Civilian and Military Parachute Injuries

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Disclosures

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- Surgical Consultant and Speaker's Bureau for KCI
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Objectives

1) Review the incidence and types of civilian parachute injuries
2) Discuss military parachute training, injuries and why they occur
3) Reviewed the comparison of military versus recreational parachute injuries in our 16 year comprehensive study

Civilian/Military Parachute Injuries

- Parachuting as a sport or military exercise is regarded as one of the most challenging and demanding efforts
- Requires a high degree of mental and physical fitness

Civilian/Military Parachute Injuries

In the beginning (1997 A.D)

- M and M with Chairman James Malone and Trauma and Burn Director William Schiller
- Risk for injury never changes
- Reviewing the MIHS experience
- 2013 a young German Special Forces Officer came to the MIHS Trauma Center post parachute injury

Civilian/Military Parachute Injuries

- The medical literature shows that injury rates between 2 - 20 injuries per 1000 jumps (literature slightly varies from 2 to 4%)
  - That number is fixed in stone no matter how much experience the jumper has or how many times they have jumped after a certain point of experience
- True for both military and civilian jumpers
- Vast majority of civilian jumps occur in good conditions and during the daylight hours
- This is not true for the military under combat situations

Dhar D. Retrospective study of injuries in military parachuting. Med J Armed Forces India. 2007 (Oct); 63(4): 353-355.

Civilian/Military Parachute Injuries

- Even as far back as 32 years ago it was noted that civilian parachute training was less rigorous than the military parachute training
- In 1987 one group of authors reviewed 33 civilian parachute enthusiasts' injuries
  - 41 injuries over 1.5 years
- Noted was that hospital admissions skyrocketed to 82% for the higher severity of injury (felt attributed to training)
- The vast majority of injuries occurred during landing

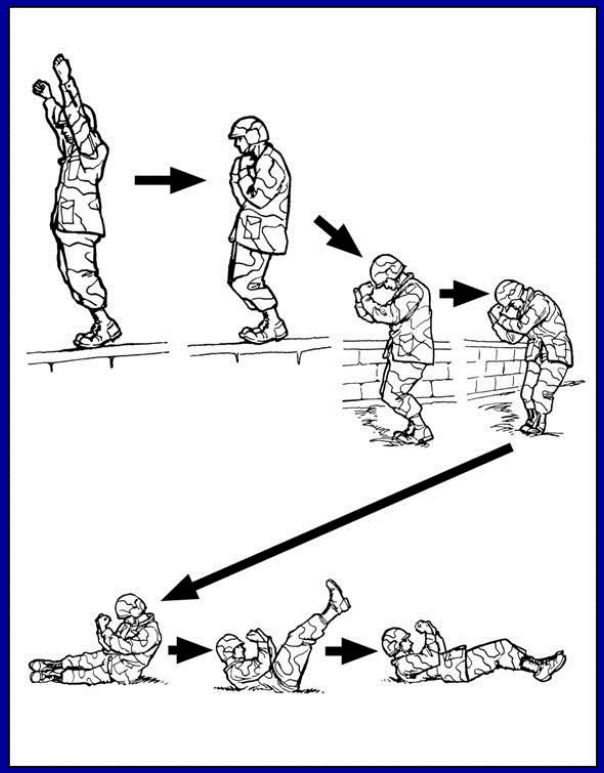
- Amamilo SC, et al. A prospective study of parachute injuries in civilians. JBJS (Br) 1987 (Jan); 69(1):17-9.

Civilian/Military Parachute Injuries

- Time in hospital varied from 2 to 42 days (average of 15.7 days)
- Time off work 4 to 60 weeks (average of 17.5 weeks)
- Typical injuries where to weight-bearing structures
  - Foot
  - Ankle (most common at 41.5%)
  - Tibia/Fibula and femur
  - Pelvis
  - Spine

Civilian/Military Parachute Injuries

PLF or Parachute Landing Fall



Civilian/Military Parachute Injuries

- More than half of these injuries were considered severe

Civilian/Military Parachute Injuries

- In the United Kingdom all parachutist belong to a parachute club which in turn belongs to the British Parachute Association
- Guided by a code of conduct
- In contrast, the military paratroopers are selected after passing a physical and medical examination
- For recreational parachuting is expected only to have a “reasonable standard” of physical fitness
- British Military program is 4 weeks of intensive training culminating in 8 qualifying jumps

Civilian/Military Parachute Injuries

Cause and type of injuries

Exiting the aircraft	2.4%
Parachute issues	9.8%
Landing (uneven terrain)	53.6%
On tarmac (hard landing)	4.9%
Legs straight, feet together	7.3%
Feet apart	4.9%
Parachute drag	2.4%
Wind turbulence (canopy collapse)	14.6%

Civilian/Military Parachute Injuries

- Specific injuries
  - Severe to Moderate Type
    - Lumbar spine fracture
    - Hip fractures
    - Dislocated knees with ischemic legs/feet
    - Fractured tibias/fibulas
    - Fracture / dislocated ankles
    - Head injury
    - Brachial plexus injuries (neuropraxia)
    - Fractured ulna
    - Pelvis fracture
    - Fractured metatarsal bones

Civilian/Military Parachute Injuries

- Minor types
  - Neck strain
  - Bruised shoulder/forearm
  - Laceration hand
  - Sprained knee
  - Sprained ankle

Civilian/Military Parachute Injuries

- Other papers have found similar civilian injury rates from 0.62% to 2.4% in aggregate
- For those that meet hospital criteria (65.8% of all injuries), the hospital admission rate of 82% for civilian injuries greatly exceeds military parachuting injuries
- Beginner civilian parachute enthusiasts have a threefold higher injury rate than more experienced civilian parachute enthusiasts
- The vast majority of injuries occur **during landing**
- Landing techniques which involve practice jumps are covered in a weekend course typically lasting only 8 to 12 hours

Essex-Lopresti P. The hazards of parachuting Br J Surg 1946; 34:1-13
Hallel (Huller) T, et al. Parachuting injuries: a retrospective study of 83,718 jumps. J Trauma 1975; 15:14-9.

Civilian/Military Parachute Injuries

"The euphoria accompanying the glorious sense of isolation whilst floating down is tempered by the anticipation of the technical difficulties of meeting the ground."

- During the last 50 feet, the ground rushes up at an increasing speed and at an angle due to horizontal drift
- Quick thinking and a determined effort are necessary to make a correct landing (more challenging for the beginner)

Civilian/Military Parachute Injuries

- Detailed civilian interviews found multiple causes for bad landings
  - Uneven terrain
  - Unexpected winds
  - Straight legs with feet apart

Civilian/Military Parachute Injuries

- Many papers felt that more training was warranted for civilians
  - Landing techniques
- But still there are fast-paced civilian education courses that can be accomplished over a weekend
- Despite more research papers in this field, no new changes had been instituted for greater training

Civilian/Military Parachute Injuries

- England has “socialized medicine”
- All injuries are therefore documented /captured from urgent care centers up to major medical centers into their national health data center
- All parachute injuries are captured because they must be reported through the British Parachute Association for data collection

Civilian/Military Parachute Injuries

- The United States does not have the same epidemiologic abilities or culture
- The United States Parachute Associations website cannot capture this data (HIPPA) unless voluntarily submitted
- Then again their website has not been updated with injury data since 2015

Civilian/Military Parachute Injuries

- Lets look at Military Training
- Reviewed papers from American, Australian, British, Belgian, Danish, French, Finnish, German, Israeli, Japanese, Malaysian, Oman, Serbian, South Korean, Russian, