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Combined Intra-Articular and Varus Opening Wedge Osteotomy for Lateral Depression and Valgus Malunion of the Proximal Part of the Tibia

Surgical Technique

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The original scientific article in which the surgical technique was presented was published in JBJS Vol. 90-A, pp. 1252-7, June 2008

ABSTRACT FROM THE ORIGINAL ARTICLE

BACKGROUND: Reconstructive surgical measures for treatment of posttraumatic deformities of the lateral tibial plateau are seldom reported on in the literature. We report the long-term follow-up results of a consecutive series of reconstructive osteotomies performed to treat depression and valgus malunions of the proximal part of the tibia.

METHODS: From 1977 through 1998, a combination of an intra-articular elevation and a lateral opening wedge varus osteotomy of the proximal part of the tibia was performed in twenty-three consecutive patients. The patients were assessed clinically and radiographically at a minimum of five years postoperatively.

RESULTS: A correction of the intra-articular depression and the valgus malalignment was achieved and the anatomic lower-extremity axis was restored in all patients. The clinical results were evaluated at a mean of thirteen years (range, two to twenty-six years) after the reconstructive osteotomy. Two patients had an early failure and were considered to have had a poor result. Two other patients had severe progression of osteoarthritis after the osteotomy, four had slight progression, and fifteen had no progression. There were no nonunions. There were two superficial wound infections, which were treated successfully without surgical intervention. According to the scale of Lysholm and Gillquist, the subjective result was excellent for seventeen patients (74%), good for three, fair for one, and poor for two.

CONCLUSIONS: A knee-joint-preserving osteotomy can provide satisfactory results in active patients with painful posttraumatic lateral depression and valgus malunion of the proximal part of the tibia.

LEVEL OF EVIDENCE: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

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A video supplement to this article will be available from the *Video Journal of Orthopaedics*. A video clip will be available at the JBJS web site, www.jbjs.org. The *Video Journal of Orthopaedics* can be contacted at (805) 962-3410, web site: www.vjortho.com.

FIG. 1-A

FIG. 1-B

Figs. 1-A and 1-B Exposure of the proximal part of the tibia. (Figs. 1-A and 1-C: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.)

INTRODUCTION

Anatomic reduction and stable fixation is the gold standard in the treatment of displaced tibial plateau fractures. However, this goal is not always achievable, and extra-articular and intra-articular malunions are often the result of conservative and operative treatment. A proximal tibial osteotomy can restore the mechanical axis or shift the mechanical axis to the uninjured compartment. In almost all severe AO type-C fractures, comminution and joint depression occur in the lateral compart-

FIG. 1-C

Detachment of the anterior tibial muscle.

FIG. 2-A

FIG. 2-B

FIG. 2-C

FIG. 2-D

(Figs. 2-A, 2-B, and 2-C: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.) **Fig. 2-A** Hohmann retractor placement to protect the neurovascular bundle. **Fig. 2-B** Beginning of the osteotomy with use of the oscillating saw. **Figs. 2-C and 2-D** Weakening of the medial cortex is started with use of the oscillating saw and is followed by passes with a small drill-bit and osteotomes.

FIG. 3-A

(Figs. 3-A and 3-C: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.) **Figs. 3-A and 3-B** The medial cortex is protected during opening of the lateral osteotomy. **Fig. 3-C** A lamina spreader is used to open the osteotomy site.

FIG. 3-B

FIG. 3-C

ment. In general, anatomic reconstruction of the large depressed medial fragments is easier to perform secondary to an easier operative exposure. Hence, the majority of primary and secondary malunions after tibial plateau fractures lead to a valgus (and intra-articular depression) malalignment. The combination osteotomy described in the present report restores intra-articular anatomy and provides varus correction, typically provides a good functional outcome, and preserves the salvage option of total knee arthroplasty. Nevertheless, optimal recovery requires a protracted period of convalescence.

SURGICAL TECHNIQUE

Osteotomy of the fibula¹: In order to achieve full correction, a mid-third, oblique osteotomy of the fibula is routinely performed,

as long as a fibular head osteotomy is not required to approach the intra-articular malunion.

Exposure of the proximal part of the tibia¹: A straight lateral parapatellar incision is utilized. The iliotibial tract is incised to the Gerdy tubercle, and the fascia of the anterior tibial muscle is opened 1 cm from the tibial crest and the muscle is detached from the bone (Figs. 1-A, 1-B, and 1-C).

Proximal tibial osteotomy^{1,2}: The neurovascular bundle is protected by blunt Hohmann retractors (Fig. 2-A). A transverse or oblique osteotomy is performed, starting 4 cm distal to the lateral articular surface and finishing 1 to 2 cm distal to the medial joint line, depending on individual anatomy. The osteotomy is started laterally with use of an oscillating saw to the depth of the medial cortex (Fig. 2-B), which is

then perforated with several passes of a small drill-bit and osteotomes (Figs. 2-C and 2-D), allowing bending of the medial cortex by gentle osteoclasis to preserve an osseous hinge. The medial hinge is protected, usually with reduction forceps (Figs. 3-A and 3-B), and a bone spreader is used to open the osteotomy site until the desired correction is achieved (Fig. 3-C).

