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Radiological and functional assessment of the tibial pilon fractures treated by Ilizarov external fixation

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Abstract
Background & Objectives: The tibial pilon fractures are one of the challenging fractures in Orthopaedics because of limited soft tissue coverage and vicinity to the articular surface. Open reduction methods breach the soft tissue, which can result in serious complications. Ilizarov external fixation is minimally invasive and yields good clinical & radiological results with comparatively less complications.
Methods: The study was conducted with 27 subjects in the age group of 18 – 80 years, between September 2014 and June 2016. Follow-up was done at 1 month, 3 months, 6 months and before completion of study for Radiological outcome using Teeny-Wiss scoring system, Clinical results using Ovadia-Beals criteria and Foot and Ankle Outcome score.
Results: 27 patients with average age of 44 years were studied. 20 cases were closed injuries and 7 were open. Most common cause was Road Traffic Accidents (21 cases), fall from height (5 cases) and a bomb blast injury.
We achieved excellent & good Clinical results in 18 cases and radiologically anatomic & good reduction in 19 cases. 3 cases had nonunion and 11 cases had soft tissue complications. There were no cases of ankle arthrodesis or amputations or Deep vein thrombosis. The FAOS and EQ5D scores were tabulated.
Conclusion: The common complications associated with Ilizarov external fixation being treatable on outpatient basis in most of the patients, makes this a better choice even in complicated cases. Patient compliance and meticulous follow-up are very important limiting factors.

Keywords: Tibial Pilon; Ilizarov external fixation; Teeny Wiss; Ovadia Beals

Introduction
Treatment of distal tibia fractures is one of the most substantial therapeutic challenges that an Orthopaedician comes across. Limited soft tissue in this region affects treatment by any means. In 1922, a French Radiologist, Destot applied the term "Pilon fractures" for the ankle fractures that involve the weight-bearing distal tibial articular surface [1]. In 1968, Ruedi's publications explained fracture types, classification, treatment methods and principles [2], which were later supported by Heim [4] and Ovadia & Beals [3]. Tornetta used ankle sparing external fixator to allow early range of motion[4]. To avoid the complications of external fixation Sirkin *et al* and Patterson & Cole popularized Staged management of these fractures [5, 6]. Ankle spanning fixator may be used as the definitive method to stabilize the distal tibia [7, 8, 9]. The spanning fixator functions to neutralize the fracture, and the articular surface is reduced and internally fixed, either percutaneously or through limited open approaches or through more extensive open reduction.

Subjects & Methods
The study was conducted between September 2014 and June 2016 using all the tibial pilon and distal tibial shaft fractures treated with ilizarov external fixator, of age group 18 – 80 years including both males & females admitted in our institution. Patients with polytrauma, previous surgeries for the same ailment and with pathological fractures were excluded. Periodic postoperative evaluation of the treated subjects during followup clinically and by taking radiographs in AP & lateral views – immediate postoperative, 1 month postoperative, 3 months postoperative and 6 months postoperative days and most recent followup before completion of the study.

Results are evaluated based on: Ovadia Beals criteria for clinical outcome
Teeny – Wiss Scoring system for Radiological outcome

Table 1: Teeny-Wiss radiological scoring system

Anatomical site Quality of reduction	Score*		
	1	2	3
Lateral malleolus Displacement	0-1 mm	2-5 mm	5 mm
Medial malleolus Displacement	0-1 mm	2-5 mm	5 mm
Posterior malleolus Displacement	0-0.5 mm	0.5-2 mm	2 mm
Mortise widening	0-0.5 mm	0.5-2 mm	2 mm
Fibular widening	0-0.5 mm	0.5-2 mm	2 mm
Talar tilt	0-0.5 mm	0.5-2 mm	2 mm
Articular gap	0-2 mm	2-4 mm	4 mm

