

# Immediate weight-bearing after osteosynthesis of proximal tibial fractures may be allowed

Karl Tobias Haak, Henrik Palm, Kim Holck, Michael Krashennikoff, Peter Gebuhr & Anders Troelsen

## ABSTRACT

**INTRODUCTION:** Immediate weight-bearing following osteosynthesis of proximal tibial fractures is traditionally not allowed due to fear of articular fracture collapse. Anatomically shaped locking plates with sub-articular screws could improve stability and allow greater loading forces. The purpose of this study was to investigate if immediate weight-bearing can be allowed following locking plate osteosynthesis of proximal tibial fractures.

**MATERIAL AND METHODS:** Locking plate osteosynthesis of partial articular proximal tibial fractures (Arbeitsgemeinschaft für Osteosynthesefragen type 41B) operated from November 2007 to September 2009 at Hvidovre Hospital were included retrospectively (n = 32). Complications, reoperations and radiographic outcome at 6-8 week of follow-up were assessed. Twenty patients were not allowed to bear weight the first 6-8 weeks, whereas twelve were allowed immediate postoperative weight-bearing.

**RESULTS:** The use of bone allograft, the number of screws inserted and the application of postoperative articular mobilizing brace were comparable between the two groups ( $p \geq 0.08$ ). Persisting depressions of the articular surface ranged from 0 to 5 mm postoperatively with no difference between the groups ( $p = 0.36$ ). At 6-8 weeks postoperatively, no changes in radiographic configuration of the fracture site were observed in either group.

**CONCLUSION:** This retrospective study suggests that immediate weight-bearing following locking plate osteosynthesis of partial articular proximal tibial fractures may be allowed. Future, larger prospective randomised studies are needed.

**FUNDING:** not relevant.

**TRIAL REGISTRATION:** not relevant.

Treatment of proximal tibial fractures is challenging. Patient recovery is dependent upon optimal joint congruency, fracture alignment and rotation, and postoperative complications such as joint stiffness, arthritis instability and pain are common. Additionally, treatment can be complicated by cartilage and soft-tissue injury, compartment syndrome and infection [1-4].

Immediate postoperative weight-bearing is traditionally not recommended following treatment of proximal tibial fractures due to fear of fracture collapse, especially at the articular surface. However, the use of new anatomical shaped locking plates with several

sub-articular screws has made it possible to obtain a more stable fracture fixation than with conventional methods. Greater loading forces may therefore be allowed [5-8].

Immediate weight-bearing and mobilisation could potentially reduce the risk of postoperative complications such as deep venous thrombosis and more rapidly secure recovery to a pre-fracture ambulation level. If early mobilization does not increase the risk of fracture collapse or compromise outcome, this treatment regime would therefore be attractive.

The aim of the present study was to investigate if immediate weight-bearing can be recommended following locking plate osteosynthesis of proximal tibial fractures. Proximal tibial fractures are heterogeneous and incidence rates are low, but we retrospectively identified a homogenous group of partial articular tibial fractures and investigated if immediate weight-bearing was associated with more complications and radiographic changes than if the patient was not allowed to bear weight during the immediate postoperative course.

## MATERIAL AND METHODS

In this retrospective study, we included patients with partial articular proximal tibial fractures (Arbeitsgemeinschaft für Osteosynthesefragen (AO) type 41B) [9] operated with the locking plate osteosynthesis technique at the Department of Orthopaedics, Hvidovre Hospital, from November 2007 to September 2009. According to Danish legislation and the design of the current project, an approval by an ethics committee was not required. Patients eligible for inclusion were identified in the logistic operation management database, Orbit (Logica, Stockholm, Sweden). Preoperative X-rays were used to determine the AO classification. Partial articular fractures included fractures with a pure split, pure depression or a combination involving only one tibial condyle. A total of 35 consecutive patients with well-defined fractures were identified. Three of these were subsequently excluded: One due to dementia, one due to lack of baseline information, and one due to lack of follow-up information after transfer to a department in Greenland. Thus, thirty-two patients were available for further data analysis.

