Fracture Pattern and Evolving Surgical Practice in Timing of Weight Bearing After Operative Ankle Fracture Fixation

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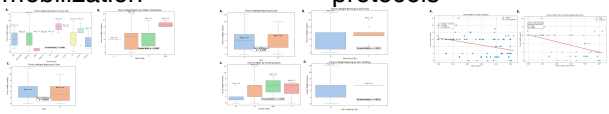
INTRODUCTION: The timing of weight bearing as tolerated (WBAT) after ankle fracture fixation is ultimately a surgeon-driven decision, informed by fracture pattern, fixation stability, and patient-specific factors. Although early WBAT may facilitate recovery, concerns persist regarding nonunion or hardware failure. This study analyzed the timing at which patients were allowed to WBAT by the operating surgeon in a controlled CAM boot setting and examined whether fracture type, patient characteristics, or fixation strategy influenced that decision. We also confirmed the absence of mechanical complications, hardware failure, and need for revision surgery across all patients.

METHODS: A retrospective cohort of 81 operatively treated ankle fractures was reviewed. Data included fracture classification (Weber A/B/C), anatomical fracture pattern (e.g., bimalleolar, trimalleolar, syndesmotic involvement), BMI, smoking status, external fixation, open fracture status, and laterality. The primary outcome was time to surgeon-directed WBAT, defined as the postoperative week in which the patient was released to begin ambulation in a CAM boot. Group comparisons and multivariable linear regression were used to assess predictors. Mechanical failure (nonunion, malunion, or hardware-related reoperation) was recorded as a secondary safety outcome.

RESULTS: Fracture pattern remained a significant predictor of WBAT clearance ($p = 0.0100$). Patients with isolated lateral malleolus fractures (mean 1.67 weeks) and bimalleolar equivalent fractures (mean 1.50 weeks) were cleared earliest, while those with syndesmotic involvement—such as LM + syndesmosis (8.0 weeks), trimalleolar + syndesmosis (6.18 weeks), and posterior + syndesmosis (8.0 weeks)—experienced the longest delays. Weber classification also influenced WBAT timing ($p = 0.0096$), with Weber B fractures cleared earlier (mean 4.02 weeks) than Weber C (5.11 weeks) or unclassified injuries (8.75 weeks). Side of injury showed a modest effect (left vs. right, $p = 0.0457$), while sex ($p = 0.2300$), smoking status ($p = 0.1631$), external fixation use ($p = 0.1423$), open fracture status ($p = 0.3399$), and requiring skin grafting ($p = 0.6119$) were not significantly associated with timing.

In multivariable regression ($R^2 = 0.305$, RMSE = 2.53), key predictors of delayed WBAT included LM + syndesmosis (+1.04 weeks), external fixation (+1.24 weeks), and certain smoking subtypes (e.g., tobacco and marijuana: +3.27 weeks). Earlier WBAT was associated with lateral malleolus fractures (–2.92 weeks), bimalleolar equivalent fractures (–2.86 weeks), and Weber B classification (–0.89 weeks). Age and BMI had negligible effects. No patients experienced mechanical failure, including nonunion, malunion, or hardware-related reoperation, regardless of WBAT timing.

DISCUSSION AND CONCLUSION: Surgeon-directed WBAT timing following ankle fracture fixation was significantly influenced by fracture pattern and Weber classification, with syndesmotic involvement and higher-energy injuries associated with delayed mobilization. However, factors such as sex, BMI, smoking status, external fixation, and open fracture did not demonstrate statistically significant delays in WBAT initiation. Notably, no mechanical failures occurred in any patient regardless of timing, supporting the safety of earlier WBAT in appropriately selected cases. These findings reinforce the role of fracture anatomy in guiding postoperative weight bearing and support a selective shift toward earlier mobilization protocols when fixation is stable.



