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ORIGINAL ARTICLE

Foot Loading Analysis of Intraarticular Tibia Pilon Fracture

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BACKGROUND: Although pilon fractures are rare, they are important for orthopedic surgeons because of the difficulty of treatment and adverse effects on gait function. The aim of the study to evaluate the relationship between the reduction quality of the fracture, functional results, ankle arthrosis and plantar pressure distribution in patients with tibia pilon fractures.

METHODS: In this study, a total of 62 patients treated for an intraarticular pilon fracture in our

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clinic between January 2015 and January 2019 were evaluated retrospectively. Postoperative reduction qualities of the patients were evaluated with the Ovadia-Beals criteria, ankle functional scores with the Teeny-Wiss score, and ankle arthrosis with the Takakura classification. In the last follow-up of the patients, foot loading analysis was performed and the results of the patients were evaluated for their relation with postoperative reduction quality, ankle functions and ankle arthrosis.

RESULTS: There were 62 patients (50 men and 12 women). The average age was 43.3 years (range 19-78). The mean follow-up was 34.3 months (range 24 - 58). The mean Ovadia-Beals score was 12.35 ± 4.6 in the postoperative plain radiographs of the patients; the mean Teeny-Wiss score in the last follow-up was 76.82 ± 17.69 , and the Takakura score was 1.47 ± 1.35 . Based on the pedobarographic measurements, 47.58% of the patients put weight on the anterior and 52.42% on the posterior of the foot in the anteroposterior plane. In the mediolateral plane, 42.15% loaded on the medial of the ankle and 57.85% loaded on the lateral of the foot.

CONCLUSIONS: Intra-articular tibia pilon fractures can be demonstrated by lateralization of the walking axis and changes in gait patterns and can be associated with clinical outcome.

Pilon fractures represent approximately 1% of all lower extremity fractures and less than 10% of all tibial fractures¹. The average patient age is 35 to 40 years, with fractures more common in men than women. Most pilon fractures are caused by varying degrees of rotation or twisting

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following axial loading, often due to high-energy trauma. Although these fractures are rare, they are considered difficult to treat because they are seen as multi-part joint fractures in a weight-bearing joint; the skin of the pilon area is thin, has poor vascularisation and no muscle insertion ^{2,3}.

The goal of orthopaedic surgery for tibial pilon fractures is the anatomical and biomechanical restoration of the joint, proper alignment, stable internal fixation, correct orientation of the ankle and early mobilisation ^{4,5}. Management of these fractures can be complex, especially when associated with significant soft tissue damage. Various surgical options and devices are available to treat these fractures. In addition, the timing of the surgery is critical in terms of the condition of the soft tissues ⁶. Currently, a two-step protocol involving first external transfixation and subsequent conversion to ORIF (open reduction and internal fixation) is a widely accepted standard to reduce the risk of soft tissue complications and infection rates ⁷⁻⁹. Adequate stabilisation should be provided with implants to ensure bone union ^{10,11}. While many believe that anatomical restoration of the articular surface is required, it is controversial and not always associated with clinical outcome ¹². Post-traumatic arthrosis of the ankle joint is a long-term problem and may affect the clinical outcome ¹³. Regarding patient outcomes, most studies focus on complications such as infection rates, pseudarthrosis or post-traumatic arthrosis and provide less information on the quality of life. This retrospective clinical study aimed to evaluate the relationship between the reduction quality of the fracture,

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functional results, ankle arthrosis and plantar pressure distribution in patients with tibia pilon fractures.

Methods

A retrospective examination was conducted on patients hospitalised and treated surgically for tibia pilon fractures at the University of Health Sciences, Kanuni Sultan Süleyman Training and Research Hospital Department of Orthopaedics and Traumatology Department, Istanbul, Turkey. All patients treated for a pilon fracture between January 2015 and January 2019 were reviewed to determine if they would be included or excluded from the study. Inclusion criteria included patients aged 18 or over, trauma limited to a unilateral pilon fracture involving the joint, and the absence of psychological discomfort or additional trauma that could affect the outcome of the pedography. The exclusion criteria included a medical history of previous fractures or musculoskeletal disorders of the lower limbs, limb heterometry, spinal disease, and heavy smoking, alcoholism or drug abuse. All hospital patient records were scanned to determine if a patient would be included in the study.