The intra-articular correction is performed through the opening wedge osteotomy as visualized through a lateral arthrotomy²⁻⁴ (Fig. 4-A). The depression of the tibial plateau can best be identified and approached with the knee in 100° of flexion. This position is facilitated by supporting the foot of the patient on a sandbag mounted onto the operating table. Further approach to the knee joint depends on the location of

FIG. 4-A

The exposure and intra-articular osteotomy of the lateral tibial condyle is done through a simple lateral arthrotomy. (Reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.)

FIG. 4-B

Figs. 4-B and 4-C
Further exposure af-
ter the osteotomy of
the Gerdy tubercle.

FIG. 4-C

Figs. 4-D and 4-E After dissection of the peroneal nerve and the osteotomy of the Gerdy tubercle as well as the fibular head, a full exposure of the lateral tibial plateau can be achieved. Eventually, the osteotomy of the Gerdy tubercle can be fixed with the plate used to secure the varus osteotomy of the proximal part of the tibia, and the fibular head osteotomy is routinely secured with a 3.5-mm lag screw.

FIG. 4-D

FIG. 4-E

the joint incongruity. With a standard lateral arthrotomy, the anterior 50% to 60% of the lateral plateau can easily be visual-

ized and approached (Fig. 4-A). To expose more posteriorly situated depressions, an osteotomy of the Gerdy tubercle and reflec-

tion of the attached iliotibial tract allow visualization of approximately 80% of the lateral plateau (Figs. 4-B and 4-C). Fi-

FIG. 5-A

FIG. 5-B

(Figs. 5-A, 5-C, and 5-D: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.) **Fig. 5-A** Intra-articular correction is performed through the extended arthrotomy and the opening wedge osteotomy. The depressed cartilage zone is marked circumferentially with a 2-mm drill-bit, either from proximal as shown here or from distal through the proximal tibial osteotomy. **Fig. 5-B** After the depressed plateau zone is marked with passes of a small drill-bit, the passes are connected with an osteotome before the complete zone can be elevated.

FIG. 5-C

FIG. 5-D

Fig. 5-C With use of a curved impactor inserted through the window, the depressed area of the plateau is elevated to conform to the lateral femoral condyle. **Fig. 5-D** To conform to the lateral femoral condyle in both extension and flexion, an overcorrection of 1 mm is created. The correction is maintained by impacting cancellous autograft bone beneath the elevated segment.

FIG. 6

A metaphyseal cortical window can be made to facilitate handling of curved instruments.

nally, an additional osteotomy of the fibular head after release of the peroneal nerve allows full anterior dislocation of the lateral tibial plateau (Figs. 4-D and 4-E). This extended approach is necessary for reconstruction of a posterolateral malunion.

Through the lateral arthrotomy, the lateral meniscus, if it is still present, can be temporarily detached to assess the tibial plateau and provide direct visualization during the elevation of the depression. Damaged regions of

the meniscus are removed while the peripheral meniscal remnants are preserved. The depressed cartilage zone is then marked circumferentially with a 2-mm drill-bit. With these drill-holes used for guidance, the depressed zone is osteotomized in the vertical plane with a small osteotome.

The intra-articular osteotomy²⁻⁴ can also be performed through the opening-wedge tibial plateau osteotomy with a small bone distractor in

situ. For this approach, including the elevation of the depressed lateral tibial plateau, it is helpful to create a small metaphyseal cortical window at the site of the tibial plateau osteotomy (Figs. 5-A through 5-D). It allows better access to the subchondral site and free handling of curved osteotomes and impactors (Fig. 6).

The intra-articular malunion may consist of one large or multiple small osteochondral fragments. With a curved impactor inserted

FIG. 7-A

FIG. 7-B

(Figs. 7-A through 7-G: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.) **Fig. 7-A** A severe depression (arrow) of the lateral tibial plateau is seen in a right knee. The photographs show a lateral view into the joint after an osteotomy of the Gerdy tubercle. FC = the distal part of the lateral femoral condyle, TP = the proximal part of the lateral tibial plateau, and I = the impactor. **Fig. 7-B** Drill-holes are placed around the depressed zone.

FIG. 7-C

FIG. 7-D

Fig. 7-C A vertical osteotomy of the depression is made through the cortical window. **Fig. 7-D** The depressed portion is elevated with use of the impactor.

