PROCEDURE 15

c0015

Opening Wedge High Tibial Osteotomy

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INDICATIONS

u0010 • Standing varus alignment.
u0015 • Symptomatic, isolated medial compartment arthritis with or without ligamentous instability.
u0020 • Medial knee pain associated with any cartilage defect (osteochondritis dissecans, avascular necrosis, focal chondral defect) with varus malalignment.
u0025 • Symptomatic medial meniscal deficiency and varus malalignment.

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CONTRAINDICATIONS

u0030 • Deformity over 15°
u0035 • Flexion contracture over 15°
u0040 • Knee flexion under 90°
u0045 • Medial/lateral tibial subluxation over 1 cm
u0050 • Excessive medial bone loss (over 3 mm)
u0055 • Inflammatory arthritis
u0060 • Arthritis in the lateral compartment
u0065 • Patella baja
u0070 • Morbid obesity (select a closing wedge osteotomy instead)
u0075 • Age over 60 (relative contraindication)

TREATMENT OPTIONS b0010

- Oral anti-inflammatory medications
- Nutricueticals
- Cortisone injections
- Viscosupplementation
- Activity modifications
- Unloader braces
- Assistive devices (canes, walkers)

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Examination/Imaging

u0115 • Examination includes:
u0120 • observation of standing and ambulation alignment (varus thrust)
u0125 • correctable varus deformity
u0130 • range of motion
u0135 • ligamentous stability
u0140 • bilateral lower extremity neurovascular exam
u0145 • patellar exam (tilt, J sign, Q angle)
u0150 • Unloader braces may be a useful nonsurgical tool to determine if an osteotomy is a viable option.
u0155 • Radiographs include four views: standing anteroposterior (AP), lateral, Merchant's, and 45° flexion posteroanterior (PA).
u0160 • The flexion PA view allows better analysis of the posterior weight-bearing portion of the articular surface that is more sensitive for detecting arthritis.
u0165 • In addition, bilateral long cassette view standing films are taken to measure the mechanical axis and degree of correction needed.
u0170 • Double-leg stance radiographs: to assess the bony deformity.
u0175 • Single-leg stance radiographs: to assess any soft tissue deformity (i.e., posterolateral knee insufficiency).
u0180 • Magnetic resonance imaging may be used to evaluate the soft tissues of the knee and the presence or absence of soft tissue fluid or joint effusion.
u0185 • Articular cartilage, menisci, and ligaments should be closely evaluated.
u0190 • Unicompartmental bone edema can be an indicator of chronic compartment overload.
u0195 • Meniscal volume can be assessed using the coronal and sagittal sequences. Careful evaluation of the previously menisectomized knee should be performed to interpret new injury versus postmenisectomized appearance.
u0200 • Gradient echo sequences are used to decipher articular cartilage from the surrounding joint fluid and subchondral bone; however, gradient echo sequences are not able to identify intrasubstance cartilage defects.

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- T2-weighted or short tau inversion recovery fluid sequences are used to evaluate internal signal within the cartilage or subchondral bone edema. u0205
- Computed tomography scans are selectively useful in cases of prior anterior cruciate ligament (ACL) reconstructions in which there is concern for bone tunnel enlargement. These scans can also help evaluate osseous overgrowth in the setting of a failed prior cartilage restoration procedure. u0210
- Calculating degree of correction (coronal plane) u0215
  - For medial compartment arthrosis, overcorrection is usually needed. Specifically, a point on an AP radiograph 62% of the width of the joint line, measured medial to lateral (roughly two-thirds of the width of the tibia plateau) u0220
    - the point of the desired mechanical axis is marked on the tibial plateau u0225
    - a line is drawn from the center of the femoral head to the desired point on the plateau u0230
    - another line is drawn from the point on the plateau to the center of the tibial plafond u0235
    - the angle formed by the two lines is the degree of correction needed (Fig. 15.1A and 15.1B) u0240
    - generally, 1 mm of opening corresponds to 1° of correction. This is only true for a tibial width of 56 mm. u0245
  - For unloading cartilage restoration procedures, correction of the mechanical axis to neutral (center of plateau) is sufficient. As a guideline, the osteotomy is possibly not necessary in this setting if correcting less than 5°. u0250 u0255
- Calculating degree of correction (sagittal plane) u0260
  - Increasing the tibial slope will: u0265
    - worsen symptoms with ACL instability u0270
    - improve symptoms with posterior cruciate ligament (PCL) instability.
  - Decreasing the tibial slope will: u0275
    - improve symptoms with ACL instability u0280
    - worsen symptoms with PCL instability. u0285

