Clinical outcome after open reduction and internal fixation of type B bimalleolar ankle fractures

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Abstract

Background
Many Studies were conducted to study the outcome of different ankle fractures, the measuring of this functional outcome can be done through functional scores. Examples of these scores include the the Olerud–Molander Ankle Score (OMAS) and the American Orthopaedic Foot and Ankle Society ankle-hindfoot score (AOFAS). The Olerud–Molander Ankle Score (OMAS) was developed to assess the function of the ankle subjectively after surgery.

Objectives
The aim of this study is to evaluate the outcome of surgical treatment of Type B Ankle Fractures and estimate the possible predictors that can affect it leading to poorer Outcome.

Patients and Methods
In current study a total of 50 patients with AO classification 44-B2.2 and 44-B2.3 ankle fractures were admitted in Al Hussain hospital and Helwan general hospital for surgery with ORIF and were reviewed retrospectively to evaluate the outcome and estimate the possible predictors that can affect it leading to poorer Outcome by using an Arabic translation of the OMAS score. Predictors which were investigated included Patient factors (Age ,Sex ,Body Mass Index) , other comorbidities (Diabetes ,Vascular diseases), habits such as Smoking . Fracture factors include (primary ankle dislocation ,associated soft tissue injury) and Surgical factors include delay of surgery, type of fixation Rehabilitation factors such as period of immobilization after surgery.

Results
In the current study, we present the outcome of 50 patients who had bimalleolar ankle fractures with AO classification 44-B2.2 and 44-B2.3 by using the OMAS score and investigating possible predictors of the outcome. Regarding OMAS score of the patients included in our study, after 1 year 27 patients (54 %) had good outcome (OMAS score >= 75) while 23 patients (46 %) had bad outcome (OMAS score < 75).The Statistical Analysis showed that two predictors only affected the final OMAS score including **delay in operative management and presence of subluxation after injury**. Also notable was that the presence of Equinus deformity is a major postoperative complication which lowers the OMAS score.

Discussion
The possible causes for bad outcome after ankle fracture surgery can be: the presence of severe injuries, the evidence is the large number of subluxation or dislocation cases including 11 cases (22 %) in the study group; another possible cause is the absence of standardized rehabilitation program for gaining the best range of motion and preventing stiffness and muscle contractures.

Conclusion
Our recommendations for treatment of ankle fractures include early management of ankle fractures according to AO guidelines, close monitoring of patients postoperatively to address any range of motion abnormality, using a postoperative rehabilitation program and finally using the OMAS score to follow patients and detect any disability after surgical management. ORIF is the treatment of choice in ankle fractures with classification 44-B2.2 and 44-B2.3, the OMAS score can be used to evaluate subjectively scored function after ankle fractures. The OMAS score can be affected negatively by the delay in surgery and the severe injuries with dislocated ankle mortise. Also we noted that presence of equinus deformity is a major postoperative complication which lowers the OMAS score significantly.

Keywords
Ankle Fractures, AO Type B ankle fractures, OMAS score, Arabic OMAS, functional outcome of ankle surgery.

Introduction

Ankle Fractures are of the most common lower extremity fractures treated in orthopaedics. [1] Reported an incidence rate range of 122-184/100,000 person-years.

Many Classifications for Ankle Fractures are now present to describe them and to provide a guide for the intervention required and for the prognosis expected of these fractures. The commonly used Classifications are the Lauge-Hansen Classification which describes fractures on the basis of the mechanism of trauma, The AO-group produced The AO (Danis-Weber) classification [2]. According to the AO (Danis-Weber) classification there are 3 main Classes A, B and C with further subgroups. The type B Fracture is the trans-syndesmotic type which is subdivided into B1, B2 and B3.

No standardized method is being used in local medical institutions to follow up patients and discover possible causes of bad outcome after ankle fracture surgery, yet no Arabic translation of the OMAS score is available for subjectively collecting data from patients. The presence of many factors that can affect the functional outcome is also needed to be investigated in order to help improve the outcome by addressing these factors. The hypothesis of this study is that by using the Arabic translation of the OMAS score the factors affecting outcome can be determined after ankle surgery.

Patients and Methods

A) Patients

From January 2016 to July 2017 a retrospective cohort study was undergone at Al-Hussain Hospital and Helwan General Hospital, Cairo, Egypt on patients who had bimalleolar ankle fractures with AO classification 44-B2.2 and 44-B2.3 who were admitted for surgery with ORIF, patients included in this study were identified by reviewing their medical records.

Inclusion criteria :

1) Age > 18 years .
2) Closed Fractures .
3) Bimalleolar Fracture at the level of syndesmosis with the AO classification 44-B2.2 and 44-B2.3 .

