Military-Trained Versus Civilian-Trained Parachuting Injuries

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Citation

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Abstract

Background: To investigate the severity of parachuting-related injuries in active military-trained paratroopers compared to civilian parachuting enthusiasts.

Methods: A retrospective review of adults treated at a level-one trauma center who were involved in parachuting accidents between 2000 and 2017 were studied and separated into two groups: those who had received military parachute training and those non-military trained, civilian parachute enthusiasts that had some form of a civilian parachute training. Independent two-mean sample t-test was used to compare age, injury severity scores, initial blood pressure, heart rate, initial Glasgow Coma Score, intensive care unit and total length of stay, and the total cost billed by the level-one trauma center and by the treating physician's medical group. Chi Square analysis was used to analyze the differences regarding gender, admission trauma level of severity, total number and type of injuries, emergency department disposition, alcohol/drug analysis and survival.

Results: Among the 77 cases (26 military and 51 civilian), the active military-trained paratroopers had statistically lower numbers of injuries as denoted by lower injury severity scores, higher initial blood pressures, shorter intensive care and overall trauma center length of stay as well as lower costs per admission. Compared to the military group, the civilian group had significantly more cases with positive alcohol/drug use.

Conclusions: It is clear that patients involved in parachuting accidents who were military trained paratroopers had significantly better outcomes than the patients having been trained in the civilian sector. This finding may simply be due to the military's more extensive training requirements. The data demonstrates that the military policy for mandatory alcohol and drug testing may very well negate these influences from being inciting factors for injury since not a single parachute injury in the military group tested positive for alcohol or drugs.

BACKGROUND

An interesting dichotomy exists between a common type of military practice and a common civilian outdoors activity known as parachuting. An extensive review of American, Australian, British, Belgian, Danish, French, Finnish, German, Israeli, Japanese, Malaysian, Oman, Serbian, South Korean, Russian, Swedish, Turkish civilian and military journal articles reveal a very systematic, standardized and organized guidelines for military parachute training as well as a discussion of injuries sustained.1-32 In the United States, the average military airborne training (jump school) involves three weeks of a step-wise progression from the class room to the final test of multiple jumps in various conditions including the day and night time. The class room instruction involves not only lectures but practical applications. Referred to as "Blocks of Instruction", paratrooper training first takes place in the classroom followed immediately by outdoor practical exercises lasting from 10 to 45 minutes regarding what was just taught.33 Because of the high standards, each successive step can lead to a military member being "washed out" of airborne training if not re-cycled back into the program. On the other hand, the civilian parachute training guidelines vary from state to state, even city to city, and can be as short as a few hours or as extensive as a few days.

As stated in one of the largest military parachuting reviews by Bricknell and Craig, the development of military parachuting techniques has allowed large numbers of soldiers to be delivered to the battlefield, from air to ground,

carrying over one hundred plus pounds of equipment with a high degree of safety. The over-riding requirement in military parachuting is to have a system which enables soldiers to land on the ground in a fit, combat-ready posture to fight for a prolonged period of time and in austere environments.1,34,35 Major military airborne operations date back to World War II and most recently in both Operation Enduing Freedom and Operation Iraqi Freedom.1, 34 Because of the sophisticated system of troop deployment, military physicians and flight surgeons have closely studied parachuting. In both peacetime and combat situations, injuries, hazardous outcomes and their impact on training as well as advances in techniques and education have been examined. For example, the Bricknell and Craig review reports the rates of the injuries from the military as well as limited civilian data. The study differentiates injuries based on the time of day (night versus day), wind velocity, type of equipment utilized, injury patterns and mechanisms of injury. However, several factors that are not well described in the literature include severity of injury upon presentation to a medical center, physiological parameters such as post-injury vital signs, as well as cost of care.

In contrast, civilian parachuting is generally performed as a form of entertainment, with little to no pressure and a low likelihood of encountering life-threatening dangers, other than the landing itself. Unfortunately, review of data from multiple European countries show very little new information available regarding civilian parachuting injuries.17 18, 28 Moreover, there is no current American data on civilian parachute injuries which makes the comparison between the military and civilian practices very difficult. However, a study from the United Kingdom suggested that the training for military parachutists was much more rigorous and extensive than their civilian counterparts and that a fast paced civilian education course could be accomplished over a weekend.18 Severity of injury rates required a hospital admission rate of over 82% in civilians compared to the military which was around 25%. In addition, the author also suggested that more rigorous health standards should be implemented in regards to age and weight to prevent the injury severity requiring subsequent hospital admission since the military maintains such high standards and have lower hospitalization rates.

