Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Orthopaedics

Prediction of Functional Outcome of Surgical Treatment in Danis-Weber Type-C Closed Ankle Fracture Using AOFAS Ankle Hind Foot Score in a Tertiary Care Hospital

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DOI: 10.36347/sjams.2023.v11i02.016 | **Received:** 08.01.2023 | **Accepted:** 13.02.2023 | **Published:** 16.02.2023

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Abstract **Original Research Article**

***Background*:** Fracture of the ankle is the most common fracture involving joints. Being a weight-bearing joint maximum thrust passes through it. It is a complex weight-bearing joint and is subjected to many different types of injury. Successful treatment will allow early mobilization to avoid complications. AOFAS Ankle Hind foot score is the most commonly used tool to measure this outcome. ***Objective*:** To assess prediction of functional outcome of surgical treatment in Danis-Weber type-C closed ankle fracture using AOFAS Ankle Hind Foot Score. ***Methods*:** A prospective observational study was carried out in Monno Medical College and Hospital, Manikganj, from June 2022 to December 2022. A total of 32 patients with Danis-Weber type-C ankle fracture were taken in this study. All the patients were initially managed by analgesic and short leg posterior slab. After admission, all were treated by ORIF with small DCP for fractured fibula and ORIF by two 4mm cannulated cancellous screws for fractured medial malleolus. Operations were done within 4 days to 14 days. The average follow up was 24 weeks. The outcome was assessed by the AOFAS score. ***Results*:** The mean age was 34.68±10.79 years with a male predominance, 23 (71%). Most of the patients, 14 (44%), were service holder. Right-sided injury, 20 (63%), were more than left. The main cause of injury was RTA, 22 (69 %), and the commonest mechanism of injury was pronation external rotation, 37 (84%). Syndesmotic injury was present in 28 (88%) cases. The mean duration of hospital stay was 14±2.68 days. Superficial infection was in 2 (6%) patients. The mean AOFAS pain score at 12^{th} and 24^{th} weeks follow up were 29.21±6.18 and 34.3±45.64, which was significant (p-.0005). The mean duration of radiological healing was 13.34±1.56 weeks. The mean dorsiflexion and plantar flexion at 12^{th} weeks follow up was respectively 8.81±1.59 and 43.18±4.70; and 24th weeks follow up was respectively 10.87±1.43 and 51.25±1.11, which was significant (p-.0005). The final AOFAS score at 12^{th} and 24^{th} weeks follow up were respectively 82±8.50 and 87±90, which was also significant (p- .0005). A satisfactory outcome was observed in 84.37% of patients and 15.63% had unsatisfactory results. ***Conclusions*:** After the operative treatment of Danis-Weber type-C ankle fracture by small DCP and two 4mm cannulated cancellous screws, the majority of the patients return to pre-injury activities. Younger age, male gender and early operation give significant radiological and early functional outcome. Ankle pain, pain at walking and rest as well as AOFAS score is improved with subsequent follow up.

Keywords: Functional outcome, Walking distance, Walking surfaces, AOFAS.

INTRODUCTION

Fracture of the ankle is the most common fracture involving joints. Being a weight-bearing joint maximum thrust passes through it. It is a complex weight-bearing joint and is subjected to many different types of injury. It has most common occurrence with the exception of a wrist fracture [1]. They account for 9% of all fractures, representing a significant proportion of workload [2]. Approximately 2% of the general population will sustain an ankle fracture during their lifetime [3]. Disability following ankle fracture may result in the serious sequel like osteoarthritis, infection etc. Slight variation from a normal alignment of joint is incompatible with proper function. Ankle fractures are common injuries that require meticulous technique to optimize outcome. The Lauge-Hansen and Danis-Weber classifications in addition to careful evaluation

