Predictors of Surgical Management in Weber B Ankle Fractures with a Radiographically Symmetric Medial Clear Space: A Multicenter Evaluation of Clinical and Imaging-Based Decision-Making

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INTRODUCTION: Isolated Weber B lateral malleolus fractures represent the most common variant of ankle fractures. While surgical treatment is generally preferred when tibiotalar translation is detected, treatment algorithms can vary when initial radiographs do not demonstrate appreciable medial clear space (MCS) widening. Surgeons may rely on weightbearing (WB) views, external rotation (ER) stress views, or the degree of fibular displacement to guide decision making, but even something as fundamental as choosing between WB and ER views remains inconsistent. Furthermore, although cartilage along the medial fibula suggests a protective buttressing effect against rotational instability, little literature exists to guide patients and surgeons on the threshold of fibular displacement beyond which this stabilizing effect is lost. This study aims to evaluate the influence of surgeon- and patient-specific factors on the decision to pursue surgical management in Weber B fractures with symmetric MCS, with the goal of understanding the factors most likely to precipitate surgical intervention.

METHODS: A retrospective chart review of adults undergoing treatment for Weber B ankle fractures with a symmetric MCS on initial radiographs at two academic and one community hospital was conducted. MCS symmetry was defined as less than a 40% difference between the superior (SCS) and medial clear space as per prior studies. A total of 100 cases were sequentially identified, of which 50 had undergone closed management and 50 had undergone surgical fixation. Patient demographics, comorbidities, radiographic ankle measurements, and the type of radiographs attained—WB, non-weightbearing (NWB), gravity stress—were recorded. We also identified individual surgeon fellowship subspecialty and years of practice. Patient-specific Area Deprivation Index (ADI) and Social Vulnerability Index (SVI) from the Neighborhood Atlas and Agency for Toxic Substances and Disease Registry were also identified. Radiographic measurements of MCS, SCS, and lateral clear space (LCS) were recorded from anterior-posterior (AP) views on NWB, WB, and gravity stress radiographs. Three-dimensional fibular displacement was calculated using both AP and lateral NWB films via the space diagonal formula. Tibiofibular overlap (TFO) was measured exclusively on AP NWB films, while the talar declination angle was assessed on lateral WB films. Univariate analysis used Chi-square or Fisher's exact test for categorical variables and Mann-Whitney U, Student's t-test, or Welch's t-test for continuous variables as appropriate. Variables significant on univariate analysis were each entered into separate multivariable logistic regressions, adjusting for age, sex, and BMI. Missing data was addressed with multiple imputation, and statistical significance was set at $P<0.05$.

RESULTS: Patients treated with ORIF were younger (45.7 vs 53.6 years; $P=0.046$) and more likely to be non-White (31% vs 10%; $P=0.02$) compared to those treated nonoperatively. No differences were observed in BMI, primary language, comorbidities, ADI, or SVI ($P>0.05$ for all). On univariate analysis, the ORIF group demonstrated a greater fibular displacement space diagonal on NWB films (5.07 vs 3.38 mm; $P<0.01$) and were more likely to have gravity stress radiographs ordered (92% vs 66%; $P<0.01$). In multivariable logistic regression, independent predictors of surgical treatment included greater fibular displacement (aOR, 0.72; 95% CI, 0.57–0.91; $P=0.01$), presence of gravity stress radiographs (aOR, 0.14; 95% CI, 0.04–0.49; $P<0.01$), and non-White race (aOR, 4.11; 95% CI, 1.20–14.02; $P=0.02$). Other radiographic features and social determinants of health were not associated with treatment choice ($P>0.05$).

DISCUSSION AND CONCLUSION: Our findings demonstrate that both radiographic and patient-driven factors impact the decision to surgically manage a Weber B ankle fracture, even if the initial MCS is symmetrical. Specifically, increased fibular displacement drives the decision for surgery, suggesting that surgeons incorporate more factors beyond the competence of the deltoid ligament complex into treatment algorithms. Furthermore, the very presence of gravity stress radiographs increases the likelihood of surgical management. Patient race may also play a role, though the implications of this as a surrogate for other socioeconomic and patient-specific factors are less clear. Additional studies are necessary to better understand the implications of increasing fibular displacement, stress radiographs independent of WB views, and patient race on treatment algorithms for symmetric Weber B ankle fractures when the initial tibiotalar relationship is maintained.

