

Fact or Fiction: Is Orthopedic Follow-Up Worse for Patients Who Sustain Penetrating Trauma?

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Abstract

Commonly accepted dogma is that patients with a long bone fracture due to a penetrating injury (gunshot wound) are less likely to follow up than blunt trauma patients. An institutional trauma database from a Level 1 academic trauma center was utilized to include all patients with long bone fractures from penetrating trauma from 2006-2009 (N = 132). Demographically matched blunt trauma patients with long bone fractures were included as a comparison group (N = 104). The medical records of these 236 patients were reviewed to observe their follow-up at 3, 6, 9, and 12 months. There was no statistically significant difference ($P = 0.736$) between the penetrating and blunt trauma patients in terms of their follow-up within 1 year from time of injury. At the 1 year end point 103/132 (78%) of the penetrating group and 83/104 (80%) of the blunt group were lost to follow-up. The results of this study call into question the routine exclusion of penetrating trauma patients from research studies, as well as encourage further research to improve patient retention.

There is a paucity of literature on how mechanism of injury may be associated with patient retention. Failure to attend outpatient clinics is a form of noncompliance and a major obstacle to safe, effective, and efficient healthcare delivery. Noncompliance may lead to increased patient morbidity and carries substantial financial

implications for the healthcare system.^{1,2} In addition to these direct patient and healthcare issues, loss of patient follow-up or the belief of potential loss of follow-up of penetrating trauma patients may also significantly affect research studies. These patients often may be excluded from studies, even if they might otherwise meet inclusion criteria, because of concerns that they are unlikely to follow-up after leaving hospital. Is this myth or fact? To validate or to disprove this selection bias, we conducted a study in which we retrospectively evaluated long bone fractures caused by either penetrating or blunt trauma.

Methods

After obtaining Institutional Review Board approval for this study, we used the trauma database of an American College of Surgeons-verified level I trauma center in a major Midwest metropolitan area to compile a list of all cases of long bone fractures caused by penetrating trauma between 2006 and 2009 (N = 132). Gunshot wounds were the mechanism of injury for the penetrating trauma. We also compiled a list of control cases—long bone fractures caused by blunt trauma in patients demographically matched to the penetrating group patients on sex, race, and age (N = 104) (Table). The mechanisms of blunt trauma included motor vehicle collisions, pedestrians struck by vehicles, falls, altercations, and crush injuries.

We retrospectively performed chart reviews to obtain patient follow-up data 3, 6, 9, and 12 months after injury from penetrating or blunt trauma. Patients scheduled to return on an as-needed basis were considered to have completed follow-up. The 2 groups were also statistically compared with respect to sex, race, age, surgical fixation, and history of tobacco, alcohol, or drug use.

Authors' Disclosure Statement: Dr. Mullis reports that he has done consulting for Zimmer Biomet, Convatec, and BoneSupport within the last 3 years, has received research support from Zimmer Biomet, and has done educational speaking for Zimmer Biomet and Smith & Nephew in the last 3 years. The other authors report no actual or potential conflict of interest in relation to this article.

Table. Penetrating Versus Blunt Patient Demographics: Sex, Race, and Age

Sex	Penetrating							Sex	Blunt							
	Male			Female					Race	Male			Female			
	B	W	H	B	W	H	Total			B	W	H	B	W	H	Total
Age group, y	Age group, y							Age group, y								
18-19	8	2	1	0	0	0	11	18-19	8	2	1	0	0	0	11	
20-29	50	9	2	5	2	0	68	20-29	21	10	2	5	2	0	40	
30-39	22	3	3	0	0	0	28	30-39	20	3	4	0	0	0	27	
40-49	8	4	0	2	2	0	16	40-49	9	4	0	1	3	0	17	
50-59	4	1	1	1	0	0	7	50-59	4	1	2	1	0	0	8	
>60	0	1	1	0	0	0	2	>60	0	1	0	0	0	0	1	
Total	92	20	8	8	4	0	132	Total	62	21	9	7	5	0	104	
	120			12					92			12				

Abbreviations: B, black; H, Hispanic; W, white.