In Arizona, where outdoor activities such as parachuting are enjoyed year-round, civilian parachuting injuries are commonly encountered and treated in a variety of settings from outpatient urgent care centers to level-one trauma centers based upon severity of those injuries. Even more fascinating was that over an 18-year period, the trauma service noted not only a small but constant number of civilian parachuting injuries but also a number of military paratroopers having come from that same civilian training airfield. Given the paucity of literature of post-injury outcomes when comparing military and civilian parachuting injuries, this retrospective study was undertaken in order to better define the nature of injuries between the two groups. Specific questions to be addressed would include, 1) whether there were significant differences between military versus civilian parachuting injuries, 2) if so, what accounts for the differences in the injury severity, 3) does the extent of training effect severity of injury, 4) what is the impact on healthcare costs for all the injured patients?

METHODS

This study retrospectively examined 77 cases of parachute-related injured patients meeting the definition for activation as a trauma patient to Maricopa Medical Center, an America College of Surgery Level I Verified Trauma Center in Phoenix, Arizona, between January 2000 to December 2017. The study utilized electronic medical records in its retrospective review of the involved patients, extracting demographic information, clinical, operative and intensive care management, complications and cost-related information. The study was approved by the Maricopa Medical Center institutional review board.

Every patient in this review participated in parachuting activities from the same jump-zone located in Southwestern Arizona. Each patient jumped from a standard propeller aircraft provided by the jump-zone. Parachuting injuries were notably separated into two distinct groups: Those who were either active military and/or reserve military status at the time of injury and thus received previous military parachute training versus those who were civilians that underwent only civilian parachute training. Total number of previous parachute jumps per individual were not recorded for either group. All of the military parachutes and their rigging were packed by a military specialist trained in standard military parachute packing. There were no civilians that were former military personnel with previous military parachute training. None of the military jumps were considered sport jumping but were considered operational exercise jumps. All jumps were freefall and no jumps utilized a static line. Of note, Table 1 illustrates the Trauma Activation Criteria for Maricopa Medical Center: Low

Severity/Trauma Consult – Green), Medium Severity/Trauma Team Activation – Yellow, High Severity/Trauma Team Immediate Activation – Red). Independent two-mean sample t-test was used to compare age, injury severity scores (ISS), initial blood pressure (BP), heart rate (HR), initial Glasgow Coma Score (GCS), number of operations, intensive care unit (ICU) length of stay (LOS), total LOS, ventilation days, number of consultations, and the total cost billed by the level-one trauma center and by the treating physician's group (Table 2). Chi Square test and Fisher Exact test were used to analyze the differences regarding demographics, mode of transportation to the trauma center, trauma activation level (degree of severity), total number and type of injuries (grouped together), number of consultations, presence of cardiac arrest, emergency department (ED) disposition (home, floor, ICU, operating room (OR)), alcohol/drug analysis, and survival or participation in donation of organs if brain death was declared (Table 3). No military patients were transferred to a military hospital or Veterans Administrative medical center for immediate care after stabilization at the Maricopa Medical Center, and only after definitive care was completed were patients discharged to home or a skilled nursing facility if required.

Table 1. Trauma activation criteria at Maricopa Integrated Health System denoted by severity.

Red - High Severity/Trauma Team Immediate Activation

- *Intubated patients transferred from the scene*
- *Patients requiring airway intervention or needle decompression*
- *Prehospital respiratory distress or agonal/assisted respirations*
- *Under 1 year with respiratory rate <20*
- *Patients intubated at a referring hospital with continued issues with ventilation or oxygenation (does not include stable airways)*
- *Hypotension/Shock (requires only 1 reading in the field or enroute)*
- *Under 15 yo SBP < 70 or evidence of poor perfusion*
- *15-65 yo with SBP < 90 mm Hg*
- *>65 yo with SBP < 110 mm Hg*
- *Transfer patients from other hospitals requiring blood to maintain vital signs*
- *External hemorrhage that is uncontrollable, requiring application of tourniquet, or continuous direct pressure*
- *Penetrating injuries to the head, neck, torso, and extremities proximal to elbow or knee (excluding animal bites not meeting other criteria)*
- *GCS less than 9 with trauma mechanism*
- *Traumatic cardiopulmonary arrest even if return of spontaneous circulation in the field*
- *Trauma resulting in quadriplegia/paraplegia*
- *Pulseless extremity secondary to trauma mechanism*
- *Amputation proximal to wrist or ankle*
- *Pregnant patient > 20 weeks gestation with vaginal bleeding*
- *Combination of trauma and > 20% BSA burn*