of the injury mechanism can help guide treatment but surgeons must be aware that there are injury patterns that will not always fit the aforementioned patterns. The principles of atraumatic soft tissue handling, rigid internal fixation and early range of motion exercises are critical for successfully treating these injuries. There are still areas of treatment uncertainty and future directed research is needed to address some of these questions [4]. The classification systems of Lauge- Hansen and Danis and Weber have been combined in the OTA classification system. The pronation external rotation (PER) injuries in the Lauge-Hansen classification are known as Weber-C or OTA type-C fractures and accounts for approximately 20% of all ankle fractures. In PER type II injuries, a rupture of the deltoid ligament or avulsion fracture of the medial malleolus is combined with an anterior syndesmotic band rupture or bony avulsion, with or without a rupture of the interosseous membrane. A PER type III injury consists of a PER type II injury with a spiral fracture of the fibula shaft, proximal to the syndesmosis. PER type IV injuries are PER type III injuries with the addition of a rupture of the dorsal syndesmotic bands or bony equivalent [5]. Despite the growing incidence of severe ankle fractures in the elderly population, there is still much controversy in the orthopaedic community regarding the best management for these fractures Recent cross-national studies have shown a significant increase in the incidence and severity of ankle fractures among the elderly population [6]. Epidemiological studies have indicated that 39% of all ankle arthritis is secondary to a previous malleolar fracture and 78% have a post-traumatic aetiology [7]. Ankle fractures are one of the most common reasons for visits to the Emergency Department. Toth, M.J. *et al.* provided a concise, comprehensive update on these frequently debated topics in the treatment of ankle fractures: 1) the indications for fixation of isolated fibula fractures; 2) the need for fixation of the posterior malleolus, 3) the role for the posterolateral approach; 4) treatment of the syndesmosis and 5) the potential role of fibular nailing [6,7]. The control group for the clinical results consisted of patients undergoing surgical therapy. The standard surgical procedure was open reduction and internal fixation following AO guidelines with subsequent early motion. The clinical outcome was measured according to the Olerud Molander ankle score. A very good result was seen in 18 patients, including 12 with 100 points, a complete remission. The remaining 3 patients showed good results (1 had 90, 2 had 85). However, functional treatment failed in 4 cases due to secondary dislocation. These patients underwent surgery without further complications. They were able to avoid surgery in 90% of our patients and got better results than with patients undergoing open reduction and internal fixation.

MATERIALS AND METHODS

A prospective observational study was carried out in Monno Medical College and Hospital, Manikganj, from June 2022 to December 2022. A total of 32 patients with Danis-Weber type-C ankle fracture were taken in this study. All the patients were initially managed by analgesic and short leg posterior slab. After admission, all were treated by ORIF with small DCP for fractured fibula and ORIF by two 4mm cannulated cancellous screws for fractured medial malleolus. Patients with age between 18 to 60 years were inclusion criteria. Patients with closed Danis-Weber type-C ankle fracture and injury of less than 3 weeks. Operations were done within 4 days to 14 days. The average follow up was 24 weeks. The outcome was assessed by the AOFAS score.

Data Collection Procedure

Cases were selected from orthopaedics department of Monno Medical College, Manikganj, having closed Danis-Weber type-C ankle fracture. After counselling for surgery, pre-operative data were collected. An informed written consent was taken for operation and anesthesia after proper pre-operative check-up. Operations were done in different units by different surgeons. Pre-operative, per-operative and post-operative data were recorded. Each patient followed up for 24 weeks for radiological and functional evaluation and limited physiotherapy was given. Final radiological and functional scoring was done and recorded for final outcome evaluation 24 weeks after operation and was evaluated by AOFAS score.

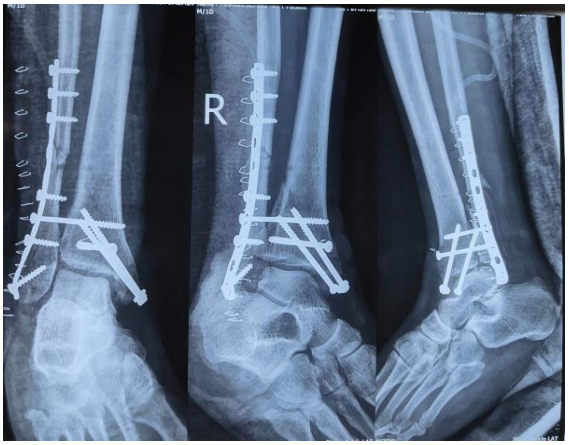
Statistical Analysis

Analysis done by SPSS 22 for windows software. The data tabulated and quantitative parameters such as age of patient summarized in terms of mean with standard deviation, to understand the variation present in the data. Percentage expression for positivity of scoring estimated along with 95% confidence interval. The significance of the results as determined in 95% confidence interval and a value of $p<0.05$ considered to be statistically significant.

