Emergency Tourniquet Use To Stop Bleeding In Major Limb Trauma

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Introduction: Hemorrhage from injured extremities continues to be one of the leading sources of death on the battlefield (1). Data from recent conflicts involving U.S. military personnel confirmed the continued importance of improving prehospital hemorrhage control. In response, the U.S. Army implemented a rapid design, testing, training and fielding program for battlefield tourniquets and tourniquets have become common on the battlefields of Iraq and Afghanistan, both in the hands of medical and lay personnel.

We performed a prospective study at the U.S. combat support hospital in Baghdad, Iraq of patients who had tourniquets applied in the field or in the emergency department. Our objective was to determine if emergency tourniquet use saves lives and to measure complications.

Materials and Methods: The protocol was approved by the review board. The study period was from March to October, 2006, at Ibn Sina Hospital, Baghdad, Iraq. This was a prospective observational survey with cohort and subgroup analyses. All patients at the combat support hospital who had a tourniquet of any type used in their emergent health care (prehospital or emergency department [ED]) were included. The study group of 232 patients (220 males and 12 females, 8.2% of admissions) had 428 tourniquets applied on 309 limbs.

Results: Survival rate was higher in patients with tourniquets used v. tourniquets not used. We had a comparison group to compare the 232 patients with tourniquets to those who did not have but needed tourniquets used. We identified five patients (3 American, 2 Iraqi) with isolated limb injuries who were dead upon arrival at the hospital during the study period. These five were indicated for tourniquet use in the field but none was available or the patient was extricated or transported before tourniquet use was planned, but the five patients died first so tourniquets were never used in these five. In the matched cohorts of 78 patients with isolated limb injuries and tourniquet used v. five patients with isolated limb injuries and tourniquet not used, the mortality rate in those without tourniquets (5/5, 100%) and those matched with tourniquets (6/78, 7.7%) were different (p=0.001); tourniquet use was associated with better survival rates.

Survival was higher in patients with tourniquets used pre shock onset and prehospital. Deaths numbered 31 for an all-cause mortality rate of 13.4% (31/232). When analyzing tourniquet use in relation to shock onset, 10 patients had tourniquet use that was post shock onset of which 9 died (90%), and 222 patients had tourniquet use pre shock onset of which 22 died (10%; p<0.001). When analyzing tourniquet use in relation to whether the tourniquet was first placed prehospital or in the ED, prehospital tourniquets were applied in 194 patients of which 22 died (11% mortality) while 38 patients had ED application of which 9 died (24% mortality; p=0.05). The halving of the mortality rate with prehospital use was associated with a 16% improvement in survival rate which indicated 31 lives were saved.

For survival and tourniquet use, the first contingency test associated pre shock onset v. post shock onset with prehospital use (p=0.00007), the second contingency test associated pre shock onset v. post shock onset with ED use (p=0.0017), the third contingency test associated pre shock onset with prehospital v. ED use (p=0.3), the fourth contingency test associated post shock onset with prehospital v. ED use (p=1.0), the fifth contingency test associated prehospital v. ED use without any consideration of shock onset (p=0.06), the sixth contingency test associated pre v. post shock onset without any consideration of prehospital v. ED use (p=0.000000004), the seventh contingency test associated pre v. post shock onset and prehospital v. ED use without any consideration of survival (p=0.06). There was a strong association between tourniquet use pre shock onset and survival, and a weak association between prehospital use and survival.

Some morbidity was possibly associable with tourniquet use. Several types of morbidity have been attributed historically to tourniquet use. Ninety-six fasciotomies were performed in the 232 patients. Of the 87 amputation injuries, all had a surgical completion or debridement if the patient survived such that 98 limbs had an amputation injury, amputation surgery, and 11 limbs had failed salve. In 8 of the 98 limbs there was also prolonged (>2h) tourniquet use. Only 1 joint, a knee, was lost in the shortening of the amputation injuries by amputation surgery. The 10 clots included 1 deep venous thrombosis and 9 thrombectomies; all thrombectomy were during with vascular repair surgery especially when the repair was particularly distal. The 10 palsies were at the level of the tourniquet in 4 and the level of the wound in 6. The 4 palsies at the level of the tourniquet improved in the first hour to day after release, and only 1 had mild persistence at 6 days follow-up.

Tourniquet time was associated with amputation and fasciotomy but not other morbidity. The tourniquet time was <2h, the limit of the so called safe time, in 91% (251/275) of limbs with known tourniquet times. The rate of limbs with fasciotomies with tourniquet time ≤2h was 28% (75/272) and >2h was 36% (9/25). There was no apparent association of total tourniquet time and morbidity with clots, myonecrosis, rigor, pain, palsies, and renal failure as 0 of 10 clots, 1 of 5 myonecrosis morbidities, no rigor or pain case, 0 of 10 palsies, and 0 of 2 renal failure cases occurred in the limbs with a total tourniquet time >2 hours.

Discussion: Tourniquets save lives especially when used pre shock onset and prehospital. The main findings of the present study are that emergency tourniquet use in our population saved lives and that they did so better if used soon after injury. There was a strong association between tourniquet use pre shock onset and survival, and a weak association between prehospital use and survival. The current study is the largest study to date in terms of the number of patients and tourniquets used, and our data is concordant with the experience of Lakstein, et al., but the present study advances knowledge substantially by measuring substantial survival benefits and limited morbidity risks. The benefits of lives saved out weighed risks of morbidity in this study as 31 lives were saved at the cost of 1 knee.

Acknowledgements: The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Department of Defense or United States Government.


Paper No. 219 • 54th Annual Meeting of the Orthopaedic Research Society