Exclusion criteria :

1) Patients under 18 years old.
2) Patients using crutshes or other walking aids previously.
3)Patients not able to co-operate or understand the OMAS form.
4) Open fractures and degloving injuries.

Population size:

Number of patients with available data who underwent surgical fixation of ankle fractures was 80. After reviewing their post-operative X-ray 50 patients were selected.

B) Design

The current study is a retrospective cohort study, all patients were followed after 6 months and 1 year of surgery. Recruitment was done by using contact information in patients records to invite patients to participate in the study. The patients who were followed in this study were given a questionnaire for the translated to Arabic OMAS score and the history sheet for patient's data was filled. Also passive range of motion was measured and equinus deformity was noted if present. Postoperative X-ray for operated ankle were followed to detect fracture union, while preoperative X-ray for detection of dislocation were noted.

C) Outcomes

The patients were interviewed after surgery at 6 months and 1 year intervals to measure the OMAS score and passive range of motion between plantar surface of ankle and a line perpendicular to longitudinal axis of distal tibia, while recording possible predictors for outcome which include: Patient factors (Age ,Sex ,Body Mass Index) , other comorbidities (Diabetes ,Vascular diseases), habits such as Smoking . Fracture factors include (primary ankle dislocation ,associated soft tissue injury) and Surgical factors include delay of surgery, type of fixation, rehabilitation factors such as period of immobilisation after surgery.

Statistical analysis was performed using SPSS statistical package for social science version 24. Quantitative data were presented as mean and standard deviation, while qualitative data were presented as count (n) and percentage (%). CHI-Square was used for comparison between qualitative data and T-test was used to compare quantitative data. Binary logistic regression was used in order to determine the role and the relationship of predictive valuees of the dependent outcome of OMAS score after 1 year. P-value level of significance was :

- $P>0.05$: Non significant.
- $P<0.05$: Significant.

Results

50 patients (Ankles) with AO classification 44-B2.2 and 44-B2.3 ankle fractures were admitted for surgery with ORIF. They were evaluated in this study the OMAS score interpre- tation was :

- 75 or more as good outcome.
- Less than 75 as bad outcome.

Regarding the 12 months OMAS score 27 patients had good outcome (54 %), while 23 had bad outcome (46 %).

A) Patient criteria

1. Age and sex distribution.

Mean age for patients was 41 years (SD = 8.9) and range (23-60). T-test comparing the good outcome and bad outcome groups showed P value >0.05 (no significance).

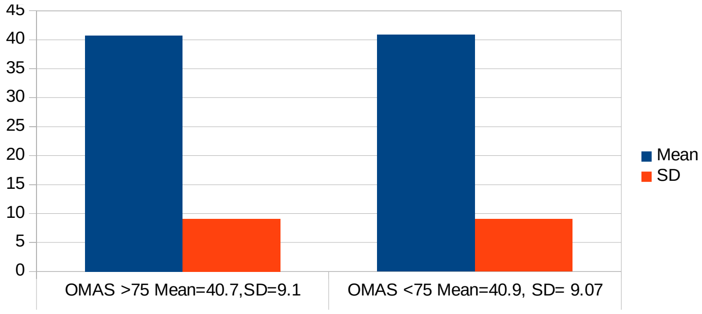

Figure 1: Chart of age distribution among patients with good and bad outcome.

Regarding sex distribution 31 (62%) of patients were females & 19 (38%) of them were males. Crosstab showed that 12 (38.7%) of females had good outcome, the rest 19 (61.3 %) had bad outcome. While 15 male (78.9 %) had good outcome and the rest 4 (21.1 %) had bad outcome.

Table 1: Table showing crosstab results between sex and outcome

Crosstab					
			outcome2		Total
			good	bad	
SEX	FEMALE	Count	12	19	31
		% within SEX	38.7%	61.3%	100.0%
		% within outcome2	44.4%	82.6%	62.0%
	MALE	Count	15	4	19
		% within SEX	78.9%	21.1%	100.0%
		% within outcome2	55.6%	17.4%	38.0%
Total		Count	27	23	50
		% within SEX	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows significance (p <0.05) between male and female groups.

Table 2: Table showing CHI-Square test between male and female groups.

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.678[a]	1	.006		
Continuity Correction[b]	6.144	1	.013		
Likelihood Ratio	8.057	1	.005		
Fisher's Exact Test				.008	.006
Linear-by-Linear Association	7.525	1	.006		
N of Valid Cases	50				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.74.

b. Computed only for a 2x2 table

2. Affected Side.

22 patients (44%) of the patients had injured right ankle, while 28 patients (56%) had injured left ankle. Crosstab showed that 16 (57.1%) of patients with left side injury had good outcome,while 12(42.9%) of patients with left side injury had bad outcome. Within the right side group 11 patients (50%) had good outcome while the other 11 patients (50%) had bad outcome.