Study Procedure

After selecting a case according to inclusion and exclusion criteria, patients were evaluated pre-operatively. After preparing the patients, operation was done. Injection Ceftriaxone and Flucloxacillin were given per-operatively followed by oral Cefixime and Flucloxacillin for 14 days. Patients were discharged from hospital at 2nd POD. 1st follow up was given at 14th POD to check any signs of infection, pain status and distal neurovascular status, Stitch was removed on the same day with follow up X-ray. Next follow up was at 6 week after operation. Range of motion was tested and repeats X-ray was done. Improvement was noted. Subsequent follow up was given at 9th, 12th, and 24th week after operation. At last follow up, X-ray was done and final assessment was done according to AOFAS.

Pic-1



Pic-2

RESULTS

Table-I: Age of the study subjects (N=32)

Age (years)	Frequency	Percentage%
18-30	16	50
31-40	8	25
41-50	6	19
51-60	2	06
Total	**32**	**100.0**
Mean± SD		34.68±10.79
Range		22-60

Table 1 demonstrates that out of 32 patients, 16 (50%) were 18 to 30 years of age, 8 (25%) were 31 to 40 years old, 6 (19%) were 41 to 50 years old and 2 (6%) were 51-60 years old. The mean age was 34.68±10.79 years, the youngest of which was 22 years and the oldest was 60 years.

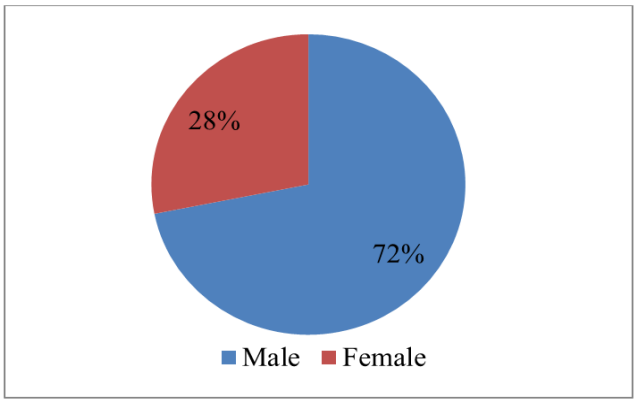


Figure-1: Pie diagram showing gender of the patient (N = 32)

Majority, 23 (72%), of the patients were male and the rest, 9 (28%), were female.

Table-II: Side of the injured limb of the study subjects (N=32)

Side involvement	Frequency	Percentage (%)
Right	20	63
Left	12	37
Total	**32**	**100.0**

Table II shows out of the 32 patients, 20 (63%) presented with right sided ankle fracture and 12 (37%) with left sided fractures.

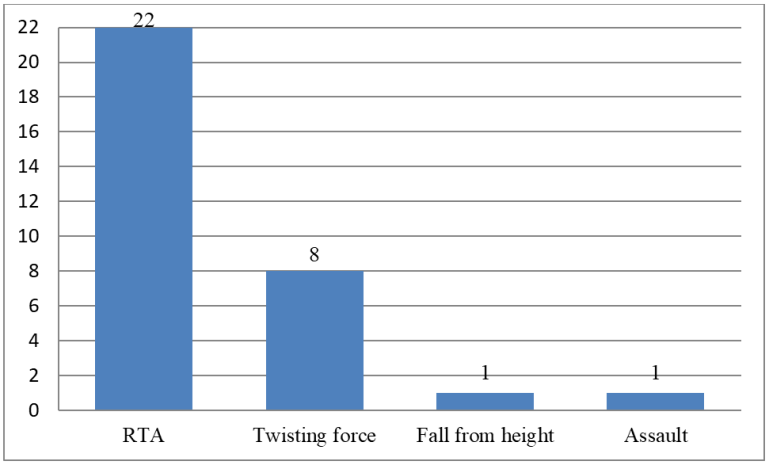


Figure-2: Bar diagram showing distribution of patients according to cause of injury (N=32)

Vast majority 22 (68.8%) of injuries were caused by RTA, 8(25%) were twisting fall, 1 (3.1%) was fall from height and another 1(3.1%) was due to physical assault.

