Prehospital Traction Splint Use in Midthigh Trauma Patients

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Abstract

Context: Traction splint (TS) use during emergency medical system transport has been theorized to relieve pain, limit continued injury from loose bone fragments, and decrease potential bleeding space in the injured thigh. Aims: This study aimed to evaluate the benefit of prehospital TS (PTS) application, using data from the trauma registry at a large Level 1 trauma center. Methods: A retrospective review of patients from the NTRACS® and Trauma One® registry at an American College of Surgeons-verified Level 1 trauma center was conducted. All patients treated between the years 2001 and 2011 who were assigned a diagnosis International Classification of Diseases-9 code of 821.01 (closed fracture of shaft and femur) and 821.11 (open fracture of shaft and femur) (femur fracture [FF]) were included. Statistical Analysis: All categorical variables between the first groups were compared using Pearson’s Chi-square and Fisher’s exact test analysis. Comparisons were made using unpaired t-tests and Mann–Whitney test or Kruskal–Wallis one-way ANOVA, followed by Dunn’s post hoc pairwise comparisons. Results: Patients with a TS and those without indicated that the patients with no traction split (NTS) had sustained injuries beyond a FF (14.43 ± 9.740 vs. 18.59 ± 12.993, P < 0.001). The three groups of TS placement (PTS, hospital, and NTS) only used patients with Injury Severity Score < 9 (n = 218). Hospital length of stay (LOS) was found to be significant (P = 0.05) between the patients who received a hospital TS (3.10 ± 1.709) and NTS (5.42 ± 5.144). Conclusion: PTS can lower LOS and mortality. Further research is needed to confirm these findings.

Keywords: Extremity Abbreviated Injury Score, Injury Severity Score, traction splint

INTRODUCTION

Femur fractures (FF) are often the result of high-velocity trauma. The severity of FF incurred through high-velocity trauma is often life-threatening. The use of traction splints (TSs) is mandated in many emergency medical system (EMS) prehospital care protocols for treatment and stabilization of a presumed FF.[3–5] TS use before transport has been theorized to relieve pain, limit continued injury from loose bone fragments, and decrease the potential bleeding space in the injured thigh.[4–5] John Hilton first introduced TSs for lower extremity fractures in 1860 and was later modified by Hugh O. Thomas.[6] The Thomas splint gained widespread use during the First World War, and there were anecdotal reports of improved mortality from FFs. Since then, many different TSs have become commercially available and have become a mainstay of prehospital care.[7]

Despite the theorized benefits of TSs in prehospital patient care, their use has recently come under scrutiny.[9] Publications have demonstrated the risks associated with TS application, and prolonged placement of TS has resulted in peroneal nerve palsies in patients.[9] In the case of a multisystem trauma patient, coexistent injuries that complicate and/or contraindicate TS use are common.[10,11] In concordance with the growing concern of TS-associated risks, some studies have failed to demonstrate a benefit for the use of TSs.[11,12] An analysis of radiographic imaging performed on pediatric patients showed that a delay in TS placement for FFs did not result in poor outcomes.[13] Furthermore, a systematic review of TSs for proximal FFs did not appear to demonstrate a benefit; however, similar studies have not been performed on midshaft FFs.[14]

The American College of Surgeons Committee on Trauma has mandated ambulances to carry TSs since 1961.[15]

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Variations in EMS FF treatment protocols, such as longboard immobilization, rigid splinting, and pain control, offer a reasonable alternative to TS placement. The longstanding use of commercial TSs has made them the prehospital standard of care, even in the absence of evidence-based evaluation of clinical benefit. We sought to investigate the efficacy of prehospital traction splints (PTSs) by retrospectively querying a large trauma registry for patients with midshaft FFs. The outcomes for units of blood transfused within 24 h, hospital length of stay (LOS), and mortality rates were compared between patients who received a PTS to those who did not.