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INSTRUMENTATION

- Opening wedge osteotomy system (Arthrex, Inc., Naples, FL, USA)
- Power drill and saw
- A large saw blade
- Fluoroscan
- Allograft cortical wedges

POSITIONING s0025

- The patient is placed supine on the operating table. A radiolucent extension is applied to enable fluoroscopic examination. Alternatively, the patient can be placed on the ipsilateral edge of the table to enable fluoroscopic access by abducting the leg. u0315
- A lateral post is applied in the middle of the thigh for the arthroscopic procedure. u0320

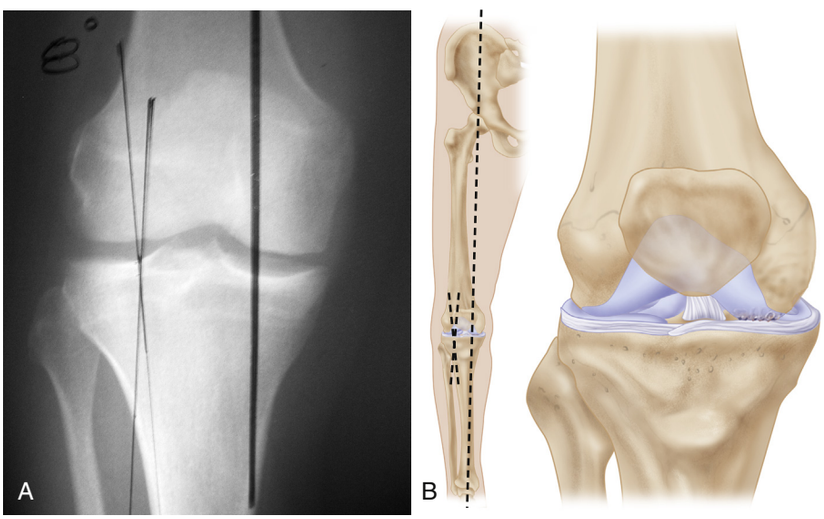

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FIG. 15.1

u0325 • A tourniquet is applied and can be used if needed. It is usually deflated prior to closure to obtain adequate hemostasis.

u0330 • If a large correction is anticipated, the ipsilateral iliac crest is draped and a rolled blanket is placed under the same buttock in anticipation of potential autograft harvest (Fig. 15.2).

s0030 ## PORTALS/EXPOSURES

u0335 • A diagnostic arthroscopy is routinely performed to verify the status of the articular cartilage and menisci. Two standard arthroscopy portals (anteromedial and anterolateral) are utilized.

u0340 • A marking pen is used to mark the tibial tubercle, the patellar tendon, and the pes anserine, and posteromedial border of the tibia.

u0345 • The high tibial osteotomy (HTO) incision can be planned by drawing a line from the distal aspect of the anteromedial portal distally to the level of the pes on the medial side of the tibial tubercle.

u0350 • The portion below the joint line can be used to perform the actual incision.

u0355 • The incision falls roughly between the tibial crest and the posteromedial tibial border.

u0360 • Dissection is made down to the anteromedial tibia and the sartorius fascia.

u0365 • The hamstring tendons are palpated and an electrocautery device is used to make a transverse cut along the superior aspect of the sartorious fascia extending from the posteromedial tibia to the level of the patellar tendon.

u0370 • The cut is curved inferiorly to follow along the medial side of the patellar tendon.

u0375 • A sleeve including the superficial medial collateral ligament (MCL) is raised subperiosteally to the posteromedial tibia.

u0380 • A large retractor is placed behind the tibia to protect the neurovascular structures.

u0385 • Alternatively, the MCL can be transected and the plate placed directly on top of the ligament.