Table 3: Table showing crosstab results between left and right sides

Crosstab					
			outcome2		Total
			good	bad	
side	LEFT	Count	16	12	28
		% within side	57.1%	42.9%	100.0%
		% within outcome2	59.3%	52.2%	56.0%
	RIGHT	Count	11	11	22
		% within side	50.0%	50.0%	100.0%
		% within outcome2	40.7%	47.8%	44.0%
Total		Count	27	23	50
		% within side	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows no significance (p >0.05) between right and left side groups.

Table 4: Table showing CHI-Square test between left and right sides.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.253[a]	1	.615		
Continuity Correction[b]	.047	1	.828		
Likelihood Ratio	.253	1	.615		
Fisher's Exact Test				.776	.414
Linear-by-Linear Association	.248	1	.618		
N of Valid Cases	50				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.12.					
b. Computed only for a 2x2 table					

3. Special Habits.

13 (20%) of patients were smokers ,while 37 (74%) were non-smokers.

Crosstab shows that 9 (69.2%) of smokers had good outcome, while 4 (30.8%) of them had bad outcome. Within the non-smoker group, 18 (48.6 %) of them had good outcome while 19(51.4%) had bad outcome.

Table 5: Table showing crosstab results between smokers and non-smokers.

Crosstab					
			outcome2		Total
			good	bad	
smoking	NO	Count	18	19	37
		% within smoking	48.6%	51.4%	100.0%
		% within outcome2	66.7%	82.6%	74.0%
	YES	Count	9	4	13
		% within smoking	69.2%	30.8%	100.0%
		% within outcome2	33.3%	17.4%	26.0%
Total		Count	27	23	50
		% within smoking	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows no significance (p >0.05) between smoker and non-smoker groups.

Table (6): Table showing CHI-Square test between smokers and non-smokers.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.641[a]	1	.200		
Continuity Correction[b]	.917	1	.338		
Likelihood Ratio	1.680	1	.195		
Fisher's Exact Test				.332	.170
Linear-by-Linear Association	1.608	1	.205		
N of Valid Cases	50				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.98.					
b. Computed only for a 2x2 table					

4. <u>Mode of Trauma.</u>

35 patient (70 %) were injured by ankle twisting trauma, while 15 patients (30 %) were injured by road traffic accidents.

Crosstab showed that 21 (60%) of patients with simple trauma had good outcome, while 14 (40%) of patients with simple trauma had bad outcome.

Within the group of polytrauma 6 patients (40%) of patients had good outcome, and 9 patients (60%) had bad outcome.

Table 7: Table showing crosstab results between simple and polytrauma groups

Crosstab					
			outcome2		
			good	bad	Total
trauma	SIMPLE	Count	21	14	35
		% within trauma	60.0%	40.0%	100.0%
		% within outcome2	77.8%	60.9%	70.0%
	POLYTRAUMA	Count	6	9	15
		% within trauma	40.0%	60.0%	100.0%
		% within outcome2	22.2%	39.1%	30.0%
Total		Count	27	23	50
		% within trauma	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows no significance (p >0.05) between simple and polytrauma groups.

Table 8: Table showing CHI-Square test between simple and polytrauma groups

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.691[a]	1	.193		
Continuity Correction[b]	.982	1	.322		
Likelihood Ratio	1.693	1	.193		
Fisher's Exact Test				.228	.161
Linear-by-Linear Association	1.657	1	.198		
N of Valid Cases	50				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.90.					
b. Computed only for a 2x2 table					

5. <u>Preoperative Skin Condition.</u>

10 patients (20%) had bad skin condition, while 40 (8%) had good skin condition.

Crosstab showed that 5 patients (50%) out of 10 with bad skin condition had bad outcome, while the other 5 (50%) had good outcome.

22 patients (55%) out of 45 with good skin condition had good outcome, while 18 patients (45%) out of 45 with good skin condition had bad outcome.

Table 9: Table showing crosstab results between good and bad skin condition groups

Crosstab					
			outcome2		Total
			good	bad	
soft_t	NO	Count	22	18	40
		% within soft_t	55.0%	45.0%	100.0%
		% within outcome2	81.5%	78.3%	80.0%
	YES	Count	5	5	10
		% within soft_t	50.0%	50.0%	100.0%
		% within outcome2	18.5%	21.7%	20.0%
Total		Count	27	23	50
		% within soft_t	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test showed no significance (>0.05).

