

# Predictors of short-term functional outcome following proximal tibial fractures

## – AO classification type C –

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**Objective:** Proximal tibial fractures are often difficult to treat and secondary osteoarthritis due to residual malalignment or irregularity of the articular surface is a common problem, especially in patients with comminuted fractures. The purpose of this retrospective study was to assess the relationship between the functional outcome and certain anatomical parameters as predictors for the prognosis in patients with AO type C fractures.

**Methods:** Clinical and functional data were collected on 24 AO type C fractures of the proximal tibia in 23 patients. The following factors were evaluated: the anatomical outcome, the tibial angle, the femoro-tibial angle, the medial and lateral tibial plateau angles, residual irregularity of the tibial plateau articular surface, and the functional outcome. The length of the follow-up period was 12 to 72 months.

**Results:** A large tibial angle and a small medial tibial plateau angle were associated with a worse functional outcome. All of the knees with residual irregularity of the medial tibial plateau articular surface had a worse functional outcome, while lateral irregularity was associated with various outcomes.

**Conclusion:** These findings suggested that the medial compartment of the knee joint is more important than the lateral compartment for the short-term functional outcome.

**Key words:** proximal tibial fracture, residual irregularity of the tibial plateau articular surface, tibial plateau angle

## INTRODUCTION

Proximal tibial fracture is a common injury, with some of these fractures being caused by a strong impact such as a traffic accident and others being caused by the relatively weak impact of a fall in elderly people. Such fractures are frequently intraarticular and/or comminuted, so that initial treatment including open reduction and internal fixation is often difficult. Furthermore, it is likely that secondary osteoarthritis will occur due to residual malalignment of the lower extremity or irregularity of the articular surface, especially in patients with comminuted intraarticular fractures.

According to the AO classification [1], type C fractures have all of the adverse characteristics mentioned above and therefore, are likely to be associated with a worse clinical outcome. The purpose of the present study was to retrospectively assess the relationship between the functional outcome and several anatomical parameters as predictors for the prognosis in patients with AO type C fractures of the proximal tibia.

## PATIENTS AND METHODS

We reviewed the medical records and radiographs of all the patients attending Tokai University Hospital or affiliated hospitals from January 1996 to December 2002 who had a diagnosis of proximal tibial fracture. From among them, we selected all of the patients with AO type C proximal tibial fractures that could be fol-

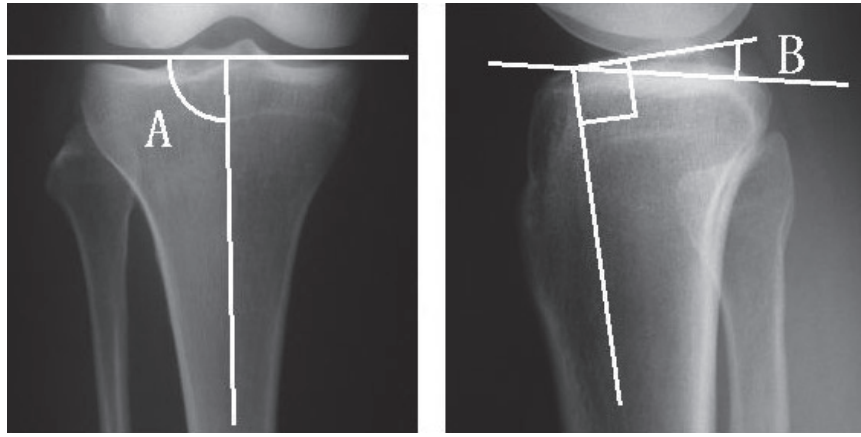
lowed for more than 1 year after injury.

Overall evaluation was performed by examining the clinical outcome in relation to various anatomical parameters. The clinical outcome was scored according to the functional grading method of Hohl and Luck [2]. We used the tibial angle [3], the femoro-tibial angle, and the medial and lateral tibial plateau angles as anatomical parameters (Fig. 1). We also examined the anatomic grade [2] and the residual irregularity of the tibial plateau articular surface as anatomical parameters. We defined what had a step-off and/or a split of more than 1 mm in the radiographs as positive irregularity. All of these parameters and the clinical outcome were examined at the time of the latest follow-up.