Table 2. Multivariable logistic regression analysis of independent predictors for operative management among patients with Weber B ankle fractures and a radiographically symmetric mortise, adjusted for age, sex, and BMI. Odds ratios reflect the association of each predictor with the likelihood of undergoing closed reduction compared to undergoing surgery.

Predictor Variable	n	Coefficient	Standard error	Odds Ratio	95% Confidence Interval	*P*-Value
MCS-SCS on WB AP Films (mm)	40	-1.07	0.72	0.34	(0.08, 1.43)	0.14
Three-Dimensional Fibular Displacement on NWB AP and Lateral Films (mm)	80	-0.33	0.12	0.72	(0.57, 0.91)	**0.01***
Gravity Stress Films Obtained (No v Yes)	95	-1.93	0.63	0.14	(0.04, 0.49)	**0.002***
Race (Non-White/White)	93	1.41	0.63	4.11	(1.20, 14.02)	**0.02***
Employment	90	-0.16	0.26	0.85	(0.51, 1.41)	0.53

Abbreviations: BMI, Body mass index; A-P, Anterior-posterior radiographic view; MCS, Medial Clear Space; SCS, Superior Clear Space; NWB Films, Non-weightbearing radiographic films; WB Films, Weightbearing radiographic films.

Statistical significance set at $P<0.05$

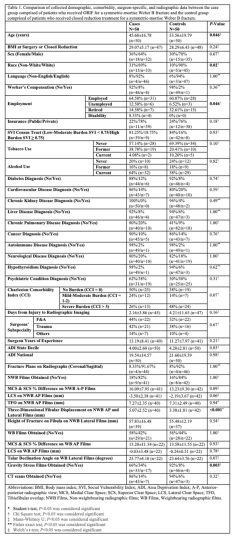

Table 1. Comparison of collected demographic, comorbidity, surgeon specific, and radiographic data between the case group comprised of patients who received ORIF for a symmetric mortise Weber B fracture and the control group comprised of patients who received closed reduction treatment for a symmetric mortise Weber B fracture.