All patients were managed in accordance with the

## ORIGINAL ARTICLE

Department of  
Orthopaedic Surgery,  
Hvidovre Hospital

Dan Med J  
2012;59(10):A4515


**FIGURE 1**

Radiograph illustrating a locking plate osteosynthesis of an Arbeitsgemeinschaft für Osteosynthesefragen/OTA type 41B partial articular proximal tibial fracture in a 46-year-old male patient. Visual holes in the femur and tibia indicate that an external fracture distracter was needed during surgery.

department's protocol for proximal tibia fractures which includes prophylactic antibiotics and postoperative low-molecular-weight heparin. With the patient in a supine position, under C-arm guidance and, when needed, with the use of an external fracture distracter, reduction of the articular surface was achieved through the fracture gap or through a small cortical window osteotomy distal to the fracture. The plate (LCP Proximal Tibial Plate 4.5/5.0 lateral, Synthes, Solothurn, Switzerland or

OptiLock Periarticular Plating System, Proximal Tibial Plate Application, Biomet, Parsippany, NJ, USA) was inserted through a curved anterolateral incision and additional stab-incisions were made for the distal screws (**Figure 1**). The plan for postoperative weight-bearing and hospital discharge was given individually by the surgeon.

The patients were divided into two groups; the first group was not allowed to bear weight for the first 6-8 postoperative weeks ( $n = 20$ ), whereas the second was allowed immediate postoperative weight-bearing ( $n = 12$ ). The two groups were compared with respect to patient demographics, fracture characteristics, operative management, complications and death.

Demographics (age, gender), American Society of Anesthesiologists (ASA) score, impaired mobilization before fracture, bone grafting and postoperative regime compliance were assessed from the patients' records, as were subsequent complications (reoperation and mortality) and distress (pain, impaired knee joint motion, need of specialized physiotherapy, extended length of bandaging).

Deformation was assessed from immediate postoperative X-rays position and the number of plates, the number of screws used, postoperative depression of the tibial articular surface, postoperative width of the fracture, articular congruence and varus-valgus (axial). The postoperative depression and width of the fractures were assessed by digital X-ray measurements in the Radiology Information Service system, IMPAX-RIS (Agfa, Köln, Germany). Depression was measured as the verti-


**TABLE 1**

Income and immediate postoperative data for patients included in the statistical analysis ( $n = 32$ ). The p-value presents the comparison between the two postoperative regimes, immediate weight bearing versus non-weight-bearing after locking plate osteosynthesis.

	Non-weight-bearing ( $n = 20$ )	Weight-bearing ( $n = 12$ )	p-value
Females, n	11	6	0.78 <sup>a</sup>
Age, years, mean (range)	51.5 (21-68)	43.5 (24-63)	0.12 <sup>b</sup>
Impaired mobilization, n	1	2	0.54 <sup>c</sup>
ASA score, n			0.94 <sup>d</sup>
I	13	9	
II	6	3	
III	1	0	
<i>Operative result</i>			
Postoperative joint line depression, mm, median (range)	1 (0-4)	0 (0-5)	0.36 <sup>d</sup>
Postoperative width, mm, median (range)	1 (0-8)	0 (0-4)	0.07 <sup>d</sup>
Bone grafting, n	10	2	0.08 <sup>c</sup>
Screws in plate, n, median (range)	7 (5-11)	8 (5-9)	0.84 <sup>d</sup>
Screws in plate under joint line with three screws, n	19	12	
Varus-valgus angulation, °, median (range)	90 (86-92)	90 (83-91)	0.39 <sup>d</sup>
Anatomical articular joint congruence, n	11	6	0.78 <sup>a</sup>
Articular mobilizing brace, n	19	12	1.00 <sup>c</sup>

ASA = American Society of Anesthesiologists.

Pearson's  $\chi^2$ -test; b) t-test; c) Fisher's exact test; d) Wilcoxon rank-sum test.



TABLE 2

	Non-weight-bearing (n = 20)	Weight-bearing (n = 12)	p-value
<i>Fractures 6-8 weeks postoperatively, n</i>			
Collapse	0	0	
Loosening of hardware	0	0	
<i>Complications, n</i>			
No complications	9	6	0.70 <sup>a</sup>
Pain	4	1	
Impaired range of motion	5	3	
Psychological complaints	1	0	
Bandaging complaints	1	0	
Instability of the knee	1	0	
Reoperation	0	0	
Mortality	1	1	
No information about complications	1	3	

a) Fisher's exact test.

Outcome data for the two study groups. Six to eight weeks postoperative X-ray assessment and complications compared for the non-weight-bearing and the immediate postoperative weight-bearing study group.

cal distance from the displaced articular surface to a line drawn through the unaffected articular plateau. The increase in width of the tibial plateau was assessed by measuring the gap (horizontal distance) to the displaced component. Articular congruency was assessed by a visual judgment. Varus-valgus deformation was measured as the angle between a central line in the tibia and a line through the tibial articular surface.