**Methods**

This is a retrospective review of patients from the NTRACS© and Trauma One© registry databases at an American College of Surgeons-verified Level 1 trauma center. All patients treated between the years 2001 and 2011 who were assigned a diagnosis International Classification of Diseases (ICD)-9 code of 821.01 (closed fracture of shaft and femur) and 821.11 (open fracture of shaft and femur) were included. A manual chart review was used to exclude patients who were assigned an inaccurate ICD-9 code. Patients were also excluded from the study if they were transferred from the emergency department (ED) to another hospital, as their outcome and complications were unknown.

Patient demographics (age in years, gender, and weight in kilograms), Injury Severity Score (ISS), Extremity Abbreviated Injury Scale (AIS), units of blood transfused in the first 24 h, hospital LOS, and mortality were included in the registry report. Information about TS placement, including the location of placement (prehospital vs. hospital), patient complications, including deep venous thrombosis (DVT), pulmonary embolism (PE), fat embolus, compartment syndrome, loss of fixation/nonunion, leg wound skin breakdown, wound infection, peroneal nerve injury, and vascular compromise were collected through a manual chart review.

The ISS and AIS scales were included in the trauma registry database and were collected for each patient. The ISS is an anatomical scoring system that provides an overall score for patients with multiple traumatic injuries. It correlates with mortality, morbidity, and hospitalization time after trauma. The AIS is an anatomically based scoring system that classifies each injury in a body region on a 6-point scale from 1 being minor to 6 being untreatable. The highest three body region AIS are then squared and added together to obtain the total ISS. For example, a FF has an AIS of 3. Therefore, a patient with an isolated FF would have an ISS of 9.

Data were initially divided into two groups: patients who received a PTS and patients who did not (NTS). Patients with NTS were further separated into two subgroups: patients who received a TS while in the ED and patients who did not receive a TS at all. Finally, all patients who had an ISS < or >9 were excluded to minimize sampling error [Figure 1]. Patients with ISS <9 would not have a FF and therefore would be excluded.

Patients with ISS >9 would have other major body region injuries which may confound outcome variables.

Data were collected in an Excel 2013 spreadsheet (Microsoft, Redmond, WA). Statistical analysis was performed using SPSS (IBM Corp. Released in 2013. IBM SPSS Statistics for Windows, version 21.0. Armonk, NY, USA: IBM Corp.) and Primer of Biostatistics (7th Ed., Glantz). All categorical variables between the first groups were compared using Pearson’s Chi-square and Fisher’s exact test analysis. Comparisons were made using unpaired t-tests and Mann–Whitney test or Kruskal–Wallis one-way ANOVA, followed by Dunn’s *post hoc* pairwise comparisons. Significance was attributed to *P* < 0.05. Logistic regression analysis was used to control for confounding variables after significant factors were determined with the initial nonparametric testing. Patients who died in the emergency room were removed from the calculations pertaining to complications since they did not survive long enough to develop complications.

**Results**

Initially, the ICD-9 report included a total of 601 patients who were assigned a code of 821.01 and 821.11. Twenty-two patients were excluded due to a coding error or the patient being transported to another hospital. Of these participants (*n* = 579), there was a male predominance 402 (69.4%) in comparison to 177 (30.6%) females. Patients included in our study averaged 36 ± 22 years of age and weighed 79 ± 25 kg. Out of the 579 patients who were enrolled in the study, 44 (8%) died in the ED.

![Figure 1: Patient group sample](image)
Patients were separated into two groups: patients who received a PTS 173 (30%) and patients who did not receive a PTS 406 (70%). The PTS group had a higher age (36.96±22.007) in contrast to the patients who did not receive a PTS (35.016±20.907). Patients with a PTS had a higher weight (79.321±21.596 vs. 78.229±25.768), and both groups had a male predominance.