Table-III: Time interval between injury and surgery of the study subjects (N-32)

Time interval between injury and surgery	Frequency	Percentage%
0-7 days	08	25
7-14 days	24	75
14-21 days	0	0
Total	**32**	**100.0**
Mean± SD		10.21±3
Range		4-14

Table III shows 8 (25%) patients' surgery was done within 1st week, 24 (75%) patients done in 2nd week from the occurrence of injury. The mean interval between injury and plate fixation was 10.21±3 days, where minimum was 4 days and maximum was 14 days.

Table-IV: Hospital stay of the study subjects (N-32)

Duration of Hospital stay(weeks	Frequency	Percentage%
0-7 days	01	03
7-14 days	19	39
14-21 days	12	38
Total	**32**	**100.0**
Mean± SD		14.2±68
Range		7-17

Table IV shows 12 (38%) patients stayed 3 weeks, 19 (59%) patients stayed 2 weeks and 1 (3%) patient stayed 1 week in Hospital. Mean duration of hospital stay was 14±2.68 days with minimum of 7 days and maximum of 17 days.

Table-V: Walking distances in block of the study subjects (N=32)

Walking distances in block	Frequency	AOFAS Score	Percentage (%)
Greater than 6	04	20	13
4-6	27	108	84
1-3	01	2	03
Less than 1	0	0	0

Table V shows 4 (13%) patients could cross greater than 6 blocks by walking, 27 (84%) patients could cross 4-6 blocks and 1 (3%) patients could cross 1-3 blocks (one block is equal to 200 meters).

Table-VI: Dorsiflexion movement of the study subjects (N=32)

Dorsiflexion	12 weeks		24 weeks		
	Frequency	%	Frequency	%	P- value
0-6°	02	06	0	0	
0-8°	19	59	04	13	
0-10°	07	22	10	31	
0-12°	04	13	18	56	
Total	**32**	**100**	**32**	**100**	
Mean ± SD		8.81±1.59		10.87±41.43	.0005
Range		0-20°		0-20°	

Data was analysed by student's t-Test (paired, one tailed) and expressed as Mean ± SD.

Table VI demonstrates that in 12 weeks follow up, 2 (6%) patients had 0-6° dorsiflexion, 19 (59%) patients had 0-8° dorsiflexion, 7(22%) 0-10° dorsiflexion and 4(13%) patients had 0-12° dorsiflexion. In 24 weeks follow up, 4 (13%) patients had 0-8° dorsiflexion, 10 (31%) patients had 0-10°dorsiflexion and 18 (56%) patients had 0-12° dorsiflexion. The mean dorsiflexion was 8.81±1.59 in 12 weeks follow up and 10.87±41.43 in 24 weeks follow up; the P- value was 0.0005, that is <0.05 which is statistically significant**.**

Table-VII: Planter flexion of the study subjects (N-32)

Plantar flexion	12 weeks		24 weeks		
	Frequency	%	Frequency	%	P- value
0-40°	10	31	6	19	
0-46°	17	53	3	09	
0-52°	05	16	23	72	
Total	**32**	**100**	**32**	**100**	
Mean ± SD		43.18±4.70		51.25±1.11	.0005
Range		0-55°		0-55°	

Data was analysed by student's t-Test (paired, one tailed) and expressed as Mean ± SD.

Table VII demonstrates in 12 weeks follow up, 10 (31%) patients had 0-40° plantar flexion, 17 (53%) patients had 0-46° plantar flexion and 5 (16%) patients had 0- 52° plantar flexion. In 24 weeks follow up, 6 (19%) patients had 0- 40° plantar flexion, 3 (9%) patients had 0-46° plantar flexion and 23 (72%) patients had 0-52° plantar flexion. The mean plantar flexion were 43.18±4.70 in 12 weeks follow up and 51.25±1.11 in 24 weeks follow up; the P-value was 0.0005, that is <0.05 which is statistically significant.

