Triplane fractures of the distal tibia in children

Adrian Chong Beng Tan, Roland Weng Wah Chong, Arjandas Mahadev
Department of Orthopaedics, KK Women’s and Children’s Hospital, Singapore

ABSTRACT

Purpose. To review 28 cases of paediatric triplane fractures of the distal tibia over a 7-year period in a tertiary paediatric hospital.

Methods. Records of 21 boys and 7 girls aged 11 to 15 (mean, 13) years presented with triplane fractures of the left (n=14) and right (n=14) ankles were retrospectively reviewed.

Results. Injury mechanism included low-energy trauma (n=10) and moderate-energy trauma (n=18). Fractures were 2-part in 20 patients, 3-part in 6, and 4-part in 2. 11 patients had concomitant fibular fractures. Articular displacement was <2 mm in 17 patients and ≥2 mm in 11 patients. 17 patients were treated conservatively (cast immobilisation); 11 were treated surgically by closed reduction and percutaneous pinning (n=1), open reduction and percutaneous pinning (n=5), closed reduction and internal fixation (n=3), or open reduction and internal fixation (n=2). Transepiphyseal partially threaded cannulated screws were used for fixation. The mean period of casting was 5.8 weeks, and the mean non-weight bearing period was 6.1 weeks. The mean follow-up period was 14.2 (range, 9–20) weeks. All patients had excellent outcome. No patient had any infections, delayed or non-union. Six patients had decreased range of motion and 4 had pain 4 weeks after cast removal.

Conclusion. Treatment outcome of triplane fractures of the distal tibia in children is good when guidelines are closely adhered to.

Key words: adolescent; ankle injuries; ankle joint; fibula; talus; tibia; treatment outcome

INTRODUCTION

The triplane fracture of the distal tibia is a multiplanar injury with 3 possible fracture configurations. The fracture pattern extends through the transverse (growth plate), sagittal (epiphysis), and coronal (distal tibial metaphysis) anatomic planes, disrupting the tibial articular surface of the ankle. Injury to the epiphysis in adolescence results in specific injury
patterns owing to the change in biomechanics. Anatomic reduction is necessary to prevent malalignment and subsequent early degenerative changes. We review 28 cases of paediatric triplane fractures of the distal tibia over a 7-year period in a tertiary paediatric hospital.

MATERIALS AND METHODS

Between January 2002 and January 2009, records of 21 boys and 7 girls aged 11 to 15 (mean, 13) years with triplane fractures of the left (n=14) and right (n=14) ankles were retrospectively reviewed. Patient age, gender, mechanism of injury, diagnosis, management, cast immobilisation duration, treatment outcome, and complications (pain, restricted range of motion or functional deficits) were recorded, as were the number and displacement of fragments. Computed tomography was performed in 2 patients for further evaluation (Figs. 1 and 2).

Triplane fractures with articular displacements of <2 mm were treated with cast immobilisation, whereas those with >2 mm displacement were treated with closed reduction and internal fixation. Open reduction was performed when the displacement was >2 mm after closed reduction.

Fracture union, presence of a deformity, premature closure of the growth plate, and post-traumatic arthritis were assessed on radiographs. Treatment outcome (pain, activity, function of ankle joint, walking ability, and radiographic result) was evaluated using a modified Weber protocol as excellent, good, fair, or poor. Scores for each item could range from 1 to 4.

RESULTS

Injury mechanism included low-energy trauma (n=10) such as walking, and falling off a low bed or chair, and moderate-energy trauma (n=18) such as soccer injuries (n=4), falling from a height of >1 m (n=3), skateboarding (n=3), running (n=2), martial arts training (n=2), ice-skating (n=2), bicycling (n=1), and playing softball (n=1) [Table].

Figure 1  A 12-year-old boy with a 3-part triplane fracture of the left ankle: (a) radiographs and (b) computed tomography showing a sagittal split through the epiphysis, a coronal split through the distal tibial metaphysis, and a transverse split through the growth plate, (c) 3-dimensional reconstruction of the fractures, and (d) good healing and congruent articular surface 4 months after conservative treatment.
Fractures were 2-part in 20 patients, 3-part in 6 (Fig. 1), and 4-part in 2 (Fig. 2). 11 patients had concomitant fibular fractures. Articular displacement was <2 mm in 17 patients and ≥2 mm in 11 patients. 17 patients were treated conservatively with cast immobilisation (Fig. 1); 11 were treated surgically by closed reduction and percutaneous pinning (n=1), open reduction and percutaneous pinning (n=5), closed reduction and internal fixation (n=3), or open reduction and internal fixation (n=2). Transepiphyseal partially threaded cannulated screws were used for fixation (Fig. 2).

The mean period of casting was 5.8 weeks, and the mean non–weight bearing period was 6.1 weeks. For patients treated conservatively, the mean non–weight bearing period was 6.7 weeks. For those treated surgically, the mean period of casting was 4.6 weeks and the mean non–weight bearing period was 5.3 weeks.

The mean follow-up period was 14.2 (range,
9–20) weeks. All patients had excellent outcome. No patient had any infections, delayed or non-union. Six patients had decreased range of motion and 4 had pain 4 weeks after cast removal.

**DISCUSSION**

The paediatric triplane ankle fracture is a transitional injury. Physeal closure of the distal tibia begins centrally and extends medially and then laterally. The anterolateral quadrant of the physis closes last. This gradual and asymmetric closure occurs over 18 months to 2 years and explains its specific fracture patterns.4

Triplane ankle fractures represent 5% to 10% of paediatric intra-articular ankle injuries, and typically occur in children aged 12 to 15 years (more commonly in boys than girls). Undisplaced triplane fractures can be managed with immobilisation in a long-leg cast. Displaced fractures can be treated with closed or open reduction and internal fixation through an anterolateral or anteromedial approach. Although triplane fractures are not associated with growth arrest as most of the physis has closed, they may lead to early arthritis owing to joint surface disruption or joint malalignment.2 Intra-articular reduction to within 2 mm is necessary for optimal outcome; residual displacement of >2 mm necessitates surgical treatment.1,5,6 Fixation devices can be percutaneous wires or cannulated cancellous transepiphyseal screws, depending on the surgeon’s preference.

Computed tomography and 3-dimensional reconstruction improve understanding of injury patterns and assist in the management decision.7 This further delineates epiphyseal and physeal involvement, the number of fragments, the appearance of the Salter-Harris fracture in each plane, and the degree of separation of the epiphyseal fragments. Meticulous placement of cannulated screws is necessary to avoid penetrating both the articular surface and physis.

For severely displaced fractures, articular reduction through an open approach can be extensive.
Arthroscopy-assisted methods facilitate anatomic reduction and minimal soft-tissue disruption, and may be augmented by intra-operative intensified imaging. The modified Weber protocol has been used for evaluation of treatment outcome of ankle fractures in adults and triplane fractures in children.

Treatment outcome is good when guidelines are closely adhered to.

DISCLOSURE

No conflicts of interest were declared by the authors.

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