The overall mortality between the two groups was not statistically significant. Mortality in the PTS group was 9 (5%) in comparison to the no TS group 35 (9%) (P = 0.103). The AIS was similar in both the PTS and no TS groups (3.04 ± 0.014 vs. 3.05 ± 0.022, P = 0.709). There was a lower ISS in the PTS group (14.43 ± 9.740 vs. 18.59 ± 12.993, P < 0.001). Similarly, PTS had a lower LOS (6.70 ± 17.061 vs. 8.57 ± 11.316, P = 0.004) and lower units of blood transfused within the first 24 h (1.64 ± 5.658 vs. 3.81 ± 12.746, P < 0.001) in contrast to the no PTS group [Table 1].

Pearson’s Chi-square and Fisher’s exact test was used to analyze the following complications: DVT, PE, fat embolus, compartment syndrome, loss of fixation/nonunion, skin breakdown, wound infection, peroneal nerve injury, and vascular compromise. When comparing complications between the PTS and no PTS, we cannot conclude a significant difference (P = 0.739).

Patients who did not receive a PTS were further categorized into subgroups of patients who received a TS while in the ED 198 (34%) and patients who did not receive a TS at all 208 (36%); all three groups were further analyzed. Age was found statistically significant when comparing the three groups: PTS 35 ± 21, ED 31 ± 17.8, and none 43 ± 24, P < 0.001. Similar to the previous group, there was a male predominance with PTS having 129 (75%) males, ED TS at 143 (72%) males, and no PTS/TS at 130 (63%) males, P = 0.024. Weight was not found to be statistically significant PTS 79 ± 22 kg, ED 77 ± 23 kg, and none 80 ± 28 kg, P = 0.449.

Similar to the PTS and no PTS, complications were analyzed in regard to the following: DVT, PE, fat embolus, compartment syndrome, loss of fixation/nonunion, skin breakdown, wound infection, peroneal nerve injury, and vascular compromise. When comparing complications between the PTS, ED TS, and NTS, we cannot conclude a significant difference (P = 0.771).

In comparison to the first two groups, AIS was not found to be statistically significant in effect of TS used for the three conditions (P = 0.931). A Kruskal–Wallis H-test provided very strong evidence of a difference (P < 0.001) between the mean ranks of at least one-pair groups regarding ISS. Dunn’s pairwise tests were carried out for the three pairs of groups. There was strong evidence of difference between PTS and TS placed in the ED group (P < 0.001) [Figure 2]. Units of blood used within the first 24 h were different between the mean ranks (P < 0.001) of at least one-pair group. The pairwise test suggested evidence of difference between the PTS and TS placed in the ED (P < 0.001). There was also a significance in effect of TS use in LOS days (P = 0.014). The pairwise test suggested evidence of difference between the no TS placed and the PTS groups (P = 0.012). The mortality rate between these three groups was found to be statistically significant. There was a total of 9 (5%) deaths in the PTS patient group, 11 (6%) in the ER TS group, and 24 (12%) in the no TS group (P = 0.027).

Patients were then excluded if their AIS was greater than 3 to account for injuries other than FF. There was a total of n = 218 patients who were included in this analysis. A total of 84 (38.5%) patients did not receive a TS, 75 (34.4%) patients received a PTS, and 59 (27.1%) received a TS in the ED.

Age was found statistically significant when comparing the three groups: PTS 39 ± 24, ED 32 ± 19, and none 51 ± 28 years of age, P < 0.001. Similar to the previous group, there was a male predominance with PTS having 129 (75%) males, ED TS at 143 (72%) males, and no PTS/TS at 130 (63%) males, P = 0.024. Weight was not found to be statistically significant PTS 79 ± 22 kg, ED 77 ± 23 kg, and none 80 ± 28 kg, P = 0.449.

