Acta Orthop. Belg., 2017, **83**, 568-573

ORIGINAL STUDY

Fixation of tibial pilon fractures based on column concept: A prospective study

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Distal tibia fractures are complex injuries with high complication rates. Limited soft tissue, poor vascularity and complexity of fracture pattern impose limitations for traditional plating techniques. Better understanding of fracture patterns using 3D-CT reconstruction, optimum pre-op planning and availability of anatomical locking plates have certainly improved the outcome in these fractures. We report the functional and radiological outcome in 12 patients of complex tibial pilon fractures, who were treated on the basis of the novel column concept.

Keywords : Tibial pilon fractures ; Column concept ; ORIF ; Distal tibia LCP.

INTRODUCTION

Tibial pilon fractures are rare injuries, usually occurring in high energy trauma involving young adults, often due to fall from height or a motor vehicle crash *(7)*. The soft tissue envelope surrounding distal tibia is often breached, which is critical in determining the timing, approach and mode of fixation. Complications are quite frequent, like compartment syndrome, wound dehiscence, infection and posttraumatic arthritis *(1)*.

Principles in treating distal tibia fractures are often challenging *(3,6,15,16)*, and various methods of osteosynthesis are available. Outcomes of these fractures are not always excellent and complications affect 20-50% of patients *(1,2,17)*.

Earlier studies identified the topography of the fracture fragments *(11,20)* but tibial pilon fixation by column-based approach is a new concept *(18)*. It helps in making necessary decision in exposure, easier reduction maneuvers and good fixation of fractured fragments of tibial pilon. Though the associated fibula fracture helps in deciphering injury-mechanism and provides reference during surgical fixation for limb length, alignment and rotation, understanding the constant fracture fragments of the distal pilon is the key in the successful reduction and fixation.

We report our experience of closed intra-articular tibial pilon fractures AO type C3 fixation with distal tibial locking plate based on column-based fixation.

MATERIALS AND METHODS

12 patients with closed distal tibia intra articular fractures, who underwent open reduction and internal fixation, between years 2013-2015 were reviewed in this study. There were 3 women and

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No benefits or funds were received in support of this study. The authors report no conflict of interests.

9 men with an average age of 33 years (range, 24-41 years).High-energy injury occurred in all 12 cases (10 road traffic accidents and 2 falls from height). All of them were initially treated with splinting either with plaster or temporary external fixator to prevent further soft tissue injury. Digital radiography with CT scan and 3D reconstruction were taken in all patients to analyze the fracture pattern. All 12 patients had 4 components of tibial pilon fracture namely anterior, medial, lateral and posterior fragments with a majority of patients having associated fibular fracture (AO type C3).
The average time period between injury and surgery was 11days (ranging 6-17 days). Type of osteosynthesis and surgical timing were determined by the surgeon according to the fracture type, fragments localization and soft tissue condition.

No patients were lost at final follow-up and 12 of patients were reviewed for clinical and radiological evaluation.

Fixation of the fibular fracture, if present was the initial step in the management. Posterolateral approach was chosen as it provides optimal length and rotation as much as possible with adequate space between other incisions. In selected cases, femoral distracter was used to maintain the required length. Anteromedial approach for tibia was the chosen approach in all patients because of it's versatility, ease and extensibility of approach. The tibiotalar joint was exposed using the distal part of the incision. If properly planned, all 4 tibial pilon columns can be approached through this single incision. The anterior, lateral and medial column can be visualized directly while the posterior column is accessed through the joint or after the deroofing of the joint. Separate stab incisions were used to fix posterior and lateral column if required. The fracture was reduced under fluoroscopy using manipulation and traction. Talar dome was used as a mould and then the fracture was initially stabilized with K-wires. Reduction was maintained by 3.5mm locking cortical screws augmented with 4-mm cannulated screws after temporary fixed with K-wires. Metaphyseal void noted intraoperatively was not deemed to be addressed. After the articular fragments were appropriately reassembled, the fracture was stabilized by locking anteromedial distal tibial plates, applied through minimally invasive technique. 2 weeks postoperatively, all patients were mobilized on a non-weight bearing Custom-made below-knee fibre-cast mould with Velcro straps for 6 weeks. Thereafter gradual ankle mobilization is initiated with partial weight bearing for 3-4 weeks till complete radiological union. If radiological progression was inadequate at any stage, the subsequent stage was delayed subsequently (Figures 1-4).

Ipsilateral fibular fracture occurred in 11 cases (91.6%) and was treated by open reduction and plate fixation in 10 cases (90% of the fractured fibulas). There was always a constant posterior fragment associated with fibular fracture. None of our patients required bone grafts to augment the fixation nor fasciocutaneous flap coverage as a secondary procedure for wound dehiscence.

At final follow-up, clinical examination, radiological and functional outcome was made. Functional outcome was assessed with American Orthopaedic Foot and Ankle Society (AOFAS) ankle score was also determined.