Rating	Points
Anatomic	8
Good	9-11
Fair	12-15
Poor	> 15

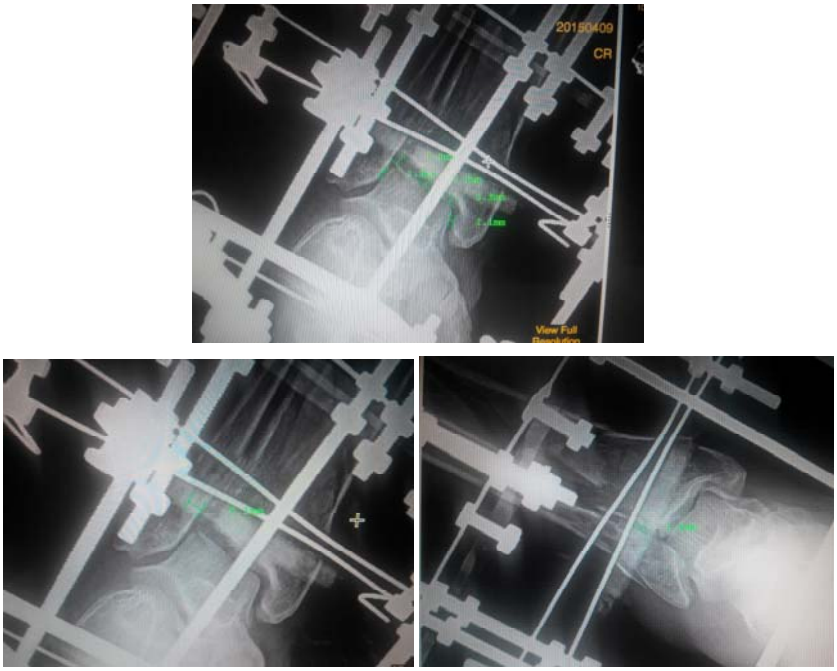

Fig 1: Xray with measurements as per Teeny-Wiss scoring

Table 2: Ovadia-Beals clinical scoring system

Objective Evaluation

RESULT	CRITERIA	SCORE
Excellent	ROM of ankle and subtalar joints is > 75% of the normal side, no tibial shortening, no equinus or calcaneus deformity.	**4**
Good	ROM of ankle and subtalar joints is between 50-75% of the normal side, no tibial shortening, no equinus or calcaneal deformity.	**3**
Fair	ROM of ankle and subtalar joints in between 25-50% of the normal side, < 1 cam tibial shortening, no equines or calcaneal deformity.	**2**
Poor	ROM of ankle and subtalar joint is between 0-25% of the normal side, > 5^0 of varus or valgus or recurvatum deformity, > 1 cm tibial shortening, equines or calcaneal deformity.	**1**

Subjective Evaluation: *This depends on the patient's subjective report of pain and performance.*

RESULT	CRITERIA	SCORE
Excellent	No pain, returned to previous level of activity, no limp.	**4**
Good	Mild pain only after strenuous activity, returned to previous level of activity, required occasional analgesics.	**3**
Fair	Moderate pain, patient could not go to previous level of activity, had to take analgesics daily, limp present.	**2**
Poor	Pain with each step, unable to work, severe limitation of walking, limp present.	**1**

Results

The study population of 27 patients comprised of 21 males and 6 females. The average age of the patients was 44 years (range 18-80 years). There were 20 closed injuries, which as per Tscherne classification were classified as 15 cases of grade 0, 1 case as grade 1, 2 cases as grade 3. There were 7 open injuries, which as per Gustilo-anderson classification were classified as 1 case each under types 1 & 2 and 2 cases under 3A & 3 cases under 3B. The most common cause for the injury being RTA in 21 cases, other 5 cases were because of fall from height and a bomb blast injury. Left lower limb was involved in 14 cases and right in 13 cases. As per AO classification, there were 4 A1, 1 A2, 5 A3, 1 B1, 3 C1, 7 C2 and 6 C3 cases. As per Ruedi-Allgower classification, intra-articular fractures were 15, of which 2 cases were type I, 8 type II and 5 type III cases. Calcaneal plate was used in 13 cases. 2 patients were lost for follow-up after application of the fixator.

