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# Combination of interfragmentary screws and locking plates in distal meta-diaphyseal fractures of the tibia: A retrospective, single-centre pilot study

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ABSTRACT

If distal tibia fractures cannot be treated with intramedullary nails, locking compression plates, such as the LCP Medial Distal Tibia Plate of Synthes, are used. Bridge plating with interfragmentary movement is the strategy for such osteosynthesis. Interfragmentary movement is difficult to predict. Too much movement leads to formation of more, but less stable callus; longer time until complete fracture healing has been reported. Interfragmentary movement can be controlled by the stability and flexibility of the osteosynthesis construct. We used interfragmentary screws to limit interfragmentary movement in certain cases. We noticed a tendency of faster fracture healing in patients with interfragment lag screw compared with those with sole bridge plating. We therefore retrospectively assessed our patients for time until clinical fracture healing (i.e., pain-free weight bearing and visible callus in both layers on conventional plain film radiographs) and callus formation.

*Methods:* Data (from patient chart and from regular visits) of 52 patients with fracture of the distal tibia were reviewed, of which 11 were lost to follow-up. After surgery, weight bearing was limited to 20 kg for 6 weeks and then increased in weekly intervals to the pain threshold. X-rays were taken after 3 days, 6, 12 and 24 weeks and when achieving full weight bearing. Time from surgery until ability to full weight bearing was measured and compared. Callus index was measured as quotient of callus thickness and diameter of corticalis both in a.p. and sagittal direction. Statistical evaluation was done with the Mann–Whitney *U*-test.

*Results:* A total of 41 patients could be analysed; of them, 30 patients had extra-articular fractures. Four patients had 43-B and seven patients had 43-C fractures.

As many as 13/30 extra-articular fractures were treated with interfragmentary screws: In this group ($n = 11$, without considering one patient with plate failure and one with pseudarthrosis) time to full weight bearing was 11.38 weeks versus 14.9 weeks without screw ($n = 14$; without two pseudarthrosis and one deep infection) ($p = 0.044$). Callus index at full weight bearing was significantly lesser in patients with screw compared with those without.

*Conclusion:* Though interfragmentary screws seem to block necessary interfragmentary movement, we see callus formation as a sign of secondary fracture healing. The osteosynthesis construct with interfragmentary screw seems to be more stable and less flexible than sole bridge plating, leading to faster fracture healing. Interfragmentary screws might help to control and limit interfragmentary movement in certain cases.



## Introduction

Locking compression plates (LCPs) have by now become standard plates for the treatment of comminuted fractures, especially in cases where soft-tissue conditions prohibit extensive approaches. Unlike conventional compression plates, they do not alter the periosteal blood supply. The basic principle of the LCP is secondary fracture healing. For this purpose, the implant allows micro-movement of the fragments against each other, hence inducing the formation of stable fracture callus. Though, in the case of distal tibia fractures, this can also be achieved by intramedullary nailing. However, nails find their limitations in pilon fractures and meta-diaphyseal fractures reaching the distal aspect of the bone. Complication rates after intramedullary nailing can reach up to 75%, whereby mainly deviation of the axis, malrotation and pseudarthrosis have been reported.[3,13] In these cases, implants such as the Medial Distal Tibia LCP provide a good opportunity for

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fixation. This plate allows easy reduction and fixation of multi-fragment fractures without compromising the periosteal perfusion. However, fixation of fractures with locking plates is difficult and demanding, especially in complex fractures or in cases where soft-tissue conditions prohibit open reduction.

Fracture consolidation with LCPs requires interfragmentary movement to stimulate callus formation. The amount of interfragmentary movement influences callus formation. Interfragmentary movement is hereby connected to the stability and flexibility of the used implant. (Flexibility is the ability of a construct to react on forces without irreversible deformation, whereas stability describes the resistivity of materials towards irreversible bending and crippling.) It is the surgeon's task to maintain optimal flexibility in osteosynthesis to induce maximum callus formation. Working length (i.e., the distance between the screws less proximal and distal to the fracture) as well as the implant itself and the distance of the plate to the bone influence the flexibility of an osteosynthesis. Other ways to influence these parameters are the kind of fixation of the screws in the bone and the implant itself.[4] Another method to increase stiffness and reduce flexibility in a fracture zone is the moderate use of interfragmentary screws to block certain fragments towards each other or to limit interfragmentary movement.

Though performed by many surgeons, such a concept is not generally accepted and vigorously discussed. It might be regarded as a contradiction to the idea of secondary bone healing and the principles of LCPs.