Radiological records included initial, post-operative and final follow-up ankle X-rays. Initial CT scan was made for all the comminuted cases without delaying the surgical treatment. On X-rays, anatomical reduction was assessed by restitution of a normal articular surface with ankle and hind foot correct alignment. Step-off of 2 mm was considered significant (Table 1).

RESULTS

The minimal follow-up was 12 months with an average follow-up of 29 months (range 12-42 months).

Complications

Surgical complications occurred in 2 patients in the post operative period.1 patient developed skin necrosis in the 1st week postoperatively and required wound debridement and secondary suturing. 1patient developed severe pain in post-operative period and was attributed to reflex sympathetic dystrophy, which was managed with medical treatment. We did not have any complications of compartment

Fig. 1. — Pre-operative X-rays showing fracture of 4 columns of Tibial Pilon with associated fibular fracture

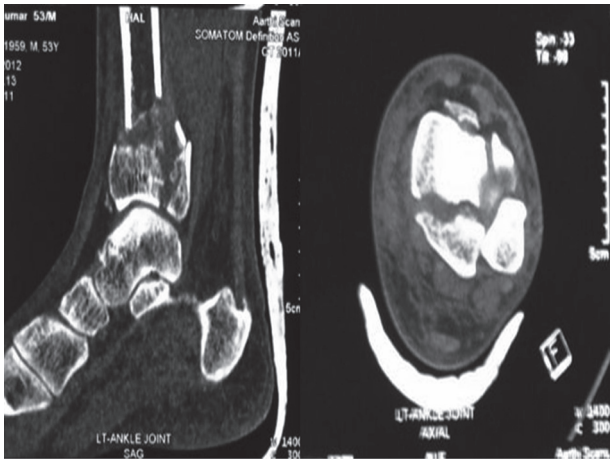

Fig. 2. —Pre-operative describing the fracture topography

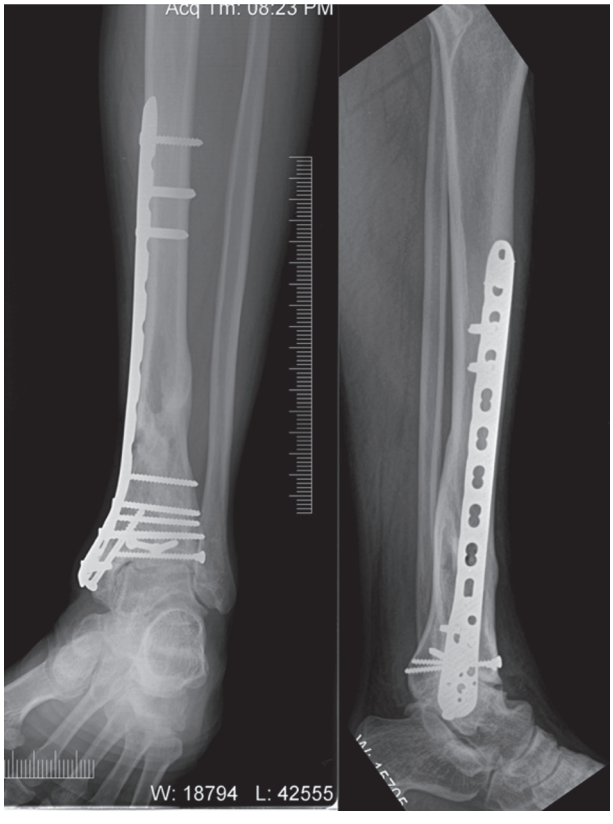

Fig. 3. — PostoperativeX-ray showing fixation of the Pilon addressed by 4-column concept

syndrome, deep vein thrombosis, refracture or late infection.

At final follow-up, there were 3 cases of delayed union.1 patient had intra-articular step-off due to secondary displacement, who went on to develop symptomatic secondary arthritis, necessitating implant removal and was managed with ankle with subtalar arthrodesis. 3 patients developed early radiological findings of arthritis after 2 years of follow up. Though these patients had limited range of movements, they were asymptomatic.

Clinical outcomes

Using the AOFAS ankle-hindfoot scale, the average functional score was 73 points (range, 30-100 points). Results were excellent in 3, good in 5, fair in 3 and poor in 1case.Referencing AOFAS ankle-hindfoot function score, the excellent or good rate was achieved 66.6% (Table 2).

The final ranges of motion averaged 20 degrees of ankle dorsiflexion and 35 degrees of ankle plantar flexion.

Fig. 4. — 2 year follow-up X-ray of the patientshowing radiological union of the fracture with good functional outcome. The patient had asymptomatic arthritis

DISCUSSION

Tibial pilon fractures represent between 1% and 10% of all the fractures of the lower extremity *(1,7)*,usually after a high energy trauma and critical soft tissue injury. The severity of the trauma, local soft tissue condition, fracture morphology and open injury play a vital role in determining the management and outcome of these fractures. Anatomical direct reduction, absolute stability, early mobilisation with sequential rehabilitation provide good results in most situations *(15,16)*. We concur that there exists an association between complication rate and clinical results with initial fracture severity *(3,6)*.