The articular reduction was anatomic in 6 cases, good in 13 cases, fair in 4 cases and poor in 2 cases as per Teeny-Wiss scoring system. The functional evaluation of the ankle was according to Ovadia-Beals scoring system. Among the 25 cases that were followed up, Objective evaluation was excellent in 6 cases, good in 12 cases, fair in 6 cases and poor in 1 case. Subjective scoring was excellent in 5 cases, good in 13 cases, fair in 6 cases and poor in 1 case. The FAOS and EQ5D5L scores were tabulated.

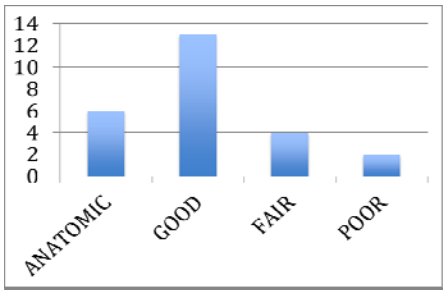

Fig 2: Teeny Wiss scoring

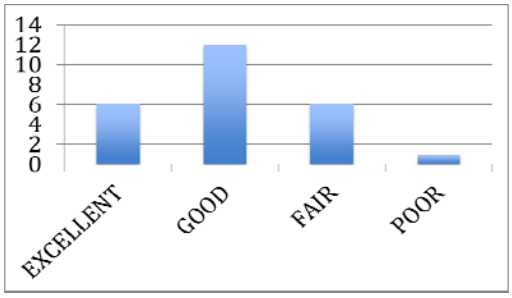

Fig 3: Ovadia Beals objective scoring

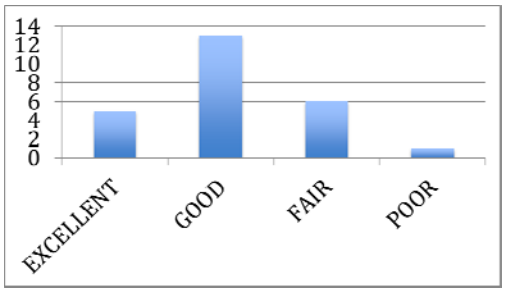

Fig 4: Ovadia Beals subjective scoring

Table 3: Foot & Ankle Outcome Score (FAOS) & EQ5D5L score.

Sl.no. of Pt	Faos Pain	Faos Symptom	Faos Adl	Faos Sport	Faos Qol	EQ 5D 5L
1	92	100	95	80	81	95
2	91	96	91	65	81	90
3	89	82	91	60	75	80
4	92	89	91	75	81	85
5	89	68	98	70	81	85
6	83	86	88	50	75	80
7	89	88	93	70	81	80
8	92	82	93	60	81	80
9	92	93	96	85	81	90
10	92	82	91	60	75	80
11	92	86	95	80	81	80
12	80	78	91	65	75	80
13	92	93	91	70	81	85
14	97	100	98	90	94	95
15	94	93	94	80	81	90
16	92	61	90	60	75	75
17	92	0	97	90	88	95
18	94	89	88	60	69	80
19	100	100	100	95	100	98
20	97	96	97	75	94	95
21	92	89	91	75	81	85
22	92	78	85	50	75	75
23	72	75	73	60	75	80
24	89	82	91	60	75	80
25	94	89	88	60	69	80

Additional procedures during the primary application of the fixator were done in 2 cases as open reduction of the fibula with 1/3rd tubular plate. 2 cases required Bone marrow infiltration, 2 cases required bone grafting and 2 cases required both bone marrow infiltration and bone grafting.

11 cases had soft tissue complications, of which 7 were minor soft tissue infections, 4 were major soft tissue infections. 1 case of major soft tissue infection required reapplication of the Ilizarov external fixation. 3 cases of nonunion (defined as no signs of union at 9 months postop). There were no cases of ankle arthrodesis or amputations or Deep vein thrombosis.