Table-VIII: Pain perception of the study subjects (N-32)

Pain	12 weeks			24 weeks			P- value
	Frequency	AOFAS Score	%	Frequency	AOFAS Score	%	
No pain	05	200	16	15	600	47	
Mild	20	600	62	15	380	50	
Moderate	07	140	22	01	20	03	
Severe	00	00	00	00	00	00	
Total	**32**	**940**	**100**	**32**	**1000**	**100**	
Mean ± SD		29.37±6.18			34.37±5.64		
Range		8-40			0-40		0.0005

Data was analysed by student's t-Test (paired, one tailed) and expressed as Mean ± SD.

Table VIII shows in 12 weeks follow up, 5 (16%) patients had no pain, 20 (62%) patients had mild pain and 7 (22%) had moderate pain. In 24 weeks follow up, 15 (47%) patients had no pain, 16 (50%) patients had mild pain and 1 (3%) had moderate pain. The mean scores of pain were 29.21±6.18 in 12 weeks follow up and 34.37±45.64 in 24 weeks follow up; the P-value was 0.0005, that is <0.05 which is statistically significant.

Table-IX: Foot alignments of the study subjects (N-32)

Alignment	12 weeks			24 weeks			P- value
	Frequency	AOFAS Score	%	Frequency	AOFAS Score	%	
Good	27	270	84	30	300	94	
Fair	05	25	16	02	10	06	
Poor	0	0	0	0	0	00	
Total	**32**	**925**	**100**	**32**	**310**	**100**	
Mean ± SD		9.21±1.84			9.68±1.22		
Range		0-10			0-10		0.083

Data was analysed by student's t-Test (paired, one tailed) and expressed as Mean±SD.

Table IX shows in 12 weeks follow up, 27 (84%) patients had good and 5 (16%) patients had fair alignments of foot. In 24 weeks follow up, 30 (94%) had good and 2 (6%) had fair alignment. The mean scores of alignment were 9.21±1.84 in 12 weeks follow up and 9.68±1.22 in 24 weeks follow up; the P-value was 0.083, that is >0.05 which is statistically insignificant.

Table-X: Final outcome comparison according to AOFAS score of the study subjects (N=32)

AOFAS Score grade	12 weeks			24 weeks			P- value
	Frequency	AOFAS Score	%	Frequency	AOFAS Score	%	
Excellent(90-100)	05	470	16	15	1424	47	
Good(80-89)	18	1520	56	12	1003	37	
Fair(6079)	09	634	28	05	357	16	
Poor(<60)	0	00	00	00	00	00	
Total	**32**	**2624**	**100**	**32**	**2784**	**100**	
Mean ± SD		82±8.50			87±9		
Range		0-100			0-100		0.0005

Data was analysed by student's t-Test (paired, one tailed) and expressed as Mean ± SD.

According to the AOFAS Score, >90 was termed excellent, 80-89 was good, 60-79 was fair and <60 was termed poor outcome. Table X demonstrates in 12 weeks follow up, 5 (16%) patients had excellent, 18 (56%) patients had good and 9 (28%) patients had fair outcome. In 24 weeks follow up, 15 (47%) patients had excellent, 12 (37%) patients had well and 5 (16%) patients had fair outcome. The average AOFAS score in 12 weeks follow up was 82±8.50 and in 24 weeks follow up was 87±90. The P-value was 0.0005 (<0.05) which was statistically significant. In this study, out of 32 patients, final outcome was satisfactory (Excellent 15 and Good 12) in 27 (84%) cases and Unsatisfactory (fair 5 and poor 0) in 5 (16%) cases according to American Orthopaedic Foot and Ankle Score.

