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Clinical Outcome after Surgical Treatment of Transitional Fractures of the Distal Tibia in Children

Klinické výsledky po chirurgickém léčení přechodných zlomenin distálního bérce u dětí

P. C. STROHM, O. HAUSCHILD, K. REISING, K. KUMINACK, N. P. SÜDKAMP, H. SCHMAL

University of Freiburg Medical Center, Department for Orthopedic and Trauma Surgery, Freiburg im Breisgau, Germany

ABSTRACT

PURPOSE OF THE STUDY

Fractures affecting a partially closed physis are described as transitional fractures. The distal tibia is one of the most common locations for transitional fractures second only to the distal radius. Aim of this retrospective study was to evaluate the clinical and radiological results after surgical treatment of transitional fractures of the distal tibia.

PATIENTS AND METHODS

From May 2003 to March 2009 24 children (median age 14 years) received surgical treatment for transitional fractures of the distal tibia. 89% (21/24) of patients were followed up after 27.5 (range 6 to 72) months to assess functional outcome (using the AO Foot and Ankle Score).

RESULTS

Nine girls and 15 boys were included in the study with the girls being younger on average (12.4 ± 0.9 vs. 14.3 ± 1.1 years, p = 0.00013). Two-plane fractures were present in 4 cases, 15 and 5 children sustained tri-plane I and II fractures, respectively. Median preoperative fracture displacement was measured at 4 mm (range 3 to 11 mm). Traumatic supination of the ankle joint during sports activities was the predominant injury mechanism (18/24 cases) followed by bicycle or motorbike accidents (6/24). A satisfactory reduction (1 mm or less) was achieved in all but one patient. In this case revision surgery was necessary to restore anatomical reduction. No perioperative complications occurred in the remaining 23 cases. Metal implants were removed upon fracture consolidation after 8.2 ± 6.7 months. At the time of follow-up none of the children were impaired in activities of daily living and there were no restrictions in sporting activity. All patients scored good or excellent results on the AO Foot and Ankle Score.

DISCUSSION

Surgical stabilization can be recommended as a safe and effective treatment strategy in displaced transitional fractures of the distal tibia and will lead to good or excellent mid term results.

Key words: transitional fracture, child, Tillaux, ankle joint.

INTRODUCTION

Physiological closure of the growth plate occurs as an expression of the increased predominance of ossification and proliferation processes and does not take place suddenly, which means that partly ossified areas coexist beside cartilaginous areas within the epiphysis. Fractures of a partially closed epiphysis are known as transitional fractures. This is a specific fracture pattern which is a combination of epiphysiolysis and epiphyseal fracture during the transition from adolescence to adulthood. In principle, transitional fractures can occur at any joint. The most frequent location for this fracture pattern is the distal radius, followed by injuries to the distal tibia (20). They account for 6–10% of all paediatric fractures of the distal tibia (1, 16). The majority of these fractures are the product of shear forces acting upon the partially closed epiphyseal growth plate. Tibial pilon fractures as described in adults normally do not occur in children and adolescents (11). Incorporation of the plate into the distal tibia is irregular and takes place from dorso-medial to ventro-lateral, whereby the process is still more systematic here than in other growth areas. For this reason, the phenomenon of transitional fracture at the distal tibial epiphysis has been defined and is most frequently described for this anatomical region (4, 13). Standard diagnostics depends on conventional radiographs of the ankle joint in two planes. The need for cross sectional imaging is the subject of controversial discussion (1, 3, 6, 12, 16, 17, 19). Treatment of this injury is conservative or surgical depending on the degree of displacement (14, 15).

The aim of this retrospective clinical study was to document treatment outcomes after transitional fracture of the distal tibia.