All procedures were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as amended in 2008. Informed consent was waived due to its retrospective nature.

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Plain radiographs and computed tomography (CT) scans were examined according to the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification system ¹⁴. The presence of accompanying lateral malleolar fractures was also evaluated in the radiographies and CTs. Medical charts were used to determine the fracture mechanism (high or low-energy), whether there was an open/closed fracture, surgical procedures, presence of comorbid diseases, smoking, the elapsed time from hospitalisation to operation, length of hospital stay, and complications. After the operation, short leg splints were routinely applied for two weeks to monitor the wound and soft tissue. This was followed by lymphatic drainage, active joint mobilisation, and physiotherapy with crutches carrying partial weight for eight to 12 weeks, depending on the type of fracture and operative treatment. When deemed necessary, patients were referred to physical therapy following treatment. Patient postoperative radiographs were scored according to the Ovadia-Beals criteria to determine the reduction quality of the fracture ¹⁵.

In the last patient follow-up, the final evaluation was made for distal tibia fractures according to the Teeny-Wiss clinical evaluation criteria. In this protocol, the assessment was made by comparing the healthy ankle with a damaged ankle. ¹⁶. In addition, ankle arthrosis was graded according to the Takakura classification scale on plain radiographs at the last follow-up ¹⁷.

Pedography was performed with an integrated measuring plate (Ack-Metisens, 48 × 42 cm, three sensors per square centimetre, 50 Hz; Novel GmbH., Istanbul, Turkey). Patients were

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allowed an unlimited number of tests. At least five accurate measurements were performed per side, and the average values were included in the subsequent analysis. Using software support (new database required © vers. 25.6.20 and a newly programmed report for force-time integral), the patient's foot was divided into four regions. The weight distribution was placed anteroposterior and mediolaterally (Figures 1.2.3.4 and 5 show the initial and follow-up graphs and pedography of a typical pilon fracture.).

Statistics

The IBM SPSS Statistics 22 for statistical analysis (SPSS IBM, Turkey) program was used to evaluate the study findings. While evaluating the study data, the suitability of the parameters to the normal distribution was assessed using the Shapiro Wilks test. The descriptive statistical methods (mean, standard deviation, frequency) and the one-way analysis of variance (ANOVA) test were used to evaluate the parameters normally distributed among the groups for the comparison of quantitative data. The Kruskal Wallis test was used for intergroup comparisons of parameters that did not show normal distribution, and Dunn's test was used to identify the group that caused the difference. Student t-test was used to compare normally distributed parameters between two groups, and Mann Whitney U test was used to compare parameters not showing normal distribution between two groups. The Chi-square and Fisher Freeman Halton tests were used to compare qualitative data. Pearson correlation analysis was used to examine the relationships between parameters suitable for normal distribution. Spearman's

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rho correlation analysis was used to examine the relationships between parameters not compatible with normal distribution. Significance was evaluated at the $p < 0.05$ level.

Results

Seventy-five patients who met the inclusion criteria were invited to participate in the study. Of those, 62 were willing to participate, and 13 were excluded from the study under the exclusion criteria (due to psychological discomfort and additional trauma). There were 50 men and 12 women. The average age was 43.3 years (range 19-78). The right side of lower extremity was affected 39 times, and the left 23 times. The mean follow-up was 34.3 months (range 24 - 58) (table 1). Six of the fractures were caused by low-energy trauma, while 56 were caused by high-energy trauma. There were eight open fractures (three Type 2 and four Type 3). According to the AO classification, 14 patients had Type B fractures, and 48 patients had type C.

All patients were operated on according to our routine treatment protocols. Although external fixators were applied to 20 patients in the first stage, fixed-angle plates were used in second stage surgery in 12 of these patients. In the remaining patients, the medial anatomic plate, the anterior anatomic plate and the medial/anterior combined anatomical plate were applied.