Table 10: Table showing CHI-Square test between good and bad skin condition groups

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.081[a]	1	.777		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.080	1	.777		
Fisher's Exact Test				1.000	.526
Linear-by-Linear Association	.079	1	.779		
N of Valid Cases	50				
a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.60.					
b. Computed only for a 2x2 table					

6. <u>Presence of dislocation.</u>

11 patients (22 % of patients) had dislocation or subluxation that needed reduction in ER department.

Crosstab showed that 2 patients (18.2%) of patients with dislocations had good outcome, while 9 patients (81.8%) had bad outcome.

Patients with no dislocations included 25 (64.1%) with good outcome, while 14 (35.9 %) had bad .outcome.

Table 11: Table showing crosstab results between dislocation and no-dislocation groups

Crosstab					
			outcome2		Total
			good	bad	
dislocation	NO	Count	25	14	39
		% within dislocation	64.1%	35.9%	100.0%
		% within outcome2	92.6%	60.9%	78.0%
	YES	Count	2	9	11
		% within dislocation	18.2%	81.8%	100.0%
		% within outcome2	7.4%	39.1%	22.0%
Total		Count	27	23	50
		% within dislocation	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test showed significance (P<0.05)

Table 12: Table showing CHI-Square test between dislocation and no-dislocation groups.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.284[a]	1	.007		
Continuity Correction[b]	5.552	1	.018		
Likelihood Ratio	7.643	1	.006		
Fisher's Exact Test				.014	.009
Linear-by-Linear Association	7.138	1	.008		
N of Valid Cases	50				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.06.					
b. Computed only for a 2x2 table					

7. <u>Diabetes Mellitus.</u>

DM was found in 2 patients (4% of patients). All were type II DM and were adequately controlled pre-operatively by using Insulin.

Crossstab showed that all 2 patients with diabetes (100%) had bad outcome.

While 27 (56.3%) patients out of 48 with no DM had good outcome, while the other 21 (43.8%) had bad outcome.

Table 13: Table showing crosstab results between DM and no DM groups

Crosstab					
			outcome2		
			good	bad	Total
DM	NO	Count	27	21	48
		% within DM	56.3%	43.8%	100.0%
		% within outcome2	100.0%	91.3%	96.0%
	YES	Count	0	2	2
		% within DM	0.0%	100.0%	100.0%
		% within outcome2	0.0%	8.7%	4.0%
Total		Count	27	23	50
		% within DM	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square Test showed no significance (P>0.05).

Table 14: Table showing CHI-Square test between DM and no DM groups

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.446[a]	1	.118		
Continuity Correction[b]	.705	1	.401		
Likelihood Ratio	3.204	1	.073		
Fisher's Exact Test				.207	.207
Linear-by-Linear Association	2.397	1	.122		
N of Valid Cases	50				
a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.					
b. Computed only for a 2x2 table					

8. <u>Vascular Diseases.</u>

No Patients were reported to have history of vascular diseases

9. <u>BMI (Kg/m^2 surface area).</u>

Mean Body Mass Index (BMI) was 24.22 ,while standard deviation was 1.5. T-Test showed no significance (P<0.05)

B) Operative data

1-<u>Delay of operative management .</u>

10 patients (20% of patients) had delayed operative

intervention more than 1 week after injury. They included patients who had marked soft tissue swelling and skin Bullae of the blood filled type.

Crossstab showed that 1 patient (10%) out of 10 delayed patients had good outcome and the other 9 patients (90%) had bad outcome.

While 26 patients (65%) out of 40 nondelayed patients had good outcome and the other 14 patients (35%) had bad outcome.

Table 15: Table showing crosstab results between delay and no delay groups

Crosstab					
			outcome2		Total
			good	bad	
delay	NO	Count	26	14	40
		% within delay	65.0%	35.0%	100.0%
		% within outcome2	96.3%	60.9%	80.0%
	YES	Count	1	9	10
		% within delay	10.0%	90.0%	100.0%
		% within outcome2	3.7%	39.1%	20.0%
Total		Count	27	23	50
		% within delay	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test is significant (P<0.05)

Table 16: Table showing CHI-Square test between delay and no delay groups.

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.742[a]	1	.002		
Continuity Correction[b]	7.654	1	.006		
Likelihood Ratio	10.697	1	.001		
Fisher's Exact Test				.003	.002
Linear-by-Linear Association	9.548	1	.002		
N of Valid Cases	50				
a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.60.					
b. Computed only for a 2x2 table					

2-Method of fixation

All patients underwent operative fixation of the fracture according to the AO guidelines. An exception to the AO guidelines one case underwent fixation of the medial malleolus fracture by k-wires only without tension band. Another case underwent fixation of medial malleolus by 1 malleolar screw and 1 K-wire (antirotation).