Variable	Category / Statistic	Count	Mean (%)	SD
Age (years)	—	81	37.25	15.75
BMI (kg/m²)	—	81	29.76	6.31
Time to WBAT (weeks)	—	81	4.41	2.51

Variable	Category	Count	Percent (%)
Sex	Female (F)	41	50.62
	Male (M)	40	47.44
Side	Right (R)	42	51.85
	Left (L)	39	48.15
Break Type	Trimalleolar (Tri)	27	33.33
	Bimalleolar + Syndesmosis (BME)	15	18.52
	Bimalleolar (BM)	14	17.28
	Trimalleolar + Syndesmosis (Tri+Syn)	11	13.58
	Bimalleolar Equivalent (BME)	6	7.41
	Lateral Malleolus (LM)	6	7.41
	Trimalleolar-equivalent (Tri-Equiv)	3	3.7
	Lateral + Syndesmosis (LM&Sy)	2	2.47
	BM (no medial malleolus)	1	1.23
	BME + Syndesmosis	1	1.23
	Posterior + Syndesmosis (P+Syn)	1	1.23
Weber Type	Weber B	66	81.48
	Weber C	9	11.11
	None	4	4.94
	Weber A	1	1.23
	Not recorded (NoW)	1	1.23
Smoker	No (N)	70	86.42
	Yes (Y)	4	4.94
	Yes (T)	3	3.7
	T&M	3	3.7
Exfix First	No (N)	66	81.48
	Yes (Y)	15	18.52
Plastics Involved	No (N)	70	86.42
	Yes (Y)	11	13.58
Open	No (N)	78	96.3
	Yes (Y)	3	3.7

Group	Category	Count	Mean	Std
Sex	F	41	4.18	2.74
	M	40	4.65	2.24
	Mann-Whitney U			**p = 0.2300**
Side	L	39	5.13	2.88
	R	42	3.76	2.14
	Mann-Whitney U			**p = 0.0457**
Break Type	BM	14	4.14	2.25
	BM (no MM)	1	8	0
	BM+Syn	16	4.73	3.2
	BME	6	1.8	0.26
	BME+Syn	1	8	NaN
	LM	6	1.67	0.52
	LM&Sy	2	8	2.82
	P+Syn	1	8	NaN
	Tri	27	4.19	2.48
	Tri+Syn	11	6.18	2.25
	Tri-Equiv	3	3.33	3.21
	Kruskal-Wallis			**p = 0.0100**
Weber Type	A	1	4	NaN
	B	66	4.02	2.9
	C	9	5.11	2.60
	NoW	4	8.75	2.99
	Kruskal-Wallis			**p = 0.0096**
Exfix First	N	66	4.22	2.26
	Y	15	5.5	3.35
	Kruskal-Wallis			**p = 0.1423**
Plastics	N	70	4.38	2.92
	Y	11	8	0.63
	Kruskal-Wallis			**p = 0.6119**
Open	N	78	4.56	2.55
	Y	3	3.67	4.16
	Kruskal-Wallis			**p = 0.3399**
Smoker	N	70	3	2.31
	Y	4	6.54	2.08
	T&M	3	5.33	4.04
	T	3	4.33	3.79
	Kruskal-Wallis			**p = 0.2900**

Feature	Coefficient (Δ weeks)
Break: Tri-Equiv	−4.00
Smoker: T&M	3.27
Smoker: Y	3.01
Break: LM	−2.92
Break: BME	−2.86
Weber: None	2.81
Smoker: N	2.79
Break: BME+Syn	1.98
External Fixation: Yes	1.24
Break: BM (no MM)	1.09
Side: Right	−1.07
Break: LM&Sy	1.04
Weber: B	−0.89
Sex: Male	0.81
Break: Tri	−0.36
Weber: C	0.34
Break: Tri+Syn	−0.26
Break: BM+Syn	0.02
Age (per year)	0.0052
BMI (per unit)	0.0051
Break: P+Syn	−0
Metric	**Value**
R^2 Score	0.305
RMSE (weeks)	2.53