Yellow - Medium Severity/Trauma Team Activation

- *Post injury seizure or GCS 9-12*
- *Any motor or sensory deficit other than quadriplegia/paraplegia*
- *Open or depressed skull fracture*
- *Crush injury to torso*
- *Abdominal pain with significant tenderness upon palpation*
- *Suspected pelvic fracture*
- *Two or more proximal long bone fractures*
- *Combination of trauma and < 20% BSA burn*
- *Abdominal seat belt sign*
- *Explosive mechanism not meeting red criteria*
- *Falls:*
- *Under 15 yo > 2 times the height of the child or > 10 ft*
- *15 yo and older >20 ft*

Green - Low Severity/Trauma Consult

- *High risk auto crash*
- *Intrusion into passenger compartment; including roof >12 inches occupant site; >18 inches any site*
- *Ejection (partial or complete) from motorized vehicle*
- *Death in same vehicle*
- *Motorcycle crash > 20 mph*
- *Auto vs pedestrian or bicyclist thrown, run over, or with significant impact (>20 mph)*
- *Pregnant patient > 20 weeks gestation with blunt trauma*
- *Injured patient on anticoagulation (excluding ASA) or with known bleeding disorder with concurrent findings of : GCS < 15, injury above clavicles, N/V, amnestic to event, or seizure*
- *Suspected multisystem injury*
- *Field "Level 1" or "Immediate"*
- *EMS request*

Table 2

Characteristics of patients with group comparisons conducted using independent two-sample t-test

	Military			Civilian			p-values
	n	Mean	Std. Deviation	n	Mean	Std. Deviation	
Age	26	34.12	7.10	51	37.16	10.47	0.14
ISS	26	8.46	6.78	51	14.39	11.30	0.005
Initial BP	26	143.19	24.40	51	129.92	22.66	0.03
HR	26	78.96	22.04	51	67.50	19.92	0.20
No of OPS	26	0.73	0.87	50	1.00	1.23	0.27
LOS	26	2.60	2.48	50	7.60	10.31	0.002
ICU LOS	25	0.52	1.19	51	3.02	8.36	0.04
Cost to trauma center	25	56937.50	71696.06	51	122897.51	175016.45	0.02
Cost to physician group	26	5107.03	7901.04	51	13149.10	26058.11	0.04
Initial GCS	26	14.42	2.40	51	13.51	3.71	0.20
Vent Days	26	0.15	0.61	51	1.73	8.08	0.17

Table 3

Characteristics of patients with group comparisons conducted using Chi Square test or Fisher Exact Test

	Military	Civilian	p-values
Gender (F/M)	2/24	12/39	0.09
Trauma Activation Level (Consult/GRN/ YLW/ RED)	3/9/8/6	4/5/24/18	0.046
ED disposition (OR or ICU/Floor or Home)	11/14	36/15	0.02
Injury Type (LPSF/TBI/IGC)	28/5/6	70/15/19	0.87
Transport (NA/air/Ground/POV)	0/23/3/0	1/44/5/1	0.78
Cardiac Arrest (Y/N)	0/26	1/50	0.59
ETOH/Drug (NA/Y/N)	3/0/23	5/10/36	0.02
Survival (Y/N)	25/1	49/2	0.77
Donor (Y/N)	0/26	1/50	0.47
Consults type (Ortho/Neuro/Other)	18/6/5	34/18/4	0.25

(LPFS) Long bones, Pelvis, Spine, Feet; (TBI) Traumatic Brain Injury; (IGC) IAI, GU, Chest