s0035 ## PROCEDURE

s0040 ### Step 1: Diagnostic Arthroscopy

u0390 • A diagnostic arthroscopy is performed to verify that the patient is a good candidate for the osteotomy procedure. Any necessary concomitant procedures are done prior to performing the osteotomy (meniscus débridement, repair or transplant; cartilage débridement or restoration).

u0395 • The irrigation fluid is aspirated at the end of the arthroscopic evaluation.

s0045 ### Step 2: Placing Guide Pins

u0400 • An incision is made, and the appropriate retractor is placed to protect the posterior neurovascular structures.

u0405 • A 2.4-mm breakaway guide pin is inserted into the tibia in an inferomedial-to-superolateral direction.

u0410 • The guide pin tip should be seated in the lateral cortex approximately 1 cm to 2 cm distal to the lateral tibial joint line, aiming for the tip of the fibular head.

f0015 **FIG. 15.2**

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STEP 2 PEARLS

- Performing the saw cut and using the osteotomes on the inferior side of the cutting guide can prevent fracture propagation into the tibial plateau.
- If the osteotomy jack does not wedge the bone open, remove it and reuse the osteotomes to complete the cut around the tibia. Always maintain the medial retractor to protect the MCL and neurovascular structures. Pay particular attention to the anterior and posterior cortex, as this is often an area of incomplete osteotomy.
- The cord of an electrocautery device can be used as a fluoroscopic mechanical axis marker over the thigh (hip to ankle) to ensure that an adequate osteotomy opening was chosen (Fig. 15.7).
  - If the osteotomy extends to the lateral tibia, it can be fixed by making a small lateral incision and placing two bone staples (Fig. 15.8) or a small plate and screws.
  - If the osteotomy extends proximally to the tibial plateau, it can be fixed using two cannulated, partially threaded AO screws from lateral to medial.

  - The position is verified with fluoroscopy. As a fluoroscopic guideline, the pin should traverse the superomedial tibial tuberosity at the junction of the patellar tendon insertion and end at the tip of the fibular head. u0415
- Insert another pin parallel to the first, taking into account the proximal slope of the tibia. u0420
- The pins are bent and broken at their breakaway point (Fig. 15.3). u0425
- A retractor is placed beneath the patellar tendon for protection. u0430

Step 3: Performing the Osteotomy Cut s0050

- The cutting guide is placed over the two pins. An oscillating saw is used to cut the tibia anteriorly, medially, and posteriorly to within 1 cm of the lateral cortex (Fig. 15.4). u0460
- Different osteotome sizes are available with the set and can be used to complete the osteotomy anteriorly and posteriorly. Fluoroscopy is used to make sure the osteotomes do not violate the lateral cortex (Fig. 15.5). u0465
- Remove the guide pins and insert the calibrated wedges loaded on their driver on the medial side of the tibia (Fig. 15.6). Gently tap the wedges to open the osteotomy. u0470
  - The markings on the side of the wedges correspond to the size of opening in millimeters. u0475
  - Rapid insertion of the wedges can lead to a lateral fracture. u0480
- The handle is removed and the wedges are left in place. u0485

Step 4: Plate Fixation s0055

- An anterior-to-posterior sloped plate of the opening size is placed in the space between the two wedges. The plate should sit just anterior to the MCL. u0490

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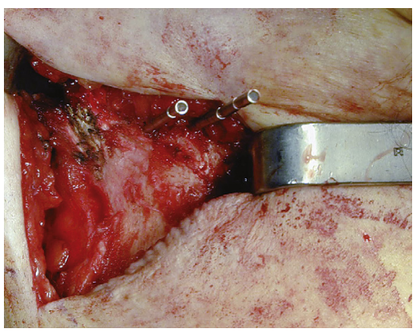

FIG. 15.3

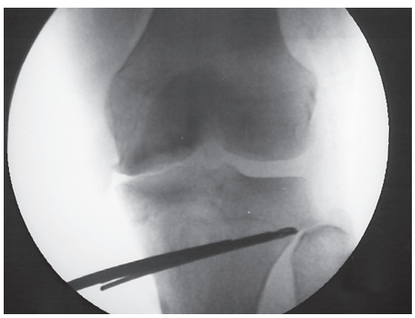

FIG. 15.4

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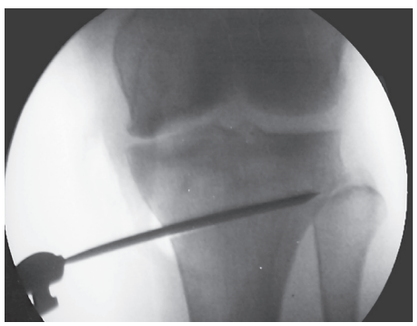