Regarding the fixation of the lateral malleolus, only one case was fixed by posterior plating while the rest 49 cases were fixed by lateral plating. The Lag screw was used in 5 cases .

The case with inadequate fixation (Figure 5) showed a longer period of immobilization, this indicates that bone healing was not achieved adequately in the expected time to allow early movement and weight bearing. Analysis of this case is discussed within the immobilization.

C) Postoperative evaluation data

1. Radiological investigations:

A) Preoperative plain X-ray.

To identify fracture classification and presence of dislocation.

Standard AP and Lateral views of the ankle were optained ,with additional Mortise view to further identify the fracture pattern **(Figure 2-3)** .

Figure 2: Preoperative X-rays of patient number 23.

Figure 3: Preoperative X-ray of patient number 13 showing subluxation which require immediate reduction.

B) Postoperative plain X-ray.
Postoperative X-ray to identify implant used and confirm the reduction of the fracture also during follow-up to identify fracture union (Figure 4).

Figure 4: Postoperative X-ray of patient number 16 just after operation

2. <u>Immobilization period.</u>

The standard period for immobilization was for 6 weeks. The duration ranged from 6 weeks to 4 months. 9 patients (18%) were immobilized more than 6 weeks, while 41(82%) were immobilized for 6 weeks only. One Case (2%) had unstable fixation of medial malleolus by K wire with no tension band (Figure 5) .

Figure 5: X-ray of patient Number 11.

Crossstab shows that 8 patients (88.9%) out of 9 immobilized more than 6 weeks had bad outcome, while only one patient (11.1%) had good outcome.

26 patients (63.4%) out of 41 immobilized only for 6 weeks had good outcome, while 15 (36.6%) had bad outcome.

Table 17: Table showing crosstab results between more than 6 weeks and 6 weeks only groups

Crosstab					
			outcome2		Total
			good	bad	
immobilization	NO	Count	26	15	41
		% within immobilization	63.4%	36.6%	100.0%
		% within outcome2	96.3%	65.2%	82.0%
	YES	Count	1	8	9
		% within immobilization	11.1%	88.9%	100.0%
		% within outcome2	3.7%	34.8%	18.0%
Total		Count	27	23	50
		% within immobilization	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows significance (P<0.05) of immobilization as a factor negatively affecting outcome.

Table 18: Table showing CHI-Square test between more than 6 weeks and 6 weeks only groups.

Chi-Square Tests					
	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.128[a]	1	.004		
Continuity Correction[b]	6.158	1	.013		
Likelihood Ratio	8.865	1	.003		
Fisher's Exact Test				.007	.006
Linear-by-Linear Association	7.965	1	.005		
N of Valid Cases	50				
a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.14.					
b. Computed only for a 2x2 table					

3. Physiotherapy.

No Postoperative physiotherapy program was applied to all patients as a routine after the period of immobilisation. Only 5 patients (10%) of patients were advised by their following doctors to undergo physiotherapy in the form of range of motion exercises.

The other 45 patients (90%) underwent no exercises.

Crossstab shows 2 patients (40%) of the 5 patients who underwent physiotherapy had good outcome. While 3 patients (60%) had bad outcome.

25 patients (55.6%) out of 45 with no physiotherapy had good outcome, while 20 patients (44.4%) had bad outcome.

Table 19: Table showing crosstab results between physiotherapy and no physiotherapy groups.

Crosstab					
			outcome2		Total
			good	bad	
physiotherapy	NO	Count	25	20	45
		% within physiotherapy	55.6%	44.4%	100.0%
		% within outcome2	92.6%	87.0%	90.0%
	YES	Count	2	3	5
		% within physiotherapy	40.0%	60.0%	100.0%
		% within outcome2	7.4%	13.0%	10.0%
Total		Count	27	23	50
		% within physiotherapy	54.0%	46.0%	100.0%
		% within outcome2	100.0%	100.0%	100.0%

CHI-Square test shows no significance (P>0.05).

Table 20: Table showing CHI-Square test between physiotherapy and no physiotherapy groups.

Chi-Square Tests					
	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.438[a]	1	.508		
Continuity Correction[b]	.036	1	.850		
Likelihood Ratio	.438	1	.508		
Fisher's Exact Test				.651	.422
Linear-by-Linear Association	.430	1	.512		
N of Valid Cases	50				
a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.30.					
b. Computed only for a 2x2 table					

4. Implant removal.

3 Cases underwent removal of implant, 2 of them after 6 months of surgery due to pain during movement and 1 case underwent revision (removal and reapplication of syndesmotic screw) due to limited dorsiflexion after surgery. Syndesmotic screw removal was done in all 6 cases, the time for removal ranged from 6 weeks to 4 months.