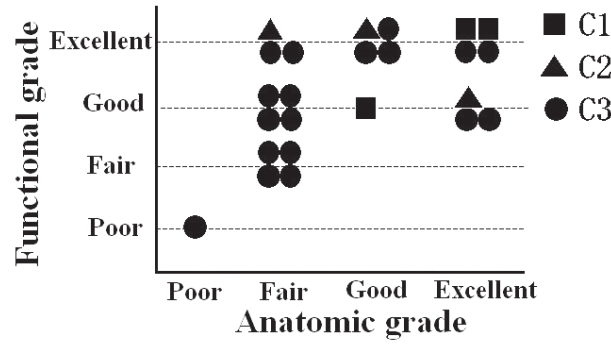
## RESULTS

One patient had bilateral fractures, so we studied 24 fractures in 23 patients. There were 16 males and 7 females with an average age of 46 years (range: 16-70 years). The mean follow-up period was 35 months in average (range: 12-72 months). Twenty-one fractures were caused by traffic accidents and 3 were due to falls. Fourteen fractures were of the closed type and 10 were open. The fractures were classified as follows: 3 were type C1, 5 were type C2, and 16 were type C3.

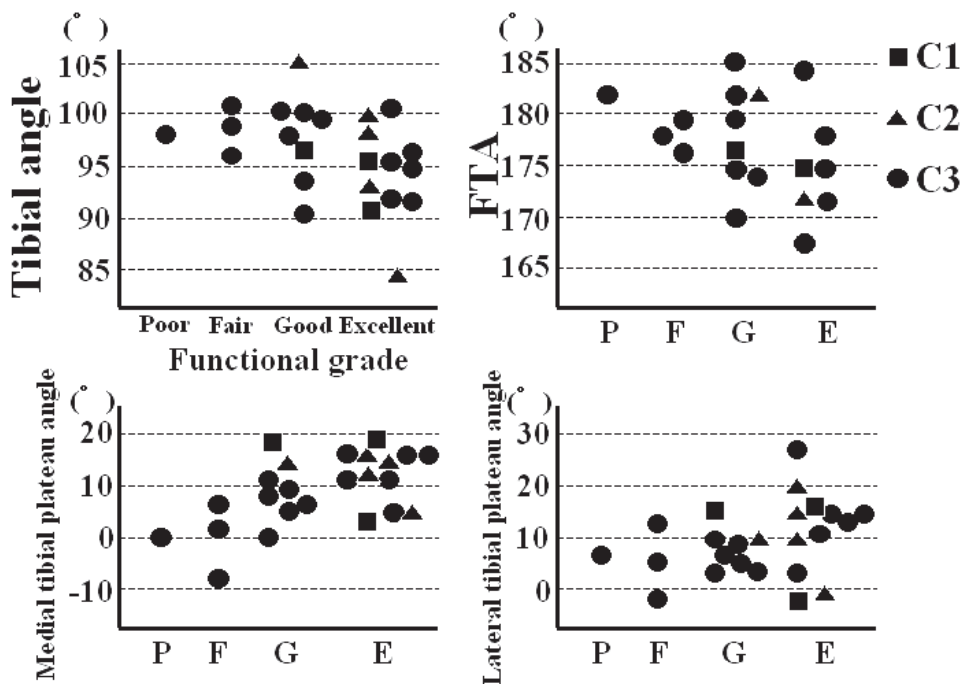
Three fractures were treated by closed methods and 21 were treated operatively with internal and external fixation. At the time of latest follow-up, all of the fractures showed complete bone union and all patients were able to walk.



**Fig. 1** Tibial angle (A) is determined in a radiograph of antero-posterior view by the line drawn through the articular surfaces of medial and lateral tibial plateau and the line drawn parallel to the axis of tibial diaphysis. Medial and lateral tibial plateau angles (B) are determined in a radiograph of lateral view by the line drawn tangential to the articular surfaces of medial and lateral tibial plateau and the line drawn vertical to the axis of tibial diaphysis.