MATERIALS AND METHODS

In the period from 5/03 to 03/09 a total of 24 children with a mean age of 14 years (11/16) were treated surgically at our hospital for transitional fracture of the distal tibia. 89% (21/24) of the children were available for standardized clinical follow-up. The Foot and Ankle Score was chosen as the instrument to assess the subjective and objective treatment outcomes (7). With this score it was possible to document both subjective and objective parameters (maximum score 100 points). Pain and function are the most important parameters. The student's t-test was used for statistical analysis.

RESULTS

In the period under investigation 9 girls and 15 boys received surgical treatment for transitional fractures. The girls were a little younger than the boys on average (12.4 ± 0.9 years vs. 14.3 ± 1.1 years, $p = 0.00013$). Four children had sustained two-plane fractures, 15 had tri-plane I and 5 tri-plane II fractures. Mean displacement at the fracture gap was 4 mm (3/11). Supination trauma during sports activity was the cause of injury in the majority of cases (18/24), followed by motor scooter and bicycle accidents (6/24). Ipsilateral tibial fracture was present in 3 cases and one child had suffered polytrauma with craniocerebral trauma.

The time of treatment in 17/24 cases was less than 6 hours after the accident and was addressed by primary closed intervention. Four other cases received treatment after 28–52 hours and, in these cases, successful closed reduction proved impossible and open reduction became imperative. Closed reduction in 17 cases was achieved by percutaneous lag screw fixation (Fig. 1). In the other 4 cases a solidified haematoma was found intraoperatively in the fracture gap and had to be excised in open surgery to permit anatomical reduction. The remaining 3 cases were tri-plane II fractures with concomitant dislocation fracture of the fibula. In these cases open reduction was performed including stabilization of the fibula (Fig. 2).

In 23/24 cases the intra- and postoperative course was uneventful. One case required surgical revision due to inadequate primary reduction. In this case primary closed reduction in percutaneous technique was followed by an open procedure. In all other cases, the fracture gaps visible on the postoperative radiographs were 1 mm or less. Implant removal for all patients was conducted at the time of follow-up, which was on average 8.2 ± 6.7 months after surgical intervention. The final follow-up assessment took place at a mean of 27.5 (6/72) months. At the time of assessment none of the children were impaired with regard to activities of daily living and all the children were able to participate in sports activities. All the children achieved good or very good outcomes on the Foot and Ankle score (Table 1).

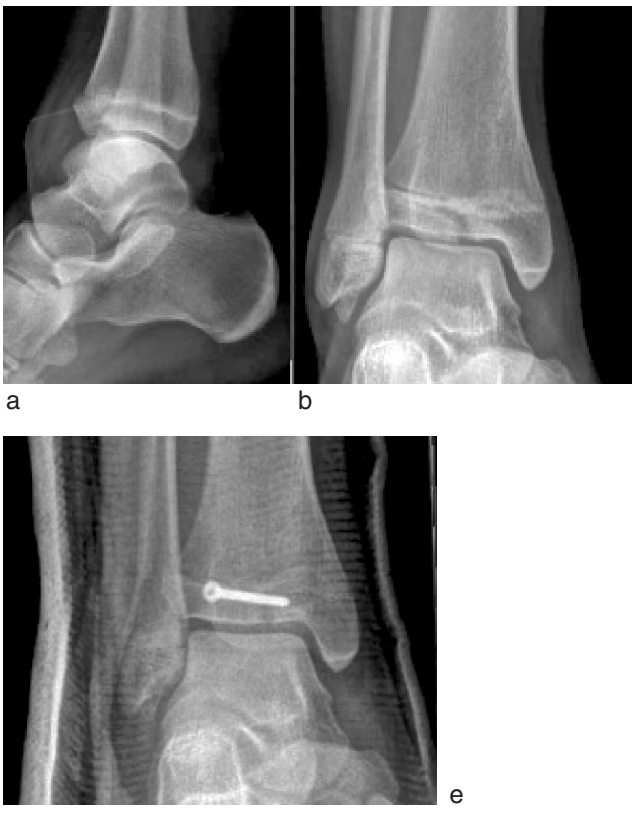


Fig. 1a–e. 14-year-old boy who was jumping while doing floor exercises and sustained this two-plane sprain fracture. Primary stabilization by percutaneous lag screw osteosynthesis.