RESULTS

During the 18 years of study, 26 military parachuting injury patients (those with military training) and 51 civilian parachuting injury patients (those with only civilian training) were discovered for our data. Tables 2 and 3 each depicts different patient characteristics and variables which were studied. In Table 2, characteristics of patients with group comparisons were conducted using independent two-sample t-test, while Table 3 revealed characteristics of patients with group comparisons conducted using Chi Square test and the Fisher Exact test. There were no statistical differences between average ages in years (military 34 versus civilian 37) as well as initial GCS (Table 2) and gender (Table 3). From Table 3, the trauma activations for the military patients were significantly less severe than those of civilian injuries, based on standardized trauma scoring (p=0.046, Table 3). Moreover, after dichotomizing the severity into two levels: low (consult or green activation) versus high (yellow or red activation), only 54% of military cases resulted in a high severity activation as compared to 82% of civilian cases (p=0.004). Similarly, when dichotomizing emergency department disposition into two levels: lower care (home discharge or surgical floor admission) versus a higher level of care (OR or ICU admission), only 44% of military cases required ED disposition to a higher level of care compared to 71% for the civilian cases (p=0.02). Furthermore, compared to the military group, the civilian group had significantly more patients with positive alcohol/drug use (p=0.02, Table 3).

The military group had lower ISS compared to the non-military group (p=0.005) and the military group had a higher initial BP obtained as compared to the civilian group (p=0.03, Table 2). Despite the grouping of injuries into three separate categories including long bone, pelvis, spine and feet (LPSF), traumatic brain injury (TBI), and torso trauma, including intraabdominal abdominal injury, genitourinary and chest (IGC), no statistical difference was noted between these three groups.

The military group had a shorter length of stay in the trauma center after sustaining their injuries compared to the non-military group (p=0.002) and the military group also had a shorter ICU stay, compared to the non-military group (p=0.04, Table 2). Despite the ventilator days for the military patients being 10 times lower than the civilian patients (0.15 days versus 1.73 days), these results were not statistically different. The number of operations did not significantly differ between the two groups. Consistent to the severity and ED disposition, the military group had statistically lower hospitalization costs at $56,937 compared to the civilian group at $122,897 (p=0.02). The military group also had significantly lower physician group costs at $5,107 compared to the civilian group at $13,149 (p=0.04, Table 2).

CONCLUSIONS

As noted in the Bricknell and Craig study, the authors summarize that military jump injuries during the daytime hours were only 1.78/1000 jumps while the civilian rate was 3.78/1000 jumps. However, the military rate increased to 5.78 if nighttime and combat jumps (i.e. full equipment and harsher circumstances) were included which has been found also to increase in other studies if such conditions exist.1,6,8,19,34 While that study had significant patient numbers, the role of developing technology in regards to parachuting as well as the applicability of the study being an occupational research survey in design, leaves many questions unanswered.34 It is clear that patients involved in parachuting accidents who trained in the military, had significantly better outcomes than those having been trained in the civilian sector.18,34 While civilian parachute enthusiasts can have up to 8 hours in parachute training, the military training extends for over 31.5 hours involving the United Kingdom.23 In addition, it was noted that the first-time jumpers complained that they were not given enough information on the risks involved and were underinsured prior to their first jump. The study concluded that better training and more information may have changed the overall hospital admissions seen with the civilian jumpers to much lower levels as seen with the military parachutist. In that study it was also noted that overall physical fitness may play a role in the higher civilian incidence in injuries. Additional studies conducted by the same author completed ten years apart showed no improvement in injury rates and questioned

why no lessons had been learned in the instruction of the novice civilian parachutist and, therefore, recommended better training, improved standards for height and weight nomograms for exclusion purposes, and improved equipment and medical insurance.19

The differences in injuries and outcomes may simply be due to the military's more sophisticated, extensive and vigorous training requirements, which include many varieties of free-fall jumps that are taught to each paratrooper beyond the five individual jumps at the end of Jump School training. Confounding these results is that upon reviewing the literature from many countries around the world, it appears that the civilian data reporting on parachuting injuries is less than adequate in the United States. While a reporting and collecting system exists within the military command structure to study common injury patterns of their paratroopers, civilian parachuting belongs to the private sector that is not regulated by a single entity although the United States Parachute Association attempts such endeavors.35 Reporting is voluntary and not mandatory. Furthermore, within the civilian sector, parachuting companies have varying degrees of requisite training that can be as short as a few hours coupled with tandem jumping before a first-time jumper is allowed to solo jump. Civilian jumpers also do not have standard requirements in terms of required physical health before jumping: age, weight, basal metabolic index (BMI), disabilities, vision, and prior injury are not used to exclude parachuting enthusiasts. While the civilian parachutist is recommended to have a general medical physical, having what is known as a third class medical certificate is little more than that required to drive a car with a valid driver's license. On the other hand, the military requirements are strict and demanding.36,37 Standards must be met for all paratroopers and can be found in the Army Regulation's 40-501, referred to as "Standards of Medical Fitness" (December 2016), and TC3-21.220, also referred to as "Static Line Parachuting Technics and Training" (October 2013), for any service participating at the jump school at Fort Benning, Georgia.33,38