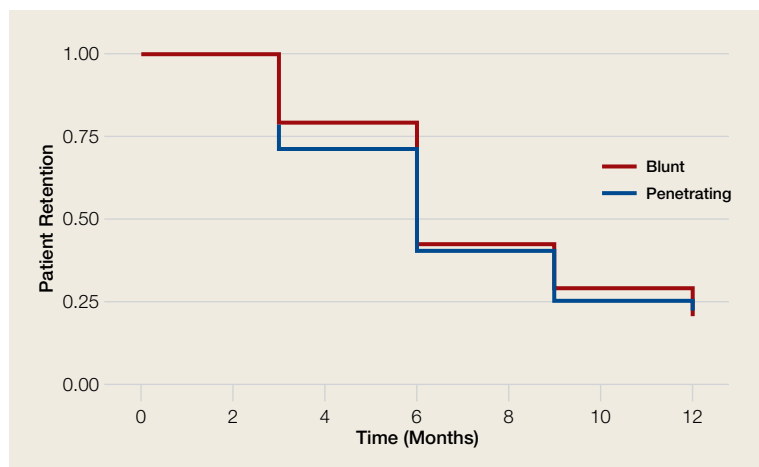


Figure. Patient retention 3, 6, 9, and 12 months after injury, based on mechanism of injury: penetrating (blue) or blunt (red).

SAS/STAT Version 8 (SAS Institute) was used to test the equality of survival functions (patient retention) for the penetrating and blunt trauma patient groups. A similar comparison was made for the categories of sex, race, and age. Pearson χ^2 test was used to compare the 12-month survival rates of the 2 treatment groups across sex and race. Binary logistic regression was used to compare the 12-month survival rates of the 2 treatment groups removing the effect of age. A comparison of the frequency distributions of the 2 treatment groups with respect to alcohol use, tobacco use, drug use, and surgical intervention was also

performed. Power analysis showed power of more than 90% in detecting at least a 20% difference in the follow-up rates between the penetrating and blunt trauma groups based on our sample size.

Results

There was no statistically significant difference ($P = .736$) between the penetrating and blunt trauma patients in terms of follow-up within 1 year after injury. At 1 year, 103 (78%) of the 132 penetrating trauma patients and 83 (80%) of the 104 blunt trauma patients were lost to follow-up (Figure). There was no statistically significant difference in the follow-up rates for sex ($P = .12$), race ($P = .96$), or age ($P = .37$). There was no statistically significant difference between the penetrating and blunt trauma groups with respect to sex ($P = .54$), race ($P = .28$), age ($P = .18$), tobacco use ($P = .13$), or alcohol use ($P = .06$). Of the 132 patients in the penetrating trauma group, 50 were African American men in their 20s. This demographic makes up 38% of all patients in the penetrating trauma group. The database of blunt trauma long bone fractures was used to demographically match the penetrating trauma group. The blunt trauma database had 1003 patients, from which 104 were matched to the penetrating trauma group. When matches were sought for the African American men in their 20s, only 21 were found in the blunt trauma database, and they were used (Table). There was a statistically significant difference between the 2 groups with respect to drug use (P

= .02), with a higher prevalence in the penetrating trauma group (30.3% vs 17.31%). There was also a statistically significant difference between the 2 groups with respect to surgical fixation ($P = .003$), with a higher rate of surgery in the blunt trauma group (89% vs 75%). The blunt trauma group was demographically matched to the penetrating trauma group with the underlying criterion being long bone fracture. The specific long bone injury was not matched between the 2 groups. Evaluation of the data showed a higher percentage of upper extremity fractures in the penetrating trauma group (38%) than in the blunt trauma group (29%). On further inspection, we found that 21% of the penetrating trauma group had humerus fractures, for which only 48% underwent surgery. In comparison, only 5.8% of the blunt trauma group had humerus fractures, for which 83% underwent surgery. This variation in long bone distribution between the 2 groups explains our finding a higher propensity for surgical fixation in the blunt trauma group (89%) compared with the penetrating trauma group (75%).