While 42 of the patients had accompanying lateral malleolar fractures, 33 underwent osteosynthesis with the lateral malleolar anatomic plate. No patients required osteosynthesis with screws alone. In the remaining nine patients, additional fixation was not used because the accompanying fibula fracture remained above the level of the syndesmosis. One patient had to

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undergo ankle fusion after 12 months due to an ongoing infection with a large bony defect after an III° open fracture (AO C3-type3). Therefore this patient was excluded from the study because pedobarographic measurements could not be made. Also, due to superficial infection, the medial tibia plate was removed in one patient, and the lateral malleolus plate was removed in another. The symptoms regressed with plate removal and debridement in these patients, and no additional surgery was performed.

The mean Ovadia-Beals score was 12.35 ± 4.6 in the postoperative plain radiographs of the patients; the mean Teeny-Wiss score in the last follow-up was 76.82 ± 17.69 , and the Takakura score was 1.47 ± 1.35 . Based on the pedobarographic measurements, 47.58% of the patients put weight on the anterior and 52.42% on the posterior of the foot in the anteroposterior plane. In the mediolateral plane, 42.15% loaded on the medial of the ankle and 57.85% loaded on the lateral of the foot.

The Ovadia-Beals criteria evaluated the postoperative reduction quality of the patients, the Teeny-Wiss score evaluated the functional results, and the Takakura classification measured ankle arthrosis. No significant difference was found between the patient groups when assessed according to the AO fracture classification types, open/closed fracture, high/low-energy, accompanying and operated lateral malleolus fracture, and the type of surgery (table2-3-4-5).

Among the patient groups, there was a statistically significant difference in the Takakura classification only in those patients with a Type 3 (AO Type B3 and C3) fracture subgroup

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related to the joint and an open fracture according to the AO fracture classification ($p < 0.05$) (table 6).

Evaluation of the pedobarographic measurements according to the Ovadia-Beals score yielded the following results (table 7)(figure 6):

- A positive 42.5% statistically significant relationship between the Ovadia-Beals score and the anterior foot load ($p: 0.001$; $p < 0.05$).
- A negative, 42.5% and statistically significant correlation between the Ovadia-Beals score and the posterior foot load ($p: 0.001$; $p < 0.05$).
- A positive, statistically significant relationship at 58% between the Ovadia-Beals score and the medial foot load ($p: 0.000$; $p < 0.05$).
- A negative 58% and statistically significant relationship between the Ovadia-Beals score and the lateral foot load ($p: 0.000$; $p < 0.05$).
- A negative, 85.7% and statistically significant correlation between the Ovadia-Beals score and the Teeny-Wiss score ($p: 0.000$; $p < 0.05$).
- A positive, 32.1% and statistically significant relationship between the Ovadia-Beals score and the Takakura score ($p: 0.011$; $p < 0.05$).

Evaluation of the pedobarographic measurements according to the Teeny-Wiss score yielded the following results (table 7)(figure 7):

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- A positive, 66.8% and statistically significant correlation between the Teeny-Wiss score and the anterior foot load (p: 0.000; p <0.05).
- A negative, statistically significant correlation between the Teeny-Wiss score and the posterior foot load (p: 0.000; p <0.05).
- A positive, 69.7% and statistically significant relationship between the Teeny-Wiss score and the medial foot load (p: 0.000; p <0.05).
- A negative, 69.7% and statistically significant correlation between the Teeny-Wiss score and the lateral foot load (p: 0.000; p <0.05).
- A negative, 29.4% and statistically significant correlation between the Teeny-Wiss score and Takakura score (p: 0.020; p <0.05).

Evaluation of the pedobarographic measurements according to the Takakura classification yielded the following results (table 7)(figure 8):

- A positive, 37% and statistically significant correlation between the Takakura score and anterior foot loading (p: 0.003; p <0.05).
- Inversely, a 37% and statistically significant correlation between the Takakura score and posterior foot loading (p: 0.003; p <0.05).
- A positive, 26% and statistically significant correlation between the Takakura score and medial foot loading (p: 0.042; p <0.05).

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- A negative, 26% and statistically significant correlation between the Takakura score and lateral foot loading ($p: 0.042$; $p < 0.05$).