When removing all other injuries besides the midshaft FF and looking at complications experienced by the three

**Table 1: Prehospital traction splint versus no prehospital traction splint**

|                     | Prehospital traction splint (n=173) | No prehospital traction splint (n=406) | P     |
|---------------------|-------------------------------------|---------------------------------------|-------|
| Age                 | 36.96±22.007                        | 35.016±20.907                        | 0.329 |
| Weight              | 79.321±15.596                       | 78.229±25.768                        | 0.042 |
| Male                | 129 (74.6)                          | 273 (67.2)                           | 0.048 |
| ISS                 | 14.43±9.740                         | 18.59±12.993                         | <0.001|
| Extremity AIS       | 3.04±0.014                          | 3.05±0.022                           | 0.709 |
| Blood within 1st 24h (units) | 1.64±5.658                     | 3.81±12.746                          | <0.001|
| Hospital LOS        | 6.70±17.061                         | 8.57±11.316                          | 0.004 |
| Mortality           | 9 (5)                               | 35 (9)                               | 0.103 |

SD: Standard deviation, ISS: Injury Severity Score, AIS: Abbreviated Injury Score, LOS: Length of stay

**Figure 2: Injury Severity Score boxplot for prehospital traction splint placement, emergency department traction splint placement, and no traction splint placement**
groups, there was no statistical significance between the groups. When comparing complications between the PTS, ED TS, and NTS, we were unable to conclude a significant difference ($P=0.243$). Units of blood ($P=0.143$) and mortality rate ($P=0.109$) were also determined to not be statistically significant. However, mortality did lower depending on when the traction was placed. NTS patients have a mortality rate ($n=5, 2.29\%$), and patients who received a PTS or ED TS had a lower mortality rate ($n=1, 0.46\%$, and $n=0, 0.00\%$, respectively). In addition, a Kruskal–Wallis $H$-test provided very strong evidence of a difference ($P=0.05$) between the mean ranks of at least one-pair groups regarding hospital LOS. Dunn’s pairwise tests were carried out for the three pairs of groups. There was strong evidence of a difference between the group that had an ED TS and those who did not get a TS.

**Discussion**

EMS protocols have advised TS placement to be utilized while transporting patients in a prehospital setting with midhigh trauma for decades. There are no studies in the literature showing any significant patient benefit for the use of TSs. There are some discussions about the risks associated with TS application, and prolonged placement of TSs may cause more harm than benefit. A study in 2001, looked at PTS and even though it had very small numbers, concluded that PTS has no benefit.\(^4\) Acknowledging the safety and necessity of this prehospital procedure is essential in effectively continuing the use of PTS. This study aimed to evaluate patient benefit and safety of the TS application, using data from the trauma registry at a large Level 1 trauma center.

While initial analysis showed no improvement between the TS and PTS groups, a higher ISS was statistically significant for patients who did not receive a PTS. Patients who received a TS in the ER received an average of 19 ISS in comparison to no TS 18 and PTS 14. The ISS threshold of 15 is defined as significant trauma.\(^{16}\) The AIS had a similar mean to all three groups given that an AIS of 3 is categorized as serious and a FF is usually provided as an example.

The average AIS was similar for both groups. Due to the similarity in AIS, we can assume that variance in ISS is not attributed to the severity of the injury. The consistency in AIS across groups provided sufficient information to infer that patients who were admitted without TS sustained trauma conflates ISS variance.

Based on our analysis we conclude that patients who arrived by EMS with no TS in place sustained greater trauma. Those with no pre-hospital TS had a higher ISS and higher blood usage within the first 24 h, and longer LOS. When separating the groups and analyzing just patients with an isolated FF, (AIS of 3 and an ISS of 9) complications and units of blood showed no difference and there was a slight decrease in mortality with the use of a TS (but numbers were very low ($n=0$ and $n=1$). However, LOS and mortality rate lowered depending on when the TS was placed.

**Limitations**

The retrospective design of the study is a substantial limitation which hinders the accuracy of patient injury. A retrospective chart review restricts our research from determining if midshaft FFs influence morbidity or if these markers of increased morbidity are a byproduct of an alternative significant multisystem trauma in our study population. Conversely, since both groups (PTS and no TS) had relatively similar AIS, we can assume that a FF injury cannot be attributed to the increased LOS and units of blood needed.

Our subgroup analysis of just patients with an isolated FF with no additional traumatic injuries to other parts of the body was used to help determine if the increase LOS was due to the TSs and not to other multisystem traumatic injuries. There was no significant difference between mortality and units of blood received in this group which leads to the conclusion that PTS likely does not make a significant difference in care of the trauma patient.