FIG. 15.5

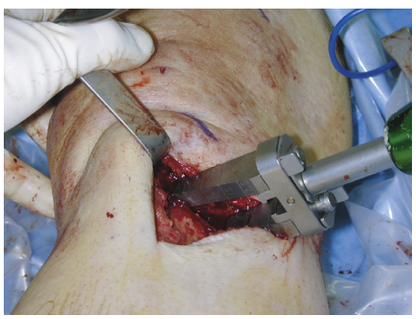

FIG. 15.6

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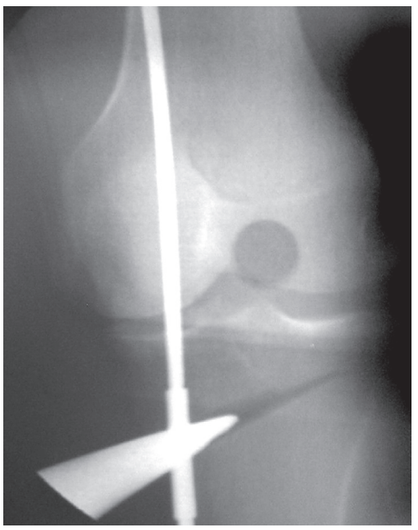


f0040 FIG. 15.7

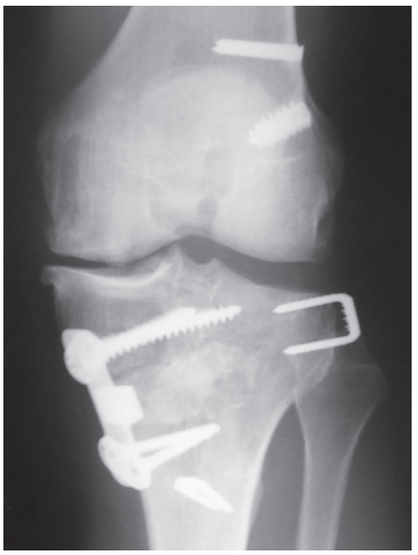


FIG. 15.8 f0045

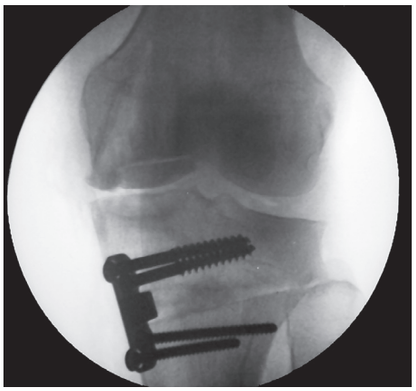


FIG. 15.9 f0050

u0495 • Two cancellous 6.5-mm screws are used to fix the proximal plate. These screws are unicortical. It is important to use fluoroscopy to make sure the screws do not penetrate the articular surface. The screws should engage and lock into the plate.

u0500 • The calibrated wedges are now removed to allow the osteotomy to close down on the plate and obtain bone-to-plate contact, as well as appropriate seating of the calibrated plate's tooth, which represents the corrective osteotomy.

u0505 • Two 4.5-mm cortical screws are used to fix the distal plate. These screws are bicortical (Fig. 15.9).

u0510 • Take care to not place the plate overly anterior unless purposely increasing tibial slope.

s0060 ## Step 5: Bone Graft the Osteotomy Site

u0515 • Allograft or autograft bone is inserted in the osteotomy site on both sides of the plate (Fig. 15.10).