Visual intra-articular fracture collapse or loosening of hardware was assessed by an audit comparing postoperative and 6-8 week follow-up radiographs.

Normally distributed data were presented as means with ranges and compared using two-sample t-test. Data that were not normally distributed were presented as median values with ranges and analysed using the two-sample Wilcoxon rank-sum (Mann-Whitney) test. Binomial data were presented as proportions and compared using Pearson's  $\chi^2$ -test or Fisher's exact test if the number of events was less than five in any group. The level of significance was set at  $p < 0.05$ .

*Trial registration:* not relevant

## RESULTS

Included in the statistical calculations were 32 patients (17 females) with a mean age of 48 years (range: 21-68) and a median ASA score of one (range: 1-3). Impaired mobilization before surgery was present in three patients. None of these were immobilised in a wheelchair.

Immediate postoperative X-rays revealed persisting depressions of the tibial articular surface that ranged from 0-5 mm postoperatively with no difference between the groups (Table 1).

The postoperative width of the tibial plateau showed a median increase of 1 mm (range: 0-8) in the

non-weight-bearing group compared with a median of 0 mm (range: 0-4) in the weight bearing group. This difference was not significant ( $p = 0.07$ ).

Further operative results in terms of use of bone allograft, number of screws inserted, varus-valgus angulations, joint congruence and the application of a postoperative articular mobilizing brace were comparable between groups (Table 1).

X-rays taken 6-8 weeks postoperatively revealed no changes in the radiographic configuration of the fractures or signs of hardware loosening in any of the patients (Table 2). None of the patients were reoperated. The number of complications and distress were comparable between groups with respect to pain, impaired range of motion, psychological complains, bandaging complains and instability of the knee. Two patients died of unrelated causes, one in each group. The proportion of patients who did not report any complications 6-8 weeks postoperatively was comparable between the groups (Table 2).

## DISCUSSION

Internal fixation of proximal tibia fractures is today widely performed by use of modern locking plates combined with minimally invasive operative techniques [10-15]. Besides being less invasive, the major advantage of locking over non-locking plates is that a more stable fixation of the fracture can be achieved [5-8].

It is known that short- and long-term postoperative complications can be affected by the postoperative rehabilitation regime [1-4]. By using locking plates, surgeons may be able to permit immediate postoperative weight bearing. This could potentially decrease the rate of postoperative complications associated with immobilization such as deep venous thrombosis and stiffness.

The traditional postoperative regime for proximal tibial fractures is approximately six weeks without weight bearing. This is mainly due to surgeons' concerns about fracture collapse. Immediate weight bearing is today allowed by some surgeons. No guidelines or consensus exist, however, about postoperative weight bearing; and no literature or former studies were found in this field. The decision to allow weight bearing versus no weight bearing is therefore solely based on the individual surgeon's judgment. Affecting this judgment are patient factors (body mass index, age, bone quality, cognitive impairment, level of mobilization before fracture and patient compliance), the fracture complexity, the operative result in terms of fracture reduction and achieved stability of fixation, surgeon and departmental routines.

In this study, two groups of patients with partial articular proximal tibia fractures were compared, all osteosynthesised with locking plates. One group was allowed to bear weight-immediately postoperatively, whereas the other was prescribed a non-weight-bearing regime.

We found no radiographic signs of fracture collapse in either of the two groups, and the numbers of patients without reported complications were comparable. These results indicate that immediate weight bearing may possibly be allowed following locking plate osteosynthesis of partial articular tibia fractures.

When interpreting these results, it is important to consider if the patient groups were comparable. In light of the absence of guidelines for the optimal postoperative regime, the surgeon's decision as to whether or not a patient was allowed to immediately weight-bear could be based on an intra-operative assessment. This could lead to the decision that patients with more complex fractures and less satisfying operative results would more frequently be included in the non-weight-bearing group. Furthermore, the operator's skills and experience could affect this judgement. In this retrospective study, we sought to minimize this bias by only including a homogenous group of patients with well-defined partial articular proximal tibial fractures (AO type 41B). In addition, our groups were comparable with respect to patient factors (gender, age, ASA, impaired mobilization) and operative results (postoperative width, depression, bone grafting, number of screws, varus-valgus angulations, articular joint congruence) (Table 1).