DISCUSSION

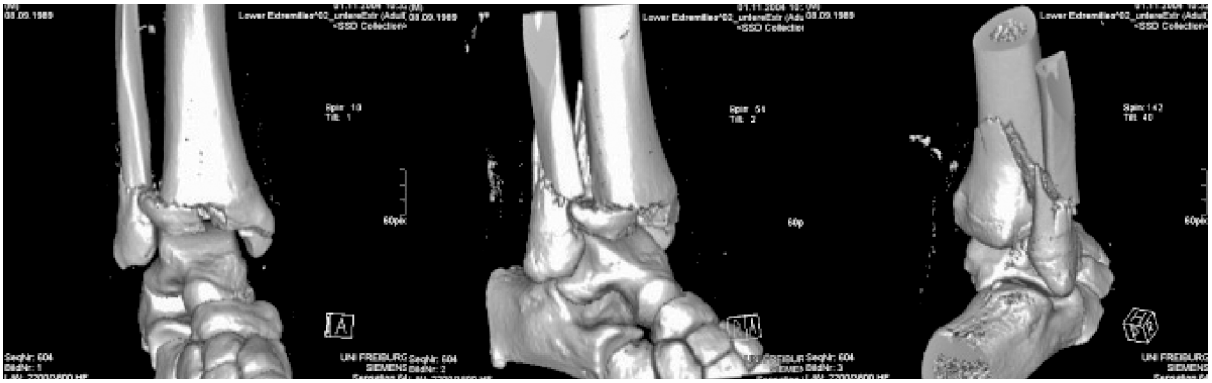
Transitional fractures of the distal tibia are relatively frequent injuries in adolescents. In the majority of cases, they arise as a result of sports accidents, falls and, depending on age, road traffic accidents. Diagnosis generally commences with conventional radiographic views of the ankle joint and some authors feel there is a need for cross sectional imaging diagnostics. Lutz von Laer analyzed a collective of 32 patients who were examined by computed tomography (CT) and reported that it was not

generally indicated (9). Brown et al. in their investigation in 2004 found that CT combined with the possibility of multiplanar reconstruction improved the surgeon's understanding of the fracture and facilitated preoperative planning (1). Seifert et al. conducted two studies and confirmed the advantages of cross sectional imaging, whereby they used magnetic resonance imaging (MRI) in their study rather than CT (16, 17). It was also pointed out that in some cases of conventional diagnosis the extent of the fracture and, in particular, fracture displacement was underestimated. In our hospital cross sectional imaging techniques are frequently used as diagnostic tools to ease interpretation of the injury and preoperative planning. As experience with these fractures increases it is no doubt possible to omit cross sectional imaging in some cases. Basically, MRI should be preferred over CT, as recommended by Seifert and other authors, if only because of the lower radiation exposure (12, 16, 17). Another advantage of MRI is also the visualization of concomitant injuries such as injuries to the ligaments as has been described in various articles (2).

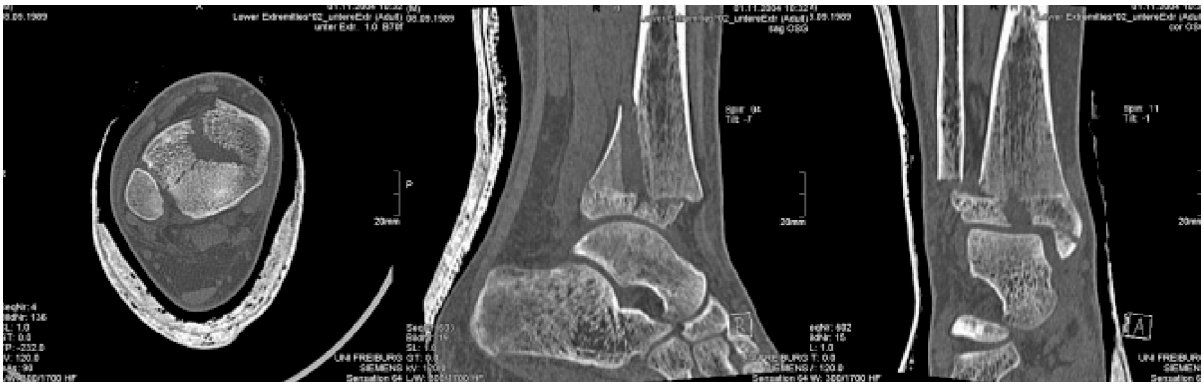
Table 1. Outcomes according to the AOFAS-Score