Topliss et al reported 6 distinct intra-articular fragments are anterior, posterior, medial, anterolateral, posterolateral, and die-punch(20). Cole et al put forward the pilon map, which showed

Table I.— Post-operative radiological evaluation for reduction of the Pilon fracture

POST-OPERATIVE RADIOLOGICAL EVALUATION FOR REDUCTION		
Grading system for reduction	**Rate**	**Cases**
Anatomic reduction	58.3%	7
Acceptable reduction	25%	3
Poor reduction	16.6%	2

comminution zones, most commonly involving the central corridor of the plafond apex and the anterolateral quarter of plafond, with axial force being the dominant factor *(11)*. The Pilon map aided management of treatment of the OTA/AO type 43C3 fractures, with respect to surgical approaches, preoperative planning, and implant strategy. Tang Xin et alclassified pilon fractures by four column theory and managed by ORIF *(18)*. The four-column theory was classified on local anatomical topography of distal tibia and fibula. The 4 columns being: anterior and posterior column are divided by an intermalleolar line and saggital midline of pilon dividing the medial and lateral columns. We report all 4 column fractures in all our 12 patients. They claimed the 4 column-classification to be helpful in column wise-surgical approaches to reduce flap complications and satisfactory reconstruction but

Table II. — Post-operative functional evaluation of the ankle using AOFAS ankle-hindfoot function score

POST-OPERATIVE FUNCTIONAL EVALUATION OF ANKLE		
Grading system for ankle function	**Rate**	**Cases**
Excellent	25%	3
Good	41.6%	5
Fair	25%	3
Poor	8.3%	1

reported the need of long term follow up for better modification of the technique.

We report an ipsilateral fibular fracture in 11 patients (91%), which was comparable to other studies in literature (73-91%) *(2,5,12)*. This high incidence is explained due to the high-energy injury in our study. Fibular osteosynthesis is an essential step in concomitant pilon fractures as maintains the tibial length, resists deforming rotational forces on pilon articular fragments and prevents valgus malunion.

Infectious or cutaneous problems and nonunion form the main problems in the postoperative period. We report early wound dehiscence in (1 patient), much lesser when compared to previous studies (6.25-50%) *(6,7,8,14,19)*.

We preferred anteromedial approach for localizing and reduction of articular fragments and fixation with anatomical locking plates. MIPPO reduces soft tissue injury and maintains bone viability and fracture hematoma, hastening the healing process *(13,14)*. Locking plates offers stable fixation of articular fragments and quicker rehabilitation. Earlier studies have proved that it is associated with late infection *(4)*, implant prominence with wound dehiscence requiring hardware removal for skin impingement) *(10,15)*, and risks of saphenous nerve and great saphenous vein injury *(10)*. However we did not encounter any of the above complications.

We report 1 case of reflex sympathetic dystrophy (8.3%), which was managed conservatively. The diagnosis was made clinically, with the patient have excruciating pain and persistent skin changes present. Most studies report a higher incidence of this complication(13.8-21%) but there is not definitive investigation to confirm the diagnosis *(4,11)*.

We report 3 patients (25%) developing symptomatic secondary arthritis, with 1 patient requiring implant exit. Our results were comparable with other studies(10-22%) *(9,17,18)*. This complication is mainly influenced by the severity of injury to joint cartilage, accuracy of articular reduction and meticulous rehabilitation protocol of the ankle joint.

We report 66.6% good to excellent outcome (8 patients) in our study. This was comparable to other studies reporting AO type C3 fractures *(2,17,18)*. The results were similar to a related study by Tang Xin et al. *(18)*. 1 patient (8.3%) had poor outcome with one requiring implant exit and subtalar arthrodesis.

No individual surgical modality has proved it's ultimate superiority, but however most authors recommend the use of a two-staged surgery in the AO Pilon C3 fractures, due to critical soft tissue injury *(9)*.Inadequate exposure and indirect reduction maintenance are prime reasons for most failures in tibial pilon fractures. We present this technique which has versatility, adequate exposure and stable fixation of all 4 columns.

CONCLUSION

Distal tibia fractures prove to be a daunting surgical challenge for most surgeons and associated complications are primarily dependent on the energy of trauma. Pre-op assessment with standard radiographs and CT provide valuable information on the major columns. This planned methodical approach provides versatility and adequate exposure to all 4 columns, thereby providing stable fixation of all major articular fragments and delivering good functional outcome. Primary Fibular osteosynthesis (if necessary),column-based stabilization of Pilon and adequate rehabilitation protocol form vital cogs in better outcome of these AO Pilon C3 fractures.

Acknowledgments

The authors acknowledge that there has not been any sort of grants, funds received in this study. No funding organizations have been involved in any manner.

All Authors disclose there is no relationships or interests that could have direct or potential influence or impart bias on the work.

All Authors feel there is no conflict, disclosure of relationships and interests, so that there is a complete and transparent process, leading to an accurate and objective assessment of the work.

All the authors disclose that there is no financial relationship with an organization that sponsored the research or compensation received for consultancy work.

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