The retrospective design of this study limits the strength of our conclusions. However, as described, a systematic and optimised collection of data was ensured. The size of the cohort was limited as this was a single-centre study, and the risk of ignoring a true difference between groups should therefore be taken into consideration. Incidence rates of proximal tibial fractures are low and to secure a larger cohort, multi-centre

studies are needed. A further limitation of this study was that only peri- and short-term postoperative outcome measures were examined and thus any long-term benefits or disadvantages of immediate postoperative weight bearing versus non-weight-bearing could not be evaluated. Ideally, future studies should therefore be designed to include long-term evaluations where final healing and any secondary bone resorption may be assessed. Standardized procedures for X-ray imaging that could minimise variations in leg alignment and image angle would also be beneficial.

This study suggests that immediate weight bearing could be allowed following locking plate osteosynthesis of partial articular proximal tibia fractures. This study is the first to explore the outcome of immediate weight bearing, and it can thus be used to generate a hypothesis for future, larger prospective randomised studies which may generate results upon which clinical recommendations may be based.

**CORRESPONDENCE:** Karl Tobias Haak, Ortopædkirurgisk Afdeling, Hvidovre Hospital, 2650 Hvidovre, Denmark. E-mail: kth@dadlnet.dk

**ACCEPTED:** 17 July 2012

**CONFLICTS OF INTEREST:** Disclosure forms provided by the authors are available with the full text of this article at [www.danmedj.dk](http://www.danmedj.dk).

#### LITERATURE

- Oh JK, Sahu D, Hwang JH et al. Technical pitfall while reducing the mismatch between LCP PLT and upper end tibia in proximal tibia fractures. *Arch Orthop Trauma Surg* 2010;130:759-63.
- Rademakers MV, Kerkhoffs GM, Sierevelt IN et al. Operative treatment of 109 tibial fractures: five-to 27-year follow-up results. *J Orthop Trauma* 2007;21:5-10.
- Lachiewicz PF, Funic T. Factors influencing the result of open reduction and internal fixation of tibial plateau fractures. *Clin Orthop Relat Res* 1990;259:210-5.
- Dirschl DR, Dawson PA. Injury severity assessment in tibial plateau fractures. *Clin Orthop Relat Res* 2004;423:85-92.
- Ehlinger M, Adam P, Bonnomet F. Minimally invasive locking screw plate fixation of non-articular proximal and distal tibia fractures. *Orthop Traumatol Surg Res* 2010;96:800-9.
- Biggi F, DiFabio S, D'Antimo C et al. Tibial plateau fractures: Internal fixation with locking plates and the MIPO technique. *Injury* 2010;41:1178-82.
- Stannard JP, Finkemeier CG, Lee J et al. Utilization of the less-invasive stabilization system internal fixator for open fractures of the proximal tibia: A multi-center evaluation. *Indian J Orthop* 2008;42:426-30.
- Boldin C, Fankhauser F, Hofer HP et al. Three-year results of proximal tibia fractures treated with the LISS. *Clin Orthop Relat Res* 2006;445:222-9.
- Marsh JL, Slong TF, Agel J et al. Fracture and dislocation classification compendium – 2007: Orthopaedic Trauma Association classification, database and outcomes committee. *J Orthop Trauma* 2007;21(suppl 10):1-133.
- Phistikul P, McKinley TO, Nepola JV et al. Complications of locking plate fixation in complex proximal tibia injuries. *J Orthop Trauma* 2007;21:83-9.
- Ricci WM, Rudzki JR, Borrelli J Jr. Treatment of complex proximal tibia fractures with the less invasive skeletal stabilization system. *J Orthop Trauma* 2004;18:521-7.
- Stannard JP, Wilson TC, Volgas DA et al. The less invasive stabilization system in the treatment of complex fractures of the tibial plateau: short-term results. *J Orthop Trauma* 2004;18:552-8.
- Nikolaou VS, Tan HB, Haidukewych G et al. Proximal tibial fractures: early experience using polyaxial locking-plate technology. *Int Orthop* 2011;35:1215-21.
- Liu F, Tao R, Cao Y et al. The role of LISS (less invasive stabilization system) in the treatment of peri-knee fractures. *Injury* 2009;40:1187-94.
- Beck M, Gradl G, Gierer P et al. Treatment of complicated proximal segmental tibia fractures with the less invasive stabilization locking plate system. *Unfallchirurg* 2008;111:493-8.