Discussion

The most significant finding of this study is that overall reduction quality worsens in patients operated on for tibia pilon fractures; the patient's functions deteriorate, and arthrosis in the ankle increases. In addition, the foot centre of gravity of patients with poor reduction quality shifts to the posterior and lateral of the foot.

Since the publication of the results for low-energy pilon fractures in 1969 by Rüedi and Allgöwer¹⁸, these fractures have been a common standard with four basic principles (restoration of length and axis, anatomical reconstruction of the articular surface, filling of the defect, and medial column support). These principles are discussed today. Today, high-velocity injuries with severely compromised soft tissues are more common, making the ORIF technique using the comprehensive approaches described by Rüedi and Allgöwer impossible. Anatomically pre-formed plates and angled fixed screws act as an internal fixator. The minimally invasive technique (MIPO) was developed to benefit soft tissues significantly. However, surgeons were concerned about postoperative soft tissue follow-up while using excessive surgical approaches in severe soft tissue injuries.

Tibial pilon fractures have always been a complex trauma for foot and ankle surgeons. The surgery results can lead to many complications from infection, deformity, nonunion, arthrodesis and amputation¹⁹. Biomechanical studies show that although joint fragmentation is

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minimal (especially 3 cm of the lower line of the fracture from the tibiotalar joint), it may not heal and bone deformities such as procurvatum/recurvatum or varus and valgus may invalidate the body's anatomical axis and sagittal balance line ^{20,21}. The formation of a limb deformity is a more critical factor in the lower than the upper extremities ²². Some studies have suggested that weak tibial consolidations are associated with knee and ankle arthrosis ²². Extra-articular fractures can cause arthrosis but are less common than intra-articular fractures ²². The general deformity of the leg will be affected by the level of deformation and the size of the angle caused by translation, rotation, and shortening ^{23,24}.

However, so far, these positive results have not been published in the literature, and complication rates, infections, and the onset of osteomyelitis remain at high levels (up to 23% as shown in the literature), and joint reduction and varus quality/valgus alignment are more demanding and challenging ²⁵. Marsh et al. suggested that correct alignment is more critical than absolute anatomical reconstruction of the articular surface ¹².

While changes in gait patterns are defined in calcaneal fractures, end-stage osteoarthrosis of the ankle and tibiotalar fusion, our study provides information about gait analysis after pilon fractures. Horisberger et al. determined the maximum force and contact area of the entire osteoarthritic foot and reduced peak pressure in the hindfoot and toes in patients with end-stage osteoarthrosis of the ankle ²⁶. Similar changes were found in patients after intra-articular fractures of the calcaneus. In those patients, lateralisation of the walking axis, a compensatory increase in pressure in the midfoot and lateral forefoot region and a

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decrease in the hindfoot pressure are described in that study²⁷. In this study, we concluded that the average centre of plantar pressure of the foot was displaced more laterally and slightly posteriorly.

Yaradılmış et al. examined 45 patients in their retrospective study and showed that functional ankle scores were significantly lower in patients with non-anatomical reduction according to the Ovadia-Beals criteria²⁸. In our research, we found a negative correlation between the Ovadia-Beals criteria and the Teeny-Wiss score. We also found that ankle arthrosis was higher in these patients, and there was a significant lateral and posterior shift in the foot pressure distribution.

In their prospective study, Sommer et al. concluded that the radiological measurements of the postoperative reduction quality they evaluated significantly affected the patients' results. In particular, the lateral malleolus length was the most important prognostic factor²⁹. In this study, all anatomical parameters were not evaluated separately; only the Ovadia-Beals criteria were examined. Poor results were observed in patients with non-anatomical reduction quality. Previously, there were reports that patient outcomes continued to improve for up to five years after pilon fractures¹². However, Sommer et al. reported they could not find a significant difference between the six-month and the second-year results in their study²⁹. Because the early-mid-term functional results for the patients were evaluated in this study, the improvements in functional results could not be documented.

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Falzarano et al. compared the pedographic results of three techniques for tibia pilon fractures. They concluded that the foot pressure distribution was the highest in the fourth metatarsal in their patient results, correlated with the Ovadia-Beals criteria ³⁰. Jansen et al. reported similar findings on intra-articular fractures of the tibial pilon but did not compare them with the reduction quality and functional results of the patients ³¹. The results of pedography in their study were similar to those obtained in this study.

