisel for a T-shaped blade plate is then passed into the proximal fragment. The blade can go in at any angle in the coronal plane provided it does not enter the knee joint or the proposed osteotomy site and provided the bony bridge below the chisel is adequate. The angle between the T-chisel and the tibial shaft is measured, and the blade plate to be used should be bent so the desired osteotomy angle is achieved when the blade plate is inserted and then secured to the tibial shaft. A very thin saw blade is then used to separate the tibial tubercle from the tibial metaphysis (*see* Fig. 3). The tibial tubercle remains attached to the proximal fragment.

The osteotomy wedge is then removed using an oscillating saw, and the medial cortex is plastically deformed as the osteotomy is closed. The medial cortex must be broken if the angular correction is large or if biplane or triplane corrections are desired.

Finally, the T-chisel is removed, the blade plate is inserted, and the tibial shaft is secured to the plate. Choices for T-profile blade plates include the 95-degree T-condylar blade plates for small-statured adults and the 90-degree T-profile intertrochanteric osteotomy blade plates (AO/ASIF 237.110 or 237.130). The mechanical axis is then checked with the electrocautery cord for accuracy. The electrocautery cord should pass through the mid third of the lateral compartment of the knee. Fine tuning of the angular correction can be performed by placing washers beneath the plate proximally or distally to achieve the desired mechanical axis (Fig. 5).

Postoperatively, full knee motion is encouraged immediately, and 50% weight bearing is recommended for 6 weeks. Thereafter, patients may progress to full weight bearing and more demanding activities as muscle strength and symptoms allow.

References

1. Aglietti P, Rinonapoli E, Stringa G, et al: Tibial osteotomy for varus osteoarthritic knee. Clin Orthop 176:239–251, 1983
2. Cartier P: Stellenwert der unikom partimentaren Prothese bei der Femorotibialarthrose mit insuffizientem Zentralpfeiler. *In* Jakob RP, Staubli HU (eds): Kniegelenk und Kreuzbander. New York, Springer Verlag, 1991, pp 588–600
3. Coventry MB: Osteotomy about the knee for degenerative and rheumatoid arthritis: Indications, operative techniques, and results. J Bone Joint Surg 55A:23–48, 1973
4. Coventry MB: Upper tibial osteotomy for gonarthrosis: The evolution of the operation in the last 18 years and long term results. Orthop Clin North Am 10:191–210, 1979
5. Engel GM, Lippert FG III: Valgus tibial osteotomy: Avoiding the pitfalls. Clin Orthop 160:137–143, 1981
6. Fujisawa Y, Masuhara K, Shiomi S: The effect of high tibial osteotomy on osteoarthritis of the knee: An arthroscopic study of 54 knee joints. Orthop Clin North Am 10:585–608, 1979
7. Hernigou PH, Medevielle D, Debeyre J, et al: Proximal tibial osteotomy for osteoarthritis with varus deformity: A ten to thirteen-year follow-up study. J Bone Joint Surg 69A:332–354, 1987
8. Insall JN, Joseph DM, Msika C: High tibial osteotomy for varus gonarthrosis: A long-term follow-up study. J Bone Joint Surg 66A:1040–1048, 1984
9. Insall JN, Shoji H, Mayer V: High tibial osteotomy: A five year evaluation. J Bone Joint Surg 56A:1397–1405, 1974
10. Jackson JP: Osteotomy for osteoarthritis of the knee. J Bone Joint Surg 40B:826, 1958
11. Jacob RP, Murphy SB. Tibial osteotomy for varus gonarthrosis: Indication, planning and operative technique. Instructional Course Lectures of the American Academy of Orthopaedic Surgeons. St. Louis, CV Mosby, 1992.
12. Katz MM, Hungerford DS, Krackow KA, et al: Results of total knee arthroplasty after failed proximal tibial osteotomy for osteoarthritis. J Bone Joint Surg 69A:225–233, 1976
13. Miniaci A, Ballmer FT, Ballmer PM, et al: Proximal tibial osteotomy: A new fixation technique. Clin Orthop 246:250–259, 1989
14. Shoji H, Insall JN: High tibial osteotomy for osteoarthritis of the knee. Int Surg 61:11–14, 1976
15. Staheli JW, Cass JR, Morrey BF: Condylar total knee arthroplasty after failed proximal tibial osteotomy. J Bone Joint Surg 69A:28–31, 1987
16. Tjornstrand BAE, Egund N, Hagstedt BV: High tibial osteotomy: A seven-year clinical and radiographic follow-up. Clin Orthop 1960:124–136, 1981
17. Wagner H: Principles of corrective osteotomies in osteoarthrosis of the knee. Progress in Orthopaedic Surgery 4:75–102, 1980
18. Ziller R, Seyfarth H: Loss of correction following high tibial osteotomy. Beitr Orthop Traumatol 21:358–363, 1974

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