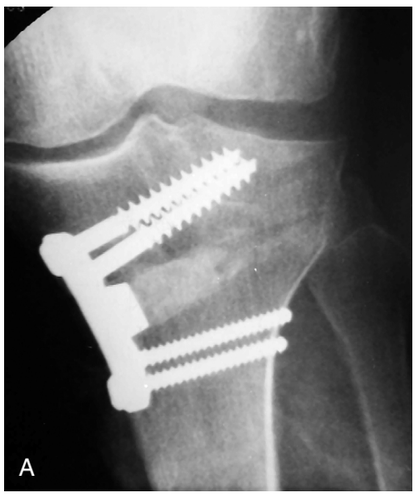
u0520 • Options for graft include:

u0525 • tricortical wedge allograft

u0530 • iliac crest autograft

u0535 • bone plugs harvested from the proximal tibia using an Osteochondral Autograft Transfer System (OATS) harvester (Arthrex, Inc., Naples, FL, USA)

FIG. 15.10 f0055



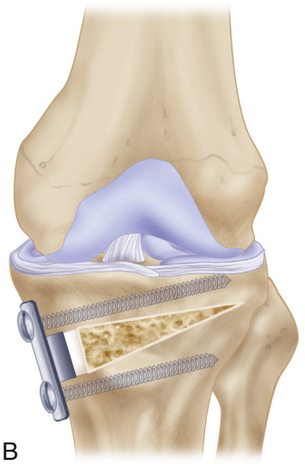


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FIG. 15.11

- synthetic bone substitutes u0540
- allograft bone chips u0545
- Final radiographs are obtained (Fig. 15.11A and 15.11B). u0550

Step 6: Closure s0065

- The tourniquet is deflated, the knee is irrigated with saline, and hemostasis is achieved. u0555
- Using #1 Vicryl, the elevated tissue on the medial side of the tibia is repaired. u0560
- The remainder of the incision is closed in layers. u0565
- A sterile dressing and a knee brace locked in extension are applied. u0570

POSTOPERATIVE CARE AND EXPECTED OUTCOMES s0070

- Phase I (0–4 weeks) u0575
  - Touch-down weight bearing is allowed with crutches for the first 2 weeks. u0580
  - Advance to full weight bearing in the next 2 weeks. u0585

u0590 • The brace is worn at all times except for continuous passive motion (CPM) use.
u0595 • CPM is used for 4 hours per day, attempting to achieve 90° of flexion.
u0600 • Physical therapy includes quadriceps sets, ankle pumps, straight leg raise (SLR) with the brace locked in extension, and nonweight-bearing calf/hamstring stretches.
u0605 • Phase II (4–6 weeks)
u0610 • Weight bearing is allowed as tolerated without crutches.
u0615 • The brace is unlocked for ambulation.
u0620 • CPM is discontinued when knee flexion achieves 90°.
u0625 • Physical therapy continues with gentle stationary bike and SLR without brace. No closed-chain exercises are done until the end of phase II.
u0630 • Phase III (6 weeks to 3 months)
u0635 • The brace is discontinued if the patient is pain free.
u0640 • Start mini-squats (0° to 45°), leg presses (0° to 60°), closed-chain terminal knee extension, balance activities, and toe raises.
u0645 • Phase IV (3–9 months)
u0650 • Progress closed-chain exercises.
u0655 • Begin treadmill walking and swimming.
u0660 • Return to full activities by the end of phase IV.

s0075 Expected Outcomes

u0665 • Data are still lacking regarding the success rates of opening wedge HTO. Overall, using lateral closing wedge osteotomies as a guideline, patients can expect the surgery to be effective for about 7 years to 10 years for medial compartment arthritis.
u0670 • Anecdotal data suggest that adding HTOs to cartilage restoration procedures shows great promise to unload malaligned affected limbs.

POTENTIAL COMPLICATIONS b0025

- Tibia fractures (<2%)
- Deep venous thrombosis (15%)
- Nonunion (<1%)

s0080 EVIDENCE

Birmingham TB, Giffin JR, Chesworth BM, Bryant DM, Litchfield RB, Willits K, Jenkyn TR, Fowler PJ: Medial opening wedge high tibial osteotomy: a prospective cohort study of gait, radiographic, and patient-reported outcomes, Arthritis Rheum 61:648–657, 2009.
In this, In this study, the authors analyzed gait, radiographic, and patient-reported outcomes over a 2-year period in 126 patients after undergoing medial opening wedge HTO. The authors reported improvement in dynamic knee joint load and patient-reported measures of pain, function, and quality of life 2 years postoperatively.