A common problem with long-term outcomes is the development of post-traumatic arthrosis and thus limited function of the injured limb. In our study, 37% of the patients had moderate or clear symptoms of post-traumatic osteoarthritis. Other authors describe rates of 10-55% [2, 18] with a correlation between the onset of fracture severity arthrosis. We also found a very high correlation between the amount of joint involvement of the fracture (in AO classification B3 and C3 fractures) and the development of arthrosis (0.021; $p < 0.05$). While Gulabi et al. achieved excellent or good results in 19 (59%) of 32 pilon fractures in the 31 patients they treated ³², this study achieved excellent and good results in 20 (32%) of 62 patients. Ketz et al. found an average AOFAS score of 76.4 in the Type C2 fracture group and 85.2 points in the Type C3 fracture group after plate osteosynthesis using different approaches ³³. Kiene et al. determined a mean AOFAS score of 81 points after combining external fixation and lag screws ³⁴.

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Limitations

Our study has some limitations. It was a retrospective single-centre study, and various fracture patterns were treated using different stabilisation techniques, including stable angular plates and external fixators as needed. Based on the AO classification, the fracture patterns, especially the extent of joint involvement, were associated with clinical and functional outcomes^{16,35}. Therefore, the result may be a bias in the pedographic results.

Conclusions

Tibial pilon fractures limit movement in the ankle joint. According to several surveys, clinical outcome and the onset of post-traumatic arthrosis are related to fracture severity, especially joint involvement based on the AO classification. With lateralisation of the walking axis, changes in walking patterns can be demonstrated and correlated with the clinical outcome. Prospective studies on more patients and comparing different treatment methods will be more helpful in this regard.

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Table 1: Distribution of information on working parameters

		Min-Max	Mean±SD (median)
Hospitalization day		2-25	6,84±4,97 (5)
Follow-up period (months)		24-58	34,34±8,49 (32)
Time from trauma to operation (days)		0-12	2,47±1,96 (2)
		n	%
Side	Right	39	62,9
	Left	23	37,1
Comorbid disease	Yes	20	32,3
	No	42	67,7

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Table 2: Evaluation of scores according to AO classification

		B (n=14)	C (n=48)	Total (n=62)	p
		Mean±SD	Mean±SD	Mean±SD	
Ovedia-Beals		11,57±4,54	12,58±4,63	12,35±4,6	¹ 0,473
Tenny-Wiss (median)		78,21±15,64 (83,5)	76,42±18,38 (82,5)	76,82±17,69 (82,5)	² 0,826
Takakura (meiyan)		1,21±0,89 (1)	1,54±1,46 (1)	1,47±1,35 (1)	² 0,753
Pedographic analyse	Anterior	46,71±3,95	47,83±6,09	47,58±5,67	¹ 0,520
	Posterior	53,29±3,95	52,17±6,09	52,42±5,67	¹ 0,520
	Medial (median)	42,93±4,01 (43)	41,92±6,25 (43,5)	42,15±5,81 (43)	² 0,926
	Lateral (meiyan)	57,07±4,01 (57)	58,08±6,25 (56,5)	57,85±5,81 (57)	² 0,926
		n (%)	n (%)	n (%)	
Ovedia-Beals	Anatomical	6 (%42,9)	12 (%25)	18 (%29)	³ 0,174
	Good	2 (%14,3)	16 (%33,3)	18 (%29)	
	Moderate	4 (%28,6)	6 (%12,5)	10 (%16,1)	
	Poor	2 (%14,3)	14 (%29,2)	16 (%25,8)	
Tenny-Wiss	Poor	3 (%21,4)	11 (%22,9)	14 (%22,6)	³ 0,564
	Fair	6 (%42,9)	22 (%45,8)	28 (%45,2)	
	Good	5 (%35,7)	10 (%20,8)	15 (%24,2)	
	Excellent	0 (%0)	5 (%10,4)	5 (%8,1)	

¹Student t Test

²Mann Whitney U Test

³Fisher Freeman Halton Test

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Table 3: Evaluation of scores according to whether the fracture is open or not