Discussion

Trauma outcomes historically have been difficult to determine because of lack of patient follow-up. In a simulation series, Zelle and colleagues³ found that the turning point from significant to nonsignificant varied from 15% to 75% loss of follow-up, thus compromising the validity of a study. They and others have emphasized the importance of establishing research protocols to minimize follow-up loss and eliminate reporting bias, ensure randomization, and report accurate outcomes.³⁻⁷

Very few have tried to investigate factors associated with failure to follow up after trauma.^{1,2,4} Leukhardt and colleagues⁴ evaluated the medical services that trauma patients follow up with most often. Orthopedic surgery had the largest portion of follow-up visits (37%), followed by the trauma surgery clinic and the emergency department (19% each). The authors also found that penetrating trauma patients were more likely to follow up, though more than 90% of the authors' patients had blunt trauma. Although our study did not support their finding, it does call into question the commonly held belief that penetrating trauma patients are less likely to follow up, as our study found no difference in follow-up between penetrating and blunt trauma patients.

One of the most interesting findings in this retrospective study is that almost 80% of patients were lost to follow-up regardless of mechanism of

injury. Most prospective studies try to reduce loss to follow-up to below 10%. This difference may be attributable to having a dedicated research team and the resources required to ensure follow-up of research patients to improve follow-up beyond baseline values. At our institution, 13 prospective studies (most multicenter) are currently enrolling patients, and the worst loss to follow-up has been 30%. The majority of the studies have loss to follow-up of 15% or less. This low rate represents a significant difference from the 80% "baseline" clinical loss to follow-up for the blunt and penetrating trauma patients treated at our institution, based on the findings of this study. We have been improving follow-up by having dedicated research coordinators call patients to remind them of their appointments (all clinic patients who are not research patients receive a recorded reminder); by having the hospital agree that research patients can be seen without charge (by the facility or the physician), which helps defray costs to the patient; and by excluding patients the principal investigator thinks are unlikely to follow up. Patients unlikely to follow up are routinely excluded by all centers that enroll in prospective studies. Although it is difficult to quantitate, this factor may play a large role in reducing loss to follow-up. Penetrating trauma patients historically routinely biased investigators to exclude them from studies, regardless of whether being considered unlikely to follow-up was an exclusion criterion. Our study results suggest this bias may not be valid.

Our study evaluated the role of mechanism of injury, penetrating or blunt trauma, and the respective orthopedic follow-up. There was no statistically significant difference in the 1-year follow-up rate based on the mechanism of injury. Our study was conducted with a well-matched control group that eliminated potential confounding variables, such as sex, race, age, tobacco use, and alcohol use. Although the prevalence of drug use was higher in the penetrating trauma group, patient retention seemed not to be affected by it. Surprisingly, patient loss to follow-up was extremely high (almost 80%) for both the penetrating and blunt trauma patient groups at the 1-year mark. Our findings call into question the commonly accepted theory that patients with penetrating injuries are less likely to follow up, at least in an academic level I trauma center population. We suggest that the commonly held belief that penetrating trauma patients are less likely to follow up may not be valid and that, when prospective studies are designed, it may not be appropriate to exclude penetrating

trauma patients on this basis alone.

The primary limitation of this study is that it was performed at a single institution. Eighty-five percent of blunt trauma patients and 93% of penetrating trauma patients live in the county that is predominantly served by our institution, and electronic medical records from all major hospitals in the metropolitan area are linked, suggesting that the large majority of patients lost to follow-up do not seek further medical care, at least not from local facilities in our metropolitan area. A prospective multicenter study is being designed to help us gain a better understanding of the variables that affect musculoskeletal trauma patient follow-up and learn interventional strategies that can be used to improve patient retention.

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This paper will be judged for the Resident Writer's Award.