DISCUSSION

In our study 32 cases were included in this study and the age range was between 18 to 60 years. The most affected group was 18 to 30 years (50%) and the mean age was 34.68±10.79 years. A similar type of study was done in India where the study subjects were between 20 to 65 years [8]. Maximum patients were included 28 to 37 years old age groups with a mean age of 56.45 years. This observation was also consistent with studies done by Hafiz, *et al.*, [10]; Alamgir, *et al.*, [1]; Shekhar and Reddy *et al.*, [9]. These studies also showed a mean age of around 35. From this study, it is evident that the ankle fracture seems to occur in relatively younger people. There were 23 male (72%) and 9 female patients (28%) in this study. This observation was evident Shekhar and Reddy *et al.*, shown 83.3% were male and 16.7% were female [9]. This is accompanying by other studies [10]. The current study showed, among 32 patients 20 (62.5%) presented with a right-sided ankle fracture and 12 (37.5%) with left-sided fractures. A similar study Hafiz, *et al.*, [10] showed the right side was affected by 58.8% and left side 41.2% cases. This observation was also consistent with [8, 10]. A study by Schepers T, *et al.*, found that both sides were equally affected. Another study found that left-sided was more involved than the right sides [8]. From this study, it is evident that the ankle fracture in our country seems to occur more on the right side. In this study, 22 (68.8%) cases were due to road traffic accidents, 16.6% cases were due to fall. In another study, Hafiz, *et al.*, [10] shown Motor vehicle accident (MVA) was the most common cause of ankle fractures (70.4% of all study subjects) and 6.2% were sports injury. The most common mechanism of Danis-Weber type-C ankle fracture was Pronation external rotation. Mechanism of injury in this study by Pronation-external rotation was found 27 (84.38%) cases among 32 which further research and support the observation [11, 12]. It was evident from this study that, there were 28(87.5%) cases out of 32 patients had a syndesmotic injury which was common in Danis-Weber type-C ankle fracture. This finding was supported by other studies also [13, 14]. In current study 8 (25%) patients' surgery was done within 1st week, 24 (75%) patients did