Nonetheless, it must be noted that the data in our study is limited to only severe post-injury outcomes requiring a trauma center evaluation and possible admission. Thus, this review fails to compare the two groups as to the overall rate of injuries in military and civilian jumping incidents and whether further civilian training could help decrease the accident rate, and injury severity. Conversely, there is not a system in place, in Arizona or any other state in the United States, that such information is published. Considering all these limitations, some authors have postulated that peacetime military injury rates should be as low as 0.8% in large scale airborne training drops from an airplane with most injuries occurring as a result of improper parachute landing falls which is the majority of causes for injury in our study.9,39 The rate of injury changes in combat situations and is reported to be as high as 30% with eight out of the top eleven injuries being orthopedic related39 and in the current conflicts in Afghanistan and Iraq, the injuries were mostly affecting the lower extremities or spine.1,39

The United States military service has its own well-trained parachute riggers to prepare each parachute to meet specific standards for each individual, operational drop. Each parachute is packed and inspected with multiple checks as part of a system put in place. This is opposed to the civilian parachute enthusiast that prepares their own parachute, relying on past training that may decay over time unless there is additional training and, consequently, has no further checks or inspections on the parachute pack. Equipment costs and maintenance may also represent confounding variables as this sport is expensive for the individual civilian parachutist, whereas for the military, the financial and replacement costs are not an issue. This represents another clear confunding factor between the military and the civilian parachutist. These additional factors, may result in military injuries being less frequent and severe compared to their civilian counterparts.

It is clear in our study, however, that initial ISS and BP, overall injury severity, ICU and hospital length of stay and overall cost all favor the military group. While the ventilator days for the military patients were 10 times lower than the civilian patients (0.15 days versus 1.73 days), these results were not statistically different, likely due to the large variability within each group. Once again, are these findings related to more intense military training, better preparation and equipment and a parachute jumper who is potentially more physically and mentally 'fit' to jump either on an occasional or routine basis? These postulates come into question when one examines the very telling results that approximately a third of civilian injuries were in patients that were found to test positive for alcohol and/or drugs. This may demonstrate that the military policy for mandatory alcohol and drug testing negates these influences from being inciting factors for injury since not a single parachute injury in the military group tested positive for alcohol or drugs. Ideally, further studies, including multi-center reviews, are

necessary to further delineate the specifics as to why such differences in injury severity occur.

The system of reporting accidents, injuries, and post-injury outcomes is unreliable in the civilian sector which makes tracking much more difficult in the state of Arizona. The leading American parachuting association known as the United States Parachuting Association (USPA) is a voluntary, non-profit membership organization, but the latest data reported on their website is outdated, with data from July 2015 being the most recently inputted on their website as of the writing of this paper.35 While there is some aggregated data mentioned on their website from 2016, there is no individual reporting as previous documented. In order to better understand the increased severity of injuries in the civilian population, a national reporting system that is transparent and frequently updated, that not only gathers but publishes parachute training site policies, the presence of a uniform education curriculum as well as a monthly updated list of civilian injuries is essential, perhaps similar to the British Parachute Association, to which all parachute clubs in the United Kingdom belong and all injuries are mandatorily reported.40 While some critics of such a system may argue that such disclosure may not be cost-effective or result in longer and more intense education as well as mandatory alcohol/drug testing prior to jumping, the results in our study suggest otherwise.

SUMMARY

The data in this review clearly shows that ISS, initial BP, ICU and total hospital LOS as well as overall medical costs favor the military airborne training as it relates to parachute injuries. Furthermore, there is a poor reporting systems and lack of standardization within the civilian parachuting industry's training which should necessitate the development of a national United States civilian reporting system and uniform educational curriculum. Such a reporting system would publish training duration, educational content at civilian training centers, and rates of injuries. One final recommendation might be that random urinary drug screening be implemented secondary to the large percentage of civilian parachutists testing positive in what some might consider an extreme sport that requires the utmost attention to detail without impairment. All of the findings should provide critical information for the parachuting enthusiast as well as assist in a better understanding of post-injury outcomes, financial costs in the hopes of determining the ideal length of training and how to improve upon the sequela of parachuting injuries.

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