			Cases N=80	Controls N=80	P-Value
Age (years)			41.4±16.78 (n=80)	51.9±19.79 (n=80)	**0.044***
BMI at Surgery or Closed Reduction			29.07±5.17 (n=67)	28.29±4.41 (n=48)	0.287
Sex (Female/Male)			36%/64% (n=30/n=53)	50%/50% (n=40/n=40)	0.47†
Race (Non-White/White)			13%/89% (n=11/n=74)	10%/90% (n=8/n=72)	**0.02†**
Language (Non-English/English)			9%/91% (n=8/n=84)	4%/96% (n=3/n=67)	1.00††
Worker's Compensation (No/Yes)			92%/8% (n=86/n=8)	98%/2% (n=98/n=1)	0.26††
Employment	**Employed**		72.50% (n=58)	85.00% (n=68)	**0.044†**
	Unemployed		18.50% (n=15)	8.50% (n=7)	
	Retired		04.50% (n=3)	22.63% (n=13)	
	Disability		8.33% (n=6)	0% (n=0)	
Insurance (Public/Private)			22%/78% (n=18/n=62)	24%/76% (n=19/n=61)	0.35†
SVI Census Tract (Low-Moderate Burden SVI = 0.75/High Burden SVI ≥ 0.75)			91.25%/8.75% (n=73/n=9)	94%/6% (n=82/n=8)	0.93†
Tobacco Use	**Never**		57.14% (n=24)	49.30% (n=34)	0.18†
	Former		38.78% (n=19)	20.47% (n=18)	
	Current		4.08% (n=2)	15.20% (n=13)	
Alcohol Use	**Never**		26% (n=18)	24% (n=12)	0.82†
	Former		69% (n=48)	71% (n=36)	
	Current		6% (n=12)	10% (n=29)	
Diabetes Diagnosis (No/Yes)			88%/12% (n=84/n=8)	92%/8% (n=88/n=8)	0.74†
Cardiovascular Disease Diagnosis (No/Yes)			86%/14% (n=82/n=12)	90%/10% (n=86/n=8)	0.39†
Chronic Kidney Disease Diagnosis (No/Yes)			100%/0% (n=70/n=0)	94%/6% (n=48/n=2)	0.49††
Liver Disease Diagnosis (No/Yes)			92%/8% (n=88/n=8)	98%/2% (n=94/n=2)	1.00††
Chronic Pulmonary Disease Diagnosis (No/Yes)			80%/20% (n=80/n=18)	81%/19% (n=52/n=15)	1.00†
Cancer Diagnosis (No/Yes)			90%/10% (n=85/n=9)	86%/14% (n=69/n=7)	0.76†
Autoimmune Disease Diagnosis (No/Yes)			89%/11% (n=85/n=11)	94%/6% (n=90/n=5)	1.00††
Neurological Disease Diagnosis (No/Yes)			80%/20% (n=80/n=18)	82%/18% (n=81/n=18)	1.00†
Hypothyroidism Diagnosis (No/Yes)			89%/11% (n=84/n=11)	94%/6% (n=87/n=6)	0.42††
Psychiatric Condition Diagnosis (No/Yes)			82%/18% (n=118/n=10)	59%/98% (n=25/n=223)	0.33†
Charleston Comorbidity Index (CCI)	**No Burden (CCI = 0)**		50% (n=20)	18% (n=18)	0.07†
	Mild-Moderate Burden (CCI = 1-2)		28% (n=12)	18% (n=7)	
	Severe Burden (CCI > 3)		20% (n=13)	68% (n=24)	
Days from Injury to Radiographic Imaging			2.16±0.86 (n=45)	4.21±11.65 (n=47)	0.10†
Surgeon Subspecialty	**F&A**		49% (n=22)	32% (n=22)	0.47†
	Trauma		42% (n=19)	18% (n=196)	
	Others		10% (n=7)	10% (n=6)	
Surgeon Years of Experience			11.15±8.41 (n=69)	11.27±7.97 (n=41)	0.23†
AIM State Beds			4.00±2.68 (n=55)	4.28±2.81 (n=50)	0.85†
AIM National			31.3±14.83 (n=50)	21.60±19.29 (n=50)	0.50†
Fracture Plane on Radiographs (Coronal/Sagittal)			8.33%/91.67% (n=6/66)	0%/92% (n=0/n=96)	1.00††
NWB Films Obtained (No/Yes)			8%/92% (n=9/n=81)	2%/98% (n=4/n=92)	1.00†
MCS & SCS % Difference on NWB A-P Films			16.69±7.81 (n=41)	17.23±8.36 (n=42)	0.89†
LCS on NWB AP Films (mm)			-1.58±2.26 (n=41)	-2.39±3.87 (n=42)	0.86†
TFO on NWB AP Films (mm)			5.27±2.35 (n=41)	7.21±2.49 (n=40)	0.56†
Three-Dimensional Fibular Displacement on NWB AP and Lateral Films (mm)			5.67±2.52 (n=41)	3.38±1.81 (n=42)	**<0.001†**
Height of Fracture on Fibula on NWB Lateral Films (mm)			57.81±16.48 (n=41)	35.48±12.25 (n=42)	0.34†
WB Films Obtained (No/Yes)			10%/92% (n=25/n=211)	50%/49% (n=20/n=212)	1.00†
MCS & SCS % Difference on WB AP Films			32.28±11.34 (n=22)	31.58±11.33 (n=22)	0.83†
LCS on WB AP Films (mm)			-10.81±5.68 (n=22)	-9.24±8.31 (n=22)	0.79†
Talar Declination Angle on WB Lateral Films (degrees)			23.77±6.18 (n=22)	23.64±3.76 (n=22)	0.85†
Gravity Stress Films Obtained (No/Yes)			68%/34% (n=53/n=17)	52%/8% (n=90/n=8)	**0.001†**
CT scans Obtained (No/Yes)			68%/34% (n=54/n=17)	52%/8% (n=90/n=8)	0.32†

Abbreviations: BMI, Body mass index; SVI, Social Vulnerability Index; ADI, Area Deprivation Index; A-P, Anterior-posterior radiographic view; MCS, Medial Clear Space; SCS, Superior Clear Space; LCS, Lateral Clear Space; TFO, Tibiofibular overlap; NWB Films, Non-weightbearing radiographic films; WB Films, Weightbearing radiographic films.

* Student t-test, *P*<0.05 was considered significant
† Chi Square test, *P*<0.05 was considered significant
†† Fisher Exact Without, *P*<0.05 was considered significant
‡ Pearson Correlation, *P*<0.05 was considered significant
§ Welch's t-test, *P*<0.05 was considered significant