Tibial Shaft Fractures Secondary to Low-Energy Gunshot Wounds Have a Higher Infection Rate than Previously Thought

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INTRODUCTION:

Tibial fractures from low-energy gunshot wounds (GSW) are unfortunately common. The Gustillo-Anderson classification is used to guide treatment in open fractures, but the application to GSW-related fractures is less clear. It has been suggested that these injuries are less contaminated than open fractures caused by blunt-force mechanisms. In contrast, our experience is that GSW-related tibia fractures frequently produce severe soft-tissue injuries and higher rates of complications than what is typically reported. So we asked: Is the infection rate of tibia shaft fractures secondary to low-energy gunshot wounds (LE-GSW) worse than closed and open fractures caused by blunt-force mechanisms?

METHODS:

A retrospective chart review from 7/2013 – 8/2021 was performed within our hospital system. Patients 16 – 65 years old who underwent IMN fixation for tibial fractures were included. Exclusion criteria were less than 45 days of follow-up, pre-existing infection, non-firearm ballistic injury, delayed presentation for more than 24 hours, and high-energy GSW. 158 patients were divided into four groups: LE-GSW (n=30), closed (n=68), type I/II open (n=41), and type III open (n=19). Comparisons between demographic, comorbidity, and clinical variables were made. Deep infection was the primary outcome of interest. The secondary outcome was related reoperation. The Fisher exact test and Chi Square analysis were used for categorical data and Mann Whitney-U for continuous variables.

RESULTS:

LE-GSW fractures had a 33.3% rate of deep infection and a 66.7% related reoperation rate. Deep infection rate was significantly higher than type I/II (9.8%, $p = 0.018$) and closed (1.5%, $p < 0.0001$). Reoperation rate was also higher than type I/II (29.3%, $p = 0.0034$) and closed (13.2%, $p < 0.0001$). Compared to type III, there were no significant differences in deep infection (10.5%, $p = 0.095$) and reoperation (78.9%, $p = 0.52$). Compared to the rest of the sample, the LE-GSW group were more likely to be male (93.3% vs. 60.2%) and had higher rates of illicit drug use (63.3% vs. 18.8%,), smoking (60.0% vs. 35.9%), and alcohol use (76.6% vs. 57.0%, $p < 0.05$). Fractures caused by LE-GSW were more likely to involve the proximal (46.7%) or distal (30.0%) one-third of the tibia, whereas other mechanisms typically involved the middle one-third in roughly half of cases ($p<0.05$).

DISCUSSION AND CONCLUSION:

Though lacking robust interobserver reliability, Gustillo and Anderson's work on open fracture classification has stood the test of time for its clinically applicability and usefulness in guiding treatment. It has been suggested that fractures secondary to LE-GSWs can be treated as less contaminated than type I open fractures, or perhaps even as closed fractures. Shorter intravenous antibiotic regimens and substitution with an oral antibiotic course showed no difference in infection rates in previous series. Our interest in performing this study was the seemingly high rate of our patients who returned with infection after this injury.

We found that these injuries carry a higher rate of both infection and related reoperation compared to closed injuries and type I and II open fractures. In fact, the rate of these complications is comparable to type III open fractures. The limited soft tissue envelope of the anteromedial tibia, proportionally large zone of injury in relation to the leg, and variable severity of soft tissue injury likely contribute to these differences.

When planning antibiotic therapy, debridement, and operative fixation of LE-GSW tibial shaft fractures, the treating surgeon should have a high index of suspicion for a potentially severe degree of soft tissue injury irrespective of the "low-energy" mechanism. Additionally, it is important to be aware that both injury and patient factors may contribute to a high incidence of complications in this population.

In conclusion, tibial shaft fractures caused by LE-GSW have a deep infection and related reoperation rate higher than type I/II open fractures and closed fractures. Cases with more severe soft-tissue injury should be treated similar to high-grade open fractures.

Table 1: Demographics

	Total Count	Deep Infection Count (%)	No Deep Infection Count (%)	*p* -value
	158	17	141	--
Age (Average ± SD)	38.27 ± 14.27	40.29 ± 10.94	38.02 ± 14.64	0.412
Sex				
Male	108	16 (94.1%)	89 (63.1%)	--
Female	50	1 (5.9%)	52 (36.9%)	0.0122*
Race				
American Indian / Alaska Native	6	2 (11.8%)	4 (2.84%)	0.126
Asian	2	0 (0%)	2 (1.4%)	--
Black / African American	10	2 (11.8%)	8 (5.7%)	0.293
White	132	12 (70.6%)	120 (85.1)	0.161
Unknown / Not Reported	8	1 (5.9%)	7 (5%)	1
BMI (Average ± SD)	28.25 ± 6.27	27.01 ± 6.16	28.41 ± 6.31	0.15
Smoker	64	10 (58.8%)	54 (38.3%)	0.103
Illicit Drug Use	43	8 (47.1%)	35 (24.8%)	0.079
Alcohol Use	96	11 (64.7%)	85 (60.3%)	0.798
Comorbidities				
HTN	32	3 (17.6%)	29 (20.6%)	1
DM	20	3 (17.6%)	17 (12.1%)	0.455
HLD	17	2 (11.8%)	15 (10.6%)	1
CKD	2	0 (0%)	2 (1.4%)	1
ESRD	1	0 (0%)	1 (0.7%)	1
Autoimmune	3	0 (0%)	3 (2.1%)	1
Neuropathy	5	3 (17.6%)	2 (1.4%)	1
Fracture Location				
Proximal Tibia	26	5 (29.4%)	21 (14.9%)	0.127
Mid-Tibia	72	7 (41.2%)	65 (46.1%)	0.700
Distal Tibia	60	5 (29.4%)	55 (39%)	0.441
Gustillo Group				
Closed	68	1 (5.9%)	67 (47.5%)	0.001*
GSW	30	10 (58.8%)	20 (14.2%)	<0.001*
I/II	41	4 (23.3%)	37 (26.2%)	1
III	19	2 (11.8%)	17 (12.1%)	1
Follow Up Duration	275 ± 290	237 ± 147	280 ± 303	0.787

Table 1: Demographics between patients with diagnosed deep infection and those not diagnosed. Statistical test for categorical data was completed with Chi-squared or Fisher's Exact Test if individual cell values were <5. Continuous data was analyzed with Mann Whitney U-Test. Significance set to 0.05. (*) denotes significance. (SD) standard deviation; (HTN) hypertension; (DM) diabetes mellitus; (HLD) hyperlipidemia; (CKD) chronic kidney disease; (ESRD) end-stage renal disease; (GSW) gun shot wound.