		Fracture Type		p
		Open (n=8)	Close (n=54)	
		Mean±SS	Mean±SS	
Ovedia-Beals		14,88±4,45	11,98±4,54	¹ 0,097
Tenny-Wiss (<i>median</i>)		69,5±24,79 (84)	77,91±16,42 (82)	² 0,455
Takakura (<i>meiyan</i>)		2,63±1,77 (3,5)	1,3±1,21 (1)	² 0,040*
Pedographic analyse	Anterior	49,13±6,88	47,35±5,51	¹ 0,414
	Posterior	50,88±6,88	52,65±5,51	¹ 0,414
	Medial (<i>median</i>)	40,38±7,85 (40,5)	42,41±5,49 (43,5)	² 0,542
	Lateral (<i>meiyan</i>)	59,63±7,85 (59,5)	57,59±5,49 (56,5)	² 0,542
		n (%)	n (%)	
Ovedia-Beals	Anatomical	2 (%25)	16 (%29,6)	³ 0,084
	Good	0 (%0)	18 (%33,3)	
	Moderate	3 (%37,5)	7 (%13)	
	Poor	3 (%37,5)	13 (%24,1)	
Tenny-Wiss	Poor	3 (%37,5)	11 (%20,4)	³ 0,649
	Fair	3 (%37,5)	25 (%46,3)	
	Good	2 (%25)	13 (%24,1)	
	Excellent	0 (%0)	5 (%9,3)	

¹Student t Test

²Mann Whitney U Test

³Fisher Freeman Halton Test

*p<0.05

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Table 4: Evaluation of scores according to the mechanism of fracture occurrence

		Energy Level		p
		Low (n=6)	High (n=56)	
		Mean±SD	Mean±SD	
Ovedia-Beals		11±2,97	12,5±4,73	¹ 0,304
Tenny-Wiss (<i>median</i>)		85,33±6,89 (84)	75,91±18,28 (82,5)	² 0,504
Takakura (<i>meiyan</i>)		1,67±1,37 (1,5)	1,45±1,36 (1)	² 0,578
Pedographic analyse	Anterior	43,33±3,67	48,04±5,68	¹ 0,053
	Posterior	56,67±3,67	51,96±5,68	¹ 0,053
	Medial (<i>median</i>)	44,17±3,43 (44)	41,93±5,99 (43)	² 0,431
	Lateral (<i>meiyan</i>)	55,83±3,43 (56)	58,07±5,99 (57)	² 0,431
		n (%)	n (%)	
Ovedia-Beals	Anatomical	1 (%16,7)	17 (%30,4)	³ 0,170
	Good	4 (%66,7)	14 (%25)	
	Moderate	1 (%16,7)	9 (%16,1)	
	Poor	0 (%0)	16 (%28,6)	
Tenny-Wiss	Poor	0 (%0)	14 (%25)	³ 0,108
	Fair	5 (%83,3)	23 (%41,1)	
	Good	0 (%0)	15 (%26,8)	
	Excellent	1 (%16,7)	4 (%7,1)	

¹Student t Test

²Mann Whitney U Test

³Fisher Freeman Halton Test

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Table 5: Evaluation of scores between those with and without accompanying fibula fracture

		Accompanying fibula fracture		p
		Yes (n=42)	No (n=20)	
		Mean±SD	Mean±SD	
Ovedia-Beals		12,93±4,83	11,15±3,91	¹ 0,156
Tenny-Wiss (<i>median</i>)		75,6±19,09 (85)	79,4±14,43 (82)	² 0,769
Takakura (<i>meiyan</i>)		1,55±1,42 (1)	1,3±1,22 (1)	² 0,590
Pedographic analyse	Anterior	48,43±5,66	45,8±5,4	¹ 0,088
	Posterior	51,57±5,66	54,2±5,4	¹ 0,088
	Medial (<i>median</i>)	41,55±6,19 (42,5)	43,4±4,82 (43,5)	² 0,261
	Lateral (<i>meiyan</i>)	58,45±6,19 (57,5)	56,6±4,82 (56,5)	² 0,261
		n (%)	n (%)	
Ovedia-Beals	Anatomical	12 (%28,6)	6 (%30)	³ 0,201
	Good	9 (%21,4)	9 (%45)	
	Moderate	8 (%19)	2 (%10)	
	Poor	13 (%31)	3 (%15)	
Tenny-Wiss	Poor	10 (%23,8)	4 (%20)	⁴ 1,000
	Fair	19 (%45,2)	9 (%45)	
	Good	10 (%23,8)	5 (%25)	
	Excellent	3 (%7,1)	2 (%10)	