In order to further explore our conclusion, a prospective research study of isolated midshaft FFs without ancillary trauma is needed to confirm if mortality, units of blood used, and increased hospital LOS can be attributed to the use of TS. A primary focus on patients who only sustained midshaft FFs would allow for greater delineation through patient trauma severity. It would also negate interferences made due to the possible conflation of multisystem trauma.

**Conclusion**

This retroactive chart analysis of patients admitted to a Level 1 trauma center with high-velocity trauma resulting in a midshaft FF showed no difference in complications or mortality in patients receiving PTS versus those who did not. Patients who had a PTS placed had fewer units of blood transfused in the first 24 h and a shorter hospital LOS. However, these patients had lower ISS and thus were assumed to be not as sick as the no traction group.

**Research quality and ethics statement**

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require the Institutional Review Board/Ethics Committee review, and the corresponding protocol/approval number is 2011082. We also certify that we have not plagiarized the contents in this submission and have done a plagiarism check.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Lee C, Porter KM. Prehospital management of lower limb fractures.
2. Melamed E, Blumenfeld A, Kalmovich B, Koshashvili Y, Lin G; Israel Defense Forces Medical Corps Consensus Group on Prehospital Care of Orthopedic Injuries. Prehospital care of orthopedic injuries. Prehosp Disaster Med 2007;22:2-5.

3. Tharratt RS, Smiley CR, Iljana J. State of California Health and Safety Code Division 2.5. Available from: https://emsa.ca.gov/wp-content/uploads/sites/71/2017/07/division25.pdf. [Last accessed on 2011 Nov 13].

4. Abarbanell NR. Prehospital mid thigh trauma and traction splint use: Recommendations for treatment protocols. Am J Emerg Med 2001;19:137-40.

5. Hoppe S, Keel MJ, Rueff N, Rhoma I, Roche S, Maquungo S. Early versus delayed application of Thomas splints in patients with isolated femur shaft fractures: The benefits quantified. Injury 2015;46:2410-2.

6. Thomas HO. Diseases of the hip, knee and ankle joint with their deformities: Treated by a new and efficient method. Clin Orthop Relat Res 1974;102:4-9.

7. Daya MR, Mariani RJ, Dick T. Prehospital splinting. In: Roberts JR, Hedges JR, editors. Clinical Procedures in Emergency Medicine. 2nd ed. Philadelphia, PA: WB Saunders; 1991. p. 716-43.

8. Henry BJ, Vrahas MS. The Thomas splint. Questionable boast of an indispensable tool. Am J Orthop (Belle Mead NJ) 1996;25:602-4.

9. Bledsoe B, Barnes D. Traction splint. An EMS relic? JEMS 2004;29:64-9.

10. Mihalko WM, Rohrbacher B, McGrath B. Transient peroneal nerve palsies from injuries placed in traction splints. Am J Emerg Med 1999;17:160-2.

11. Wood SP, Vrahas M, Wedel SK. Femur fracture immobilization with traction splints in multisystem trauma patients. Prehosp Emerg Care 2003;7:241-3.

12. Gandy W, Grayson K. Sacred cows: the traction splint. Does it help patients and do we still need it on ambulances? EMS World 2014;43:25-30.

13. Chu RS, Browne GI, Lam LT. Traction splinting of femoral shaft fractures in a paediatric emergency department: Time is of the essence? Emerg Med (Fremantle) 2003;15:447-52.

14. Handoll HH, Queally JM, Parker MJ. Pre-operative traction for hip fractures in adults. Cochrane Database Syst Rev 2011;12:CD000168.

15. Equipment for Ambulances. American College of Surgeons Committee on Trauma; 2009. Available form: https://www.facs.org/-/media/files/quality‑programs/trauma/publications/ambulance.ashx. [Last accessed on 2019 Nov 30].

16. Score CG. Injury severity scoring. Trauma 1995;38:323.