Nevertheless, in several cases in which reduction of the fracture was not to be held by the plate itself, we used such screw-plate constructs when treating fractures of the distal tibia. During follow-up, we noticed a tendency towards faster fracture healing (i.e., visible callus formation and painless full weight bearing) in patients with interfragmentary screws and locking plate compared with those with locking plates alone (and comparable fracture patterns). Therefore, we performed a systematic retrospective pilot analysis of our case and addressed the following question: Is there a difference in fracture healing, time until full weight bearing and callus formation whether interfragmentary, conventional lag screws are used together with locking plates?

## Patients and methods

As this is a retrospective, single-centre study, no distinct protocol was followed for treatment. We retrospectively analysed all patients with a fracture of the distal tibia, who were treated with the Distal Tibia LCP (Synthes) between 2006 and mid-2009 in our department. Written consent to analyse the data of the patient charts for scientific purpose was available from every patient. (This consent is in accordance with the appropriate ethics committee and does allow use of data that has been gathered in line with the regular, necessary treatment. It does not allow examinations that are not necessary for treatment but of scientific interest.)

### *Operative management*

Depending on the soft-tissue conditions and the stability of the fracture, the ankle joint was either immobilised in a cast or transfixed with an external fixator. Definite surgery was done after sufficient detumescence of the soft tissue. Four surgeons were involved in the definite treatment. If the fibula had to be reduced for length reconstruction, it was addressed first. Then, the tibial fracture was reduced under fluoroscopy. In some cases, open reduction was necessary to obtain acceptable results. After reduction, the Distal Tibia LCP was inserted supra-periosteal over a short skin incision (approximately 3–4 cm in length) in the region of the medial malleolus, then consecutively fixed with screws in the proximal and distal aspect of the plate. If necessary, for every screw, a single incision was used (1–2 cm long). In some situations, adjacent screws were set in a combined, longer incision.

In some cases, sufficient reduction was not achieved or kept until final fixation of the plate. In these cases, it was the decision of the surgeon to use an interfragmentary lag screw to immobilise the fragments towards each other. In all such cases, the lag screws were conventional, 3.5-mm cortical screws. No locking screws were used. Normally, the lag screw was placed before complete locking of the plate so that the lag screw could be used to reduce the fracture or to adapt fragments with wide fracture gap. A potential external fixator was removed 3–4 days after surgery, depending on the swelling. From the first postoperative day, patients were mobilised using walking aids. The extent of physiotherapeutic treatment was also adapted to the soft-tissue swelling and the patient's abilities.

Until the end of the 6th postoperative week, every patient was allowed a partial load of 20 kg. The ankle was either immobilised in a cast or in a vacuum stabilisation system (Vacoped®, Oped GmbH, Germany). The decision of which to use was based on the patient's compliance and ability to handle the Vacoped System.

After 6 weeks, patients were allowed to increase load in weekly steps to the pain threshold.

Regular X-rays were taken on day 3 after surgery, after 6 weeks (±1 week), after 12 weeks (±2 weeks) and after 3 months (±2 weeks). Further X-rays were taken when the patient achieved full weight bearing. After 6 months, X-rays were taken in regular steps in those patients who had not achieved full weight bearing yet. These patients were seen at monthly intervals.

We retrospectively assessed the time until full weight bearing was possible. Generally, such data were available from the patient's chart and reports from regular follow-up visits. X-rays were assessed by the operating surgeon, one surgeon who did not participate in surgery and one experienced radiologist.

Quantification of the amount of formed callus was done, as described previously by Gardner et al.[5] This hemi-quantitative method describes the quotient of the thickest part of the callus and the diameter of the diaphysis at that site. Computed tomography (CT) scans were not regularly done; therefore, three-dimensional callus volume was not applicable in this retrospective study.

Sufficient healing of the fracture was assumed, if painless full weight bearing was possible and a complete callus bridging of the fracture gap was visible both in lateral and a.p. views.

### *Statistics*

For comparing time until fracture healing and for comparison of the callus index, the Mann–Whitney *U*-test was used. Significance was assumed if $p < 0.05$. Correlation was assessed for the parameters 'full weight bearing', 'surgery time in minutes', 'fracture classification' and 'soft-tissue destruction'. Correlation coefficients were determined for estimating correlations between healing time and kind of reduction (minimally invasive plate osteosynthesis (MIPO) versus open reduction and internal fixation (ORIF)), operation time, soft-tissue damage and fracture classification.

## Results

Between January 2006 and 2009, 52 patients were treated with the LCP Medial Distal Tibia Plate (Synthes). Altogether, 11 patients were lost to follow-up: six went back to their home town or country. One patient had an additional proximal tibia fracture that needed several revisions due to severe infection. One patient suffered a fracture of the tibia after a Borggreve rotationplasty (resection of the knee and replacement with the ankle) was done