¹Student t Test

²Mann Whitney U Test

³Ki-Kare Test

⁴Fisher Freeman Halton Test

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Table 6: Evaluation of the scores of the subgroups according to the AO classification

		AO subgroup			p
		Type 1 (n=11)	Type 2 (n=15)	Type 3 (n=36)	
		Mean±SD	Mean±SD	Mean±SD	
Ovedia-Beals		10,91±3,48	11,8±4,72	13,03±4,81	¹ 0,359
Tenny-Wiss (median)		82,73±8 (86)	79,27±18,21 (86)	74±19,31 (81)	² 0,289
Takakura (meiyan)		0,82±0,87 (1)	0,93±1,03 (1)	1,89±1,45 (1)	² 0,021*
Pedographic analyse	Anterior	45±4,12	47,87±3,5	48,25±6,61	¹ 0,248
	Posterior	55±4,12	52,13±3,5	51,75±6,61	¹ 0,248
	Medial (median)	43,55±3,53 (44)	43,53±4,29 (45)	41,14±6,74 (42)	² 0,571
	Lateral (meiyan)	56,45±3,53 (56)	56,47±4,29 (55)	58,86±6,74 (58)	² 0,571
		n (%)	n (%)	n (%)	
Ovedia-Beals	Anatomical	4 (%36,4)	4 (%26,7)	10 (%27,8)	³ 0,338
	Good	4 (%36,4)	5 (%33,3)	9 (%25)	
	Moderate	3 (%27,3)	3 (%20)	4 (%11,1)	
	Poor	0 (%0)	3 (%20)	13 (%36,1)	
Tenny-Wiss	Poor	1 (%9,1)	3 (%20)	10 (%27,8)	³ 0,660
	Fair	6 (%54,5)	6 (%40)	16 (%44,4)	
	Good	4 (%36,4)	4 (%26,7)	7 (%19,4)	
	Excellent	0 (%0)	2 (%13,3)	3 (%8,3)	

¹Oneway Anova Test

²Kruskal Wallis Test

³Ki-Kare Test

*p<0.05

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Table 7: Evaluation of the correlation between Ovedia-beals, Tenny-Wiss and Takakura scores and foot gait analysis scores

Pedographic Analyse		Ovedia-Beals	Tenny-Wiss	Takakura
Anterior	r	0,425	-0,668	0,370
	p	0,001*	0,000*	0,003*
Posterior	r	-0,425	0,668	-0,370
	p	0,001*	0,000*	0,003*
Medial	r	-0,580	0,697 ⁺	-0,260 ⁺
	p	0,000*	0,000*	0,042*
Lateral	r	0,580	-0,697 ⁺	0,260 ⁺
	p	0,000*	0,000*	0,042*
<i>Pearson Korelasyon Analizi</i>		<i>⁺Spearman Rho Korelasyon Analizi</i>		<i>*p<0.05</i>

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Figure 1: Anteroposterior and lateral radiographs of a 48-year-old male patient who had AO type C1 tibia pilon fracture as a result of falling from height.

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Figure 2: Anteroposterior and lateral radiographs with external fixator applied in the first intervention of the patient

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Figure 3: Anteroposterior and lateral radiographs of ORIF applied to the patient three weeks after external fixator application

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Figure 4: Anteroposterior and lateral radiographs of the patient during the two-year follow-up

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Figure 5: The result of the patient's foot loading analysis (it is observed that the foot loading has shifted to the lateral and posterior)

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Figure 6: The relationship between foot loading analysis and Ovadia-Beals Score

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Figure 7: The relationship between foot loading analysis and Teeny-Wiss Score

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Figure 8: The relationship between foot loading analysis and Takakura Classification