**Fig. 2** Relationship between the functional and anatomic grades.



**Fig. 3** Relationship between the functional grade and the various quantitative parameters.

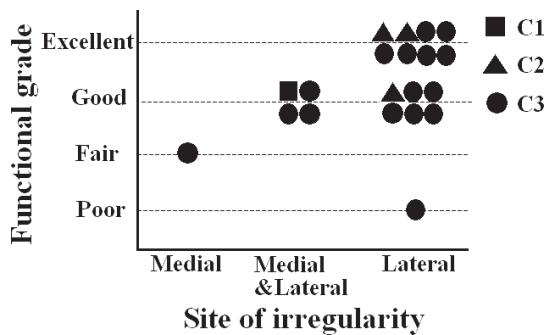


Fig. 4 Relationship between the functional grade and residual irregularity of the tibial plateau articular surface.

The overall functional grade was excellent for 11, good for 8, fair for 4, and poor for 1 of the fractures. All of the fair and poor outcomes occurred in patients with type C3 (Fig. 2).

When the relationship between the functional and anatomic grades was assessed, anatomically excellent or good cases were never evaluated as either fair or poor for the functional outcome, while all of the fair to poor functional results occurred in association with fair and poor anatomic grades, respectively (Fig. 2).

There were no apparent differences of the tibial angle among the functional grades as long as it showed a narrow distribution of the values from 90 to 100 degrees. There were also no apparent differences of the femoro-tibial angle or lateral tibial plateau angle among the functional grades. However, a smaller medial tibial plateau angle was associated with a worse functional outcome (Fig. 3).

Twenty fractures healed with residual irregularity of the tibial plateau articular surface. Residual irregularity of the medial tibial plateau articular surface was always associated with a worse functional outcome, while lateral irregularity resulted in a variable outcome (Fig. 4).

## DISCUSSION

The present findings indicate that the medial tibial plateau angle and residual irregularity of the medial tibial plateau articular surface are critical factors with respect to the short-term outcome of proximal tibial fracture, while the outcome is not much influenced by factors of the lateral compartment.

It is generally believed that precise anatomical restoration of the articular surfaces is necessary when treating intraarticular fractures [2, 4, 5, 6], as described by the anatomic grade of Hohl and Luck. However, the present study suggested that the effect on the functional prognosis of the knee joint after injury was greater for the medial compartment than the lateral compartment. Schatzker *et al.* classified this fracture with distinction between medial and lateral compartments [6]. Although they mentioned that the fractures of the medial condyle had the worst prognosis, they didn't show the data in detail. Honkonen *et al.* reported that the poorest results followed medially tilted bicondylar fractures [7]. However, in their study, it was not the compartmental factor but the malalignment of the leg that they focused on. Therefore, we would be

the first to focus on the compartmental factor as far as we could determine.

This finding may be attributable to the load-sharing mechanism of the femoro-tibial joint. An axial load acting on the normal knee joint during weight bearing produces more force on the medial condyle than the lateral condyle, and generates varus moment in the knee joint [8]. Moreover, a synergistic effect between compartmental deformity due to depression of the articular surface or secondary osteoarthritis leads to varus deformity of the leg, and varus moment generates even stronger force acting on the medial compartment. Therefore, even if the medial and lateral compartments have similar levels of residual articular irregularity, it is likely that the medial compartment will more rapidly develop secondary osteoarthritis that leads to a worse clinical outcome. However, this would only occur when patients have functional alignment of the lower limb on weight bearing, i.e., normal function of the medial collateral ligament and a normal (or near normal) femoro-tibial angle and tibial angle.

Quantitative analysis of the alignment of the knee joint showed that the knees with a smaller medial tibial plateau angle were likely to have a worse functional outcome than knees with a larger angle, as long as it was not excessively large. This would be attributable to changes of the load distribution, but we could not determine the mechanism. This problem needs to be solved in the future.

There were several limitations of this study. The first limitation was that the number of subjects was relatively small. The second limitation was that we only examined X-ray films. To more precisely evaluate the anatomical parameters, we should have examined tomograms and CT scans. The third limitation was that this study only assessed the short-term outcome, so we do not have any data about the intermediate or long-term outcome. We should adopt more than one time point for evaluation because the morphology of the united bones can change as time passes. In the future, we hope to assess the long-term influence of residual irregularity of the lateral tibial plateau on the clinical and anatomical outcome. The fourth limitation was that we did not consider complications occurring at the time of injury, such as ligamentous and meniscal damage that would have an influence on the outcome.

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