D) Postoperative Complications.

1- Postoperative Skin infection

Only 2 cases (4%) were reported to have superficial infection. They were treated by oral antibiotics and daily dressing under supervision until healing occurred.

2- Malreduction.

1 case underwent revision (removal and reapplication of syndesmotic screw) due to limited dorsiflexion after surgery.

3- Deformity.

5 cases (10%) were found to have fixed equinus deformity with no ability to dorsiflex ankle.

4- Scar.

Regarding post-operative scar, no cosmetic complaints were reported by patients, no painful scars were found and 1 case of keloid formation was found in a male patient over medial malleolus.

5- Need for removal of implants.

3 Cases underwent removal of implant, 2 of them after 6 months of surgery due to lateral ankle pain during movement (may be due to peroneal tendinitis) and 1 case underwent revision (removal and reapplication of syndesmotic screw) due to limited dorsiflexion after surgery.

E) Evaluation of postoperative clinical outcome.

1. Range of motion.

Regarding dorsiflextion 5 patients (10 %) had equinus deformity not able to dorsiflex ankle, the other 45 patients had range from 10 to 20 degrees. While plantar flexion ranged from 30 to 40 degrees (Table 21).

Table 21: Range of motion between different patients

Technique for testing	Range of Motion			
	Movement	Degree	Number	%
Passive range of motion between plantar surface of ankle and a line perpendicular to longitudinal axis of distal tibia is estimated by eye/ goniometer.	Dorsiflexion	20	20	40%
		10	25	50%
		0 (Equinus)	5	10%
	Plantar flexion	40	25	50%
		30	15	30%
		20	5	10%
		10	5	10%

Significant correlation was found between OMAS score and ROM.

Table 22: Correlation between OMAS score and ROM.

Correlations					
		OMAS6	OMAS12	D_FLEXION	P_FLEXION
OMAS6	Pearson Correlation	1	.948**	.773**	.578**
	Sig. (2-tailed)		.000	.000	.000
	N	50	50	50	50
OMAS12	Pearson Correlation	.948**	1	.762**	.642**
	Sig. (2-tailed)	.000		.000	.000
	N	50	50	50	50
D_FLEXION	Pearson Correlation	.773**	.762**	1	.558**
	Sig. (2-tailed)	.000	.000		.000
	N	50	50	50	50
P_FLEXION	Pearson Correlation	.578**	.642**	.558**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	50	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).					

2. OMAS score

Regarding OMAS score of the 50 patients included in our study, after 1 year 27 patients (54 %) had good outcome (OMAS score >= 75) while 23 patients (46 %) had bad outcome (OMAS score < 75). The average OMAS score after 6 moths was 60.3 with standard deviation 17.56, while after 1 year it improved to be 69.4 with standard deviation 17.71 . (Figure 6).

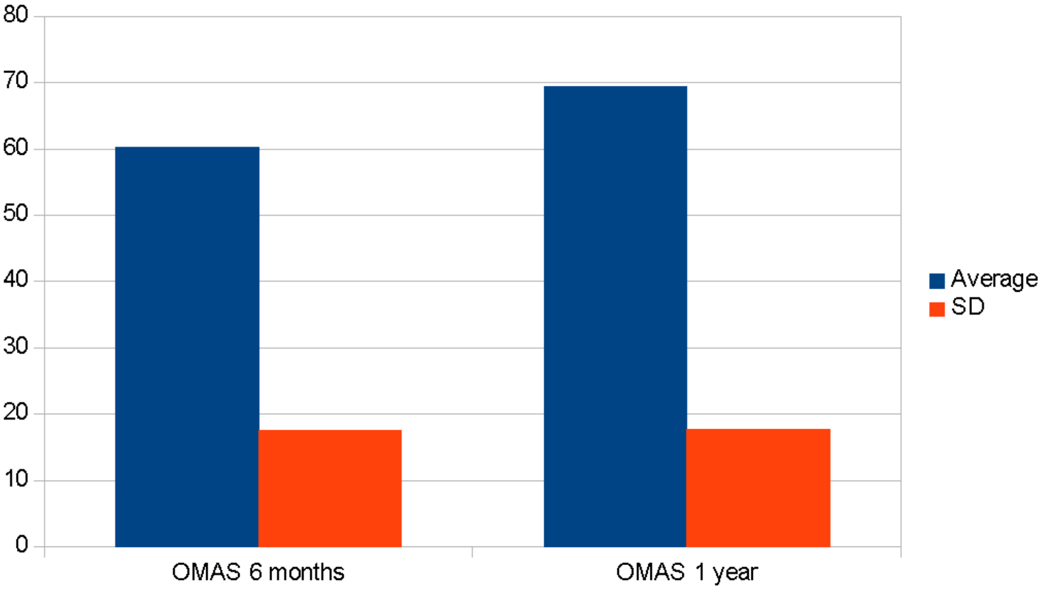

Figure 6: OMAS score results after 6 months and 1 year.