in 2nd week from the occurrence of injury and plate fixation mean duration was 10.21±3 days, where the minimum was 4 days and the maximum was 14 days. The mean interval between injury when the injury was not dealt with within a few hours due to blisters and soft tissue injury, definitive treatment deferred for several days while the leg was elevated so that the swelling could subside and skin wrinkle appears [15]. In our study, 12 (37.5%) patients stayed 3 weeks, 19 (59.4%) patients stayed 2 weeks and 1 (3.1%) patient stayed 1 week in Hospital. The mean duration of hospital stay was 14±2.68 days with a minimum of 7 days and a maximum of 17 days. Another study was done by Lamontagne, *et al.,* [16] and Alamgir, *et al.,* [1] where the mean duration of hospital stay was respectively 3.2 days and 4 days. Another study Hafiz, *et al.,* [10] revealed in most of the cases (74.4%) duration of hospital stay was less than 2 weeks. This study correlates with our study concerning the duration of hospital stay. This delay was because of the subsiding of affected limb swelling patients having financial problems and excessive hospital load of other trauma patients. The rate of infection in the present study (6.25%). Radiological evaluation revealed no talar shift in any patient. None of the patients had developed a deep infection, non- union or implant failure. The superficial infection subsided by local dressing and antibiotics. The fracture was ultimately healed. This result is supported by another study done by Tunturi, *et al.,* [17] where superficial wound infection rate was 4.86% and skin necrosis was 1.08% and in Miller (1983) where wound infection was 2.2%. Another study in 2011 was done by Schepers, *et al.,* [18] where they found the wound infection rate was 17.5%, which is more than this study. A study Tunturi *et al.,* [17] showed there were 27% of patients had difficulties walking on an uneven surface. The difficulty was due to poor alignment of the fracture fragments. In 12 weeks follow up, 2 (6%) patients had 0-6° dorsiflexion, 19 (59%) patients had 0-8° dorsiflexion, 7 (22%) 0-10° dorsiflexion and 4 (13%) patients had 0-12° dorsiflexion. In 24 weeks follow up, 4 (13%) patients had 0-08° dorsiflexion, 10 (31%) patients had 0-10° dorsiflexion and 18 (56%) patients had 0-12° dorsiflexion. The mean dorsiflexion was 8.81+1.59 in 12 weeks follow up and 10.87+41.43 in 24 weeks follow up; the P-value was 0.0005, that is <0.05 which is statistically significant. In 12 weeks follow up, 10 (31%) patients had 0-40° plantar flexion, 17 (53%) patients had 0-46° plantar flexion and 5 (16%) patients had 0-52° plantar flexion. In 24 weeks follow up, 6 (19%) patients had 0-40° plantar flexion, 3 (9%) patients had 0-46° plantar flexion and 23 (72%) patients had 0-52° plantar flexion. The mean plantar flexion was 43.18+4.70 in 12 weeks follow up and 51.25+1.11 in 24 weeks follow up; the P-value was 0.0005, which is <0.05 which is statistically significant. Siegel and Tornetta *et al.,* showed ranges of motion were mean 13° of dorsiflexion and 31° of plantar flexion [19]. In 12 weeks follow up, 5 (15.60%) patients had no pain, 20 (62.50%) patients had mild pain and 7 (21.90%) had moderate pain. In 24 weeks follow up, 15 (47%) patients had no pain, 16 (50%) patients had mild pain and 1 (3%) had moderate pain. The mean scores of pain were 29.37±6.18 in 12 weeks follow up and 34.37+45.64 in 24 weeks follow up; the P-value was 0.0005, which is <0.05 which is statistically significant. So the pain perception of the patients of this study corresponds with an Indian study [13]. The pain was mainly due to irregular physiotherapy and stiffness in most of the patients. The pain was subsided by taking NSAIDs, physiotherapy and moist hot compression. In 12 weeks follow up, 27 (84%) patients had well and 5 (16%) patients had fair alignments of the foot. In 24 weeks follow up, 30 (94%) had good and 2 (6%) had fair alignment. The mean scores of alignment were 9.21+1.84 in 12 weeks follow up and 9.68+1.22 in 24 weeks follow up; the P-value was 0.083, which is > 0.05 which is statistically insignificant. According to the AOFAS score, >90 is termed as excellent, 80-89 is good, 60- 79 is fair and <60 is termed as poor outcome. In 12 weeks follow up, 5 (16%) patients had excellent, 18 (56%) patients had well and 9 (28%) patients had a fair outcome. In 24 weeks follow up, 15 (47%) patients had excellent, 12 (37%) patients had well and 5 (16%) patients had a fair outcome. The average AOFAS score in 12 weeks follow up was 82+8.50 and in 24 weeks follow up was 87+9. The P-value was 0.0005 (<0.05) which was statistically significant. At follow up in this series, each patient was assessed for pain on full weight-bearing, functional activity, walking distance, gait abnormality, range of motion of ankle joints, ankle-hind foot stability & limitation of the activates of daily living and range of motion according to AOFAS score. According to the AOFAS Score, >90 is termed as excellent, 80-89 is good, 60-79 is fair and <60 is termed as poor outcome. In 12 weeks follow up, 5 (16%) patients had excellent, 18 (56%) patients had well and 9 (28%) patients had a fair outcome. In 24 weeks follow up, 15 (47%) patients had excellent, 12 (37%) patients had well and 5 (16%) patients had a fair outcome. The average AOFAS score in 12 weeks follow up was 82±8.50 and in 24 weeks follow up was 87+9 with the range of 63-96. The P-value was 0.0005 (<0.05), which was statistically significant. This result was better than other studies by Siegel and Tometta *et al.,* [19] where the average AOFAS score of the patient at the last follow up was 82 (range 68 to 100) and Hamid, *et al.,* [14] showed in their study that the AOFAS score for the whole population was 85.2 (range 55 to 100). So a total of 27 (84.37%) patients were in the satisfactory group and only 5 (15.63%) patients were in an unsatisfactory group.

CONCLUSIONS

After the operative treatment of Danis-Weber type-C ankle fracture by small DCP and two 4mm cannulated cancellous screws, the majority of the patients return to pre-injury activities. Younger age,

male gender and early operation give significant radiological and early functional outcome. Ankle pain, pain at walking and rest as well as AOFAS score is improved with subsequent follow up.

Conflict of Interest: None.
Source of Fund: Nil.
Author Contribution: All authors contribution in our present study.

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