Discussion

An open reduction and stable fixation of these fractures was proposed by Ruedi and Allgower in 1969. The four principles that they advocated were: (1) restoration of fibular length; (2) reduction of articular surface; (3) cancellous bone grafting of the metaphyseal defect and (4) stabilization with a medial buttress plate. These authors described excellent or good results in 74% of cases and an infection rate of 5% and wound healing problems in 12% [2]. Teeny and Wiss in 1993 found unsatisfactory results of ORIF in type III Ruedi fractures in a group of 58 patients [10]. There was a 37% incidence of wound dehiscence, infection in 37%, nonunion in 27% and poor consolidation in 23%. Poor results of ORIF were also reported by Wyrsch *et al*. [11] in a randomised study in which the ORIF method was compared to external fixation for two groups of 19 and 20 patients, respectively. In order to minimize soft tissue problems encountered in plate fixation, a staged reconstruction has been reported [12]. Bonar and Marsh [13] treated a group of 49 patients by with trans-articular external fixation and used limited surgical exposures to accomplish a small degree of internal osteosynthesis. They described an anatomic reduction in none, a good reduction in 69%, fair in 20% and poor in 11%. Soft tissue complications and deep infections are not frequent when external fixation is combined with minimally invasive surgery: Wyrsch [11] had infections in 5%, Tornetta [4] in 1 out of 17 cases, Barbieri [14] in 3 out of 37 cases. Bacon S *et al*. [15] performed a study of ORIF Vs IEF and stated that the time for union in ORIF group as 10 months and IEF group as 6 months.

Table 4: Table showing Comparison of the results of other similar published studies.

No.	Sample	Cases	Design	Intervention	Outcome measures	Results
1	Ahmet Kapukaya *et al*. [16]	14	R	Cross ankle external fixators	Teeny Wiss Ovadia Beals	Excellent or Good – 8 Fair – 3, Poor – 3 Excellent or Good – 10, Fair – 2, Poor - 2
2	Lovisetti *et al*. [17]	30	P	Ilizarov and Sheffield Circular fixator systems	Teeny Wiss Ovadia Beals	Anatomic – 5, Good – 23, Fair – 2, Poor – 0 Excellent – 6, Good – 9, Fair - 2, Poor - 2
3	Vidyadhara K. Rao *et al*. [18]	21	P	IEF	ROM AOFAS	Dorsiflexion: 5^0 - 15^0 Plantarflexion: 5^0 – 35^0 Excellent – 11, Good – 5, Fair – 4, Poor - 1
4	Stacy bacon *et al*. [15]	14	P	Staged ORIF Vs Definitive IEF	Time to union Union %	39 wks(ORIF), 25 wks(IEF) 74%(ORIF), 54%(IEF)
5	Telmo Ramos *et al*. [19]	39	P	IEF	Modified Burwell & Charnley Radiological classification	Good – 13, Fair – 21, Poor - 5
6	Brad Wyrsh *et al*. [11]	20	P	ORIF Vs IEF	Clinical Scoring system Articular Incongruity	61(ORIF), 73(IEF) Anatomic(8,4) 1mm incongruence(5,5) 2-3mm incongruence(6,10)
7	Our Study	25	P	IEF	Teeny Wiss Ovadia Beals	Anatomic – 6, Good – 13, Fair – 4, Poor – 2 Excellent – 6, Good – 12, Fair - 6, Poor - 1

In our study, the average time for union was 7 months (range from 2 ½ months – 18 months). Among which time of union for 3 cases was more than 9 months (nonunion).

The average time of union for the remaining 22 cases was 5.2 months (2½ months – 9 months).

The limitations of the present study include unequal distribution of cases in each group of the classification, duration of followup in some severely injured cases is not so adequate that they regain their adequate function and Comparative analysis is not performed with other modalities of treatment.

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