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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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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.

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. 1A and 1B** 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.)

**FIG. 1C**

Detachment of the anterior tibial muscle.
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 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.

(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.)
ment. In general, anatomic re-
construction 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 de-
pression) malalignment. The
combination osteotomy de-
scribed in the present report re-
stores intra-articular anatomy
and provides varus correction,
typically provides a good func-
tional outcome, and preserves
the salvage option of total knee
arthroplasty. Nevertheless, opti-
mal recovery requires a pro-
tracted period of convalescence.

**SURGICAL TECHNIQUE**

Osteotomy of the fibula
1: In order to achieve full correction, a
mid-third, oblique osteotomy of
the fibula is routinely performed,
as long as a fibular head osteot-
omy is not required to approach
the intra-articular malunion.

Exposure of the proximal
part of the tibia1: A straight lat-
eral parapatellar incision is uti-
лизed. The iliotibial tract is
incised to the Gerdy tubercle,
and the fascia of the anterior tib-
ial 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 osteotomy1,2:
The neurovascular bundle is pro-
tected by blunt Hohmann retrac-
tors (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 os-
teotomes (Figs. 2-C and 2-D), al-
lowing 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 correc-
tion 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 ap-
proached with the knee in 100°
of flexion. This position is facili-
tated by supporting the foot of
the patient on a sandbag
mounted onto the operating ta-
ble. Further approach to the knee
joint depends on the location of

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**FIG. 4-A**

The exposure and intra-articular osteotomy of the lateral tibial condyle is done through a simple lateral arthrotomy. (Reprinted, with permis-
sion, from: Marti RK, Kerkhoffs GM. Osteotomies for malunions of the tibial head. In: Marti RK, van Heerwaarden RJ, editors. Osteotomies
Figs. 4-B and 4-C
Further exposure after the osteotomy of the Gerdy tubercle.

FIG. 4-B

FIG. 4-C
the joint incongruency. With a standard lateral arthrotomy, the anterior 50% to 60% of the lateral plateau can easily be visualized and approached (Fig. 4-A). To expose more posteriorly situated depressions, an osteotomy of the Gerdy tubercle and reflection of the attached iliotibial tract allow visualization of approximately 80% of the lateral plateau (Figs. 4-B and 4-C). Fi-

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.
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. 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.

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. 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.
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 osteotomy 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.
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.

Drill-holes are placed around the depressed zone.

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

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 intraarticular 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 lateraled 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 continuouspassive-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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The line drawings in this article are the work of Jennifer Fairman (jfairman@fairmanstudios.com).

REFERENCES