Cole BJ, Freedman KB, Taksali S, Hingtgen B, DiMasi M, Bach Jr BR, Hurwitz DE: Use of a lateral offset short-leg walking cast before high tibial osteotomy, Clin Orthop 408:209–217, 2003.
The authors, The authors evaluated the effect of a lateral offset walking cast on patients with varus medial arthritis indicated for HTO. Nineteen patients were placed in a cast for 3 days and precast and postcast gait analysis was performed. The cast led to a 53% reduction of pain and 36% reduction in adduction moment in 17 of 19 patients who tolerated the cast. There was a correlation between the reduction of pain and adduction moment (r = 0.63).

Franco V, Cerullo G, Cipolla M, Gianni E, Puddu G: Open wedge tibial osteotomy, Tech Knee Surg 1:43–53, 2002.
Thirty patients were treated with opening wedge HTO and followed for between 36 months and 48 months. The average age was 49 years. The authors used International Knee Documentation Committee (IKDC) and Hematological Scoring System (HSS) for evaluation. Preoperatively, 11 patients were in the C group and 19 in the D group according the IKDC scales. At the latest follow-up, 17 patients were in the B group and 13 in the C group. All patients improved at least one category.

Gaasbeek RD, Welsin RT, Verdonschot N, Rijnberg WJ, van Loon CJ, van Kampen A: Accuracy and initial stability of open-wedge and closed-wedge high tibial osteotomy: a cadaveric study, Knee Surg Sports Traumatol Arthrosc 13:689–694, 2005.
The authors analyzed the differences in angle accuracy and initial stability between closing and opening wedge high tibial osteotomy using cadaveric specimens. There was a tendency to overcorrection with the closing wedge samples, but it was not statistically significant. There was no difference in the initial stability between the two techniques.

Harris JD, Hussey K, Wilson H, Pilz K, Gupta AK, Gomoll A, Cole BJ: Biological knee reconstruction for combined malalignment, meniscal deficiency, and articular cartilage disease, Arthroscopy 31: 275–282, 2015.
In this study, the authors report on the use of a malalignment procedure while simultaneously performing a meniscal transplantation and articular cartilage repair. In total, 18 patients were included, two-thirds of which had concomitant opening wedge HTO and the other third an opening wedge

distal femoral osteotomy. Patients demonstrated significant improvements in several validated patient-reported outcomes scores at a mean of 6.5-year follow-up. There was no difference between medial versus lateral pathologic conditions.

Hernigou P, Medevielle D, Debeyre J, Goutallier D: Proximal tibial osteotomy for osteoarthritis with varus deformity, J Bone Joint Surg Am. 69:332–354, 1987.
Using an opening wedge technique, the authors treated 93 knees. At a 5-year follow-up, 90% of the knees had good or excellent results. The results deteriorated over time and, after 10 years, 45% of the patients had excellent or good results.

Martin R, Birmingham TB, Willits K, Litchfield R, Lebel ME, Giffin JR: Adverse event rates and classifications in medial opening wedge high tibial osteotomy, Am J Sports Med 42:1118–1126, 2014.
In this study, the authors report on the incidence of adverse events (AEs) in 323 consecutive procedures following medial opening wedge HTO. AEs were classified into three groups; AEs requiring no additional treatment (class 1), AEs requiring additional or extended nonoperative management (class 2), and AE's requiring additional or revision surgery and/or long-term medical care (class 3). The most common AE in class 2 was a delayed union (12%). The rate of severe adverse events requiring additional surgery was 7%.

Naudie DD, Amendola A, Fowler PJ: Opening wedge high tibial osteotomy for symptomatic hyperextension varus thrust, Am J Sports Med 32:60–70, 2004.
Seventeen knees with instability rather than osteoarthritis were treated with an opening wedge high tibial osteotomy. Functional results were evaluated based on the scoring systems by Lysholm and Tegner and using a 5-point analog scale to assess knee stability and satisfaction. Patients were followed for 56 months. All patients had an increase in their activity level. All but one were satisfied with their outcome. Radiographic results showed a correction of the mechanical axis to about 46% toward the lateral side.