	Number	Median	Min/Max
Very good	15	96	(90/100)
Good	6	87	(84/89)
Fair	0		
Poor	0		

Treatment of transitional fractures may be conservative or surgical. The majority of authors recommend that fractures that are not or only slightly displaced should be treated conservatively. Slight fracture displacement is defined as 2 mm by most authors (14, 15, 19, 20). Interestingly, Schmittenbecher in his report states that 2 mm is an arbitrary value; in contrast, he cites several studies which state that precise anatomical reduction of joints and cartilage in children is of great importance in terms of long-term outcomes and prevention of arthrosis. For these reasons, the indication for surgery is often given at our hospital for displacements of less than 2 mm. We have not gained our own experience with arthroscope-assisted screw fixation as described by McGillion



a



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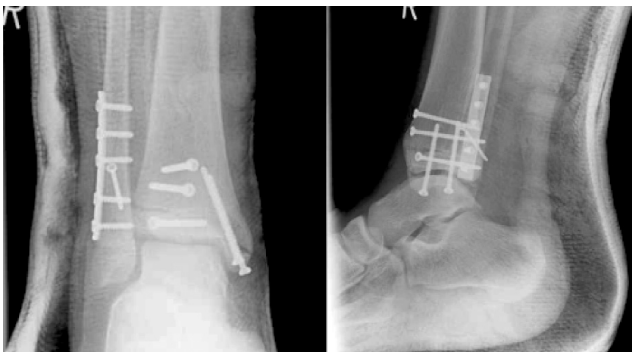

c | d

Fig. 2a–d. 15-year-old boy who sustained this tri-plane II fracture in a motor scooter accident. Stabilization of the fibula with a 1/3 tubular plate and fixation of the distal tibia with a single lag screw.

et al. (10) or with absorbable rods (5). However, since in most cases percutaneous anatomical reconstruction is successful and, in cases of open surgery, the incision is not very extensive, we do not consider arthroscopy-assisted techniques to be of vital importance. On the basis of our results we would however recommend prompt surgical intervention in order to increase the probability of a successful closed procedure.

Outcomes after transitional fractures of the distal tibia were good to very good in all studies including our own. This results corresponds to other injuries of the distal tibia in children (18). Premature epiphyseal closure due to fracture morphology and associated degree of maturation is not to be feared even though Leary et al. and Kraus did describe one such case, which however remains highly questionable in view of our study analysis (8, 9).

CONCLUSION

Transitional fractures of the distal tibia in adolescents are not rare injuries. Cross sectional imaging often provides useful insights and assists preoperative planning, whereby MRI should be preferred over CT because of the lesser radiation exposure. In our opinion, the indication for surgery should be broad since these are injuries affecting the joint. Correct diagnosis and adequate treatment will almost always produce good to very good outcomes.

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Corresponding author:
Priv. Doz. Dr. Peter C. Strohm, M.D.
University of Freiburg Medical Center
Department for Orthopedic and Trauma Surgery
Hugstetterstr. 55
D-79106 Freiburg im Breisgau
Germany
Tel: + 49 - 761 - 270 - 6130
Fax: + 49 - 761 - 270 - 9028
E-mail: peter.strohm@uniklinik-freiburg.de