F) Multivariate analysis.

The Statistical Analysis was done by SPSS software using stepwise regression model to find the factors affecting outcome and showed that two predictors affected the final OMAS score in our study including 50 patients with AO Ankle fracture classification 44-B2.2 and 44-B2.3 treated operatively by ORIF. The predictors are delay in operative management and presence of subluxation after injury.

Also notable was that the presence of Equinus deformity is a major postoperative complication which lowers the OMAS score significantly, Range of OMAS score in patients with equinus deformity was (20-50)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
	delay	3.673	1.44	6.511	1	0.011	39.383	2.344	661.748
	dislocation	2.616	1.24	4.451	1	0.035	13.676	1.204	155.325
	Constant	-26.386	7.903	11.146	1	0.001	0		

Step Summarya,b

Step	Improvement			Model			Correct Class %	Variable
	Chi-square	df	Sig.	Chi-square	df	Sig.		
1	10.697	1	0.001	10.697	1	0.001	70.00%	IN: delay
2	5.451	1	0.02	29.328	3	0	78.00%	IN: dislocation

a No more variables can be deleted from or added to the current model.
b End block: 1

Figure 7: Regression model results.

Discussion

In the current study, we present the outcome of 50 patients who had bimalleolar ankle fractures with AO classification 44-B2.2 and 44-B2.3 by using the OMAS score and investigating possible predictors of the outcome. Mean age was 41 years (range 23-60), the mean age for women is 44 years (range 23-60), while the mean age for men is 36 years (range 23-55). The side affected was 22 right Ankles and 28 left ankles with no bilateral cases. Multivariate analysis in our study showed that no effect of age, sex or side was found to have a rule in functional outcome.

The mode of trauma in the current study varied between 35 patient (70 %) who were injured by twisting ankle trauma, while 15 patients (30 %) were injured by road traffic accidents. [3] in their study found that Motor vehicle accident (MVA) was the most common cause of ankle fractures (70.4% of all study subjects). In young, active people, fractures were associated with vigorous activity. Their study shows more young male patients than our conducted study and so explains the difference in mode of trauma.

In our study the preoperative skin complications occurred in 10 patients (20%) who had preoperative skin swelling and fracture blisters of the blood filled type. These soft-tissue problems resulted in delay in operative management more than 1 week.

Only 2 cases (4%) in this study were reported to have superficial infection with no reported cases of deep infections, DM was found in 4% of patients. All were type II DM and were adequately controlled preoperatively by using Insulin. The small number of patients didn't allow investigating smoking and DM as a risk factor. The study done by Dane et al. (2011) [4] for surgical site infection (SSI) in ankle fractures excluding open fractures showed that (3.5%) experienced an SSI. (9.5%) patients with diabetes developed an SSI compared with (2.4%) of patients without diabetes

11 patients (22 % of patients) had dislocation or subluxation that needed reduction in ER department. Statistical analysis showed that ankle subluxation or dislocation resulted in worse OMAS score. This may explain the outcome which is caused be severe injuries disrupting the joint.

Mean Body Mass Index (BMI) was 24.22 ,while standard deviation was 1.5. T-Test showed no significance (P<0.05). While Van Schie-Van et al. (2012) [5] found that higher BMI gave a lower AOFAS in conservatively managed ankle fractures this may be attributed to longer period of immobilization in the group of conservatively managed group.

10 patients (20% of patients) had delayed operative intervention more than 1 week after injury. [3] reported that some patients were having financial problems and were unable to pay for the implants, causing a delay in surgical treatment. The actual causes for operative delay in our study can't be precisely attributed to a cause in each case due to retrospective design of our study. Although possible causes can be delayed transport to the ER.; Initial swelling after Trauma; Presence of fracture blisters, especially blood filled type; Non available Hardware for ORIF; Non available operating time; Non available qualified surgeons at time of injury. Statistical analysis showed that delayed surgical management affected OMAS score negatively in current study. Other studies didn't correlate the surgical delay directly to the functional

outcome, but to the incidence of soft-tissue complication occurrence.