FIG. 7-E

FIG. 7-F

Fig. 7-E Congruence of the posterior part (arrow) of the lateral tibial plateau is attained after elevation of the depressed area. FC = the distal part of the lateral femoral condyle, TP = the proximal part of the lateral tibial plateau, and I = part of the impactor. **Fig. 7-F** Complete reconstruction of the intra-articular depression.

FIG. 7-G

Impaction of triangular grafts into the opening wedge varus osteotomy achieves intrinsic stability.

FIG. 8-A

FIG. 8-B

(Figs. 8-A through 8-G: reprinted, with permission, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies for posttraumatic deformities. New York: Thieme; 2008. p 479-94.) **Fig. 8-A** An AO type-C3 tibial plateau fracture with a large medial fragment and severe lateral displacement and depression. **Fig. 8-B** After anatomic fixation of the medial fragment, the reduction is not complete and there is insufficient buttressing of the lateral compartment.

through the window, the depressed area of the plateau is elevated to conform to the lateral femoral condyle in both extension and flexion, creating an overcorrection of 1 mm. The correction is maintained by impacting cancellous autograft bone beneath the elevated segment. The lower extremity alignment is evaluated clinically by adjusting the bone spreader, and

then the intra-articular correction, the ligamentous stability, and the weight-bearing position of the knee are all checked. A further important step in the procedure is dynamic testing of the knee from full flexion to full extension to verify that articular congruence is optimal and that any osseous pivot shift has disappeared. The technique is shown in Figures 7-A through 7-G.

The operation is completed with the impaction of wedged corticocancellous autograft bone into the open gap and internal fixation with an L or a T-plate²⁻⁴. After extending the approaches, the tibial plate is usually sufficient to be used to fix both the Gerdy tubercle and the proximal tibial varus osteotomy at the same time. Finally, a lag screw is sufficient to secure the osteot-

FIG. 8-C

FIG. 8-D

Fig. 8-C The fracture has healed with narrowing of the tibial plateau, valgus angulation, and intra-articular malunion of the lateral condyle.

Fig. 8-D The lateral femoral condyle falls into the depressed tibial plateau, resulting in an osseous pivot shift sign.

FIG. 8-E

Figs. 8-E and 8-F Immediate postoperative anteroposterior (Fig. 8-E) and lateral (Fig. 8-F) radiographs showing that the lateral condyle does not fall into the tibial plateau. **Fig. 8-G** Oblique anteroposterior radiograph made 10.5 years postoperatively, showing remodeling of the lateral articular surface. The patient had pain-free, normal function of the knee.

omy of the fibular head. The only indication to approach the tibial plateau by arthrotomy and an osteotomy of the tibial tuberosity is when there is a combination of medial and lateral malunions. This approach allows full visualization, evaluation, and intra-articular correction of both knee compartments, whereas an approach with use of separate medial and lateral incisions makes intraoperative orientation more difficult.

Wound closure: The anterior tibial fascia is reattached, and a lateral fasciotomy is performed to prevent an anterior

compartment syndrome. In the presence of a lateralized patella, closing the iliotibial tract is unnecessary.

POSTOPERATIVE MANAGEMENT

Activity is restricted to functional passive motion until reduction of postoperative swelling and restoration of range of motion of the knee is accomplished. Brace protection is provided, and only toe-touch weight-bearing with crutches is allowed for eight weeks. Thereafter, an increase to full weight-bearing is allowed as tolerated. Physiotherapy is recommended throughout the

whole rehabilitation period in order to prevent inadequate mobilization and to optimize leg muscle function.

If toe-touch weight-bearing is not possible, despite careful preoperative instruction, or if poor compliance is expected, the leg is placed in a continuous-passive-motion machine to maintain function and to reduce postoperative swelling prior to immobilization in a cylinder cast.

Radiographs are made on both the first postoperative day as well as at eight weeks (Figs. 8-A through 8-G).

CRITICAL CONCEPTS

INDICATIONS:

- Painful and disabling posttraumatic intra-articular and valgus malunion of the tibial plateau in active patients. Valgus malunion of up to 20° and plateau depression of up to 20 mm can be satisfactorily corrected.
- Both conservatively as well as operatively treated tibial plateau fractures.

CONTRAINDICATIONS:

- Poor general health
- Elderly patients
- Severe loss of knee function, or the presence of advanced osteoarthritis
- Infection
- Compromised soft tissues
- Uncertain patient compliance

PITFALLS:

- Overcorrection or undercorrection of the valgus deformity
- Undercorrection of the joint surface; a slight intraoperative overcorrection of 1 mm being preferable
- Damage to the peroneal nerve
- Injury to the popliteal artery or vein
- Compartment syndrome of the anterior compartment resulting from failure to perform a routine fasciotomy
- Malunion or nonunion resulting from failure to assess lower extremity alignment and knee joint stability intraoperatively

AUTHOR UPDATE:

Currently, we perform the surgical technique as it was described in the original paper, without modification.

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