3 Cases underwent removal of implant, 2 of them after 6 months of surgery due to pain during movement and 1 case underwent revision (removal and reapplication of syndesmotic screw) due to limited dorsiflexion after surgery. Syndesmotic screw removal was done in all 6 cases, the time for removal ranged from 6 weeks to 4 months.

In the current study, the standard period for immobilization was 6 weeks. The duration ranged from 6 weeks to 4 months. 18% were immobilized for more than 6 weeks post-operatively. In our study no effect of immobilization on functional outcome was found,

5 patients (10% of patients) were advised to undergo physiotherapy in the form of range of motion exercises and exercises to increase leg and strengthening exercises to leg extensors and calf muscles. Also remarkable, is that no standard postoperative rehabilitation program was assigned to all patients in the current study, this may have led to the affection of range of motion and thus development of equinus deformity.

Regarding dorsiflextion 5 patients (10 %) had equinus deformity not able to dorsiflex ankle, the other 45 patients had range from 10 to 20 degrees. While plantar flexion ranged from 10 to 40 degrees. Presence of Equinus deformity is a major postoperative complication which lowers the OMAS score significantly, Range of OMAS score in patients with equinus deformity was (20-50). Possible causes for the equinus deformity can be contracture of posterior structures such as the achilles tendon complex; Loss of flexibility of the ankle syndesmosis; or impingement of anterior soft tissue or osteophytes.

Regarding OMAS score of the patients included and it's predictors, the Statistical Analysis showed that two predictors only affected the final OMAS score in our study including 50 patients with AO Ankle fracture classification 44-B2.2 and 44-B2.3 treated operatively by ORIF. The predictors are delay in operative management and presence of dislocation or subluxation after injury.

Hafiz et al.[3] conducted retrospective study about the operative outcome of ankle fracture operations which included 80 patients including 65 male (81.3%) and 15(18.7%) female patients. Using the Olerud and Molander scoring system (maximum 100 points), they noted that 93.8% of patients had excellent and good outcomes. There were 3 patients (3.7%) with poor results, 2 (2.5%) fair, one good (1.3%) and 74 (92.4%) excellent results. Two cases of poor results were due to deep infection, and the other case was a 71 years old with stiffness and ankle pain when walking.

Van Schie et al.[5] studied determinants of outcome in operatively and non-operatively treated Weber-B ankle fractures. Their study included Eighty-two patients who were treated conservatively and 103 underwent operative treatment. The outcome scores in the non-operative group were OMAS 93, AOFAS 98, and VAS 8. In the surgically treated group, The OMAS, AOFAS, and VAS scores were 90, 97, and 8, respectively, with outcome negatively influenced by duration of plaster immobilization. Multivariate analysis of the operatively treated patients showed that an increase in plaster immobilization gave a worse result on the OMAS and AOFAS score. The better outcome scores in conservatively managed group can be explained by the fact that more simple fracture patterns are managed conservatively e.g. unimalleolar fibular fractures type 44-A.

Regarding the poor outcome in the current study, the possible causes for this can be: the presence of severe injuries, the evidence is the large number of subluxation or dislocation cases including 11 cases (22 %) in the study group; another possible cause is the absence of standardized rehabilitation program for gaining the best range of motion and preventing stiffness and muscle contractures and also not using the removable slab didn't allow early mobility while maintaining the right angle position of the ankle leading to development of equinus deformity; the delay in operative management occurred in 10 patients (20%) more than 1 week and most patients were not operated in first day, with development of soft-tissue complications such as fracture blisters; also the unstable fixation in one case had led to delayed union and limited range of movement.

Strength of the study lies in the relatively large number of patients with the same fracture pattern allowing comparing different factors without interference from initial trauma severity as possible. The weakness lies in the retrospective nature of the study with dealing of medical records and not collecting all the data prospectively.

Conclusion

In conclusion ORIF is the treatment of choice in ankle fractures with classification 44-B2.2 and 44-B2.3, the OMAS score can be used to evaluate subjectively scored function after ankle fractures. The OMAS score can be affected negatively by the delay in surgery and the severe injuries with dislocated ankle mortise. Also we noted that presence of equinus deformity is a major postoperative complication which lowers the OMAS score significancantly.

Finally, our advice for treatment of ankle fractures.

- Early management of ankle fractures before soft tissue condition interferes with ability to operate.
- Using fixation methods according to AO guidelines to prevent delayed fracture healing.
- Close monitoring of patients postoperatively to address any range of motion abnormality and apply the management according to the cause.
- Using a postoperative rehabilitation program to ensure the best restoration of function.
- Using the OMAS score to follow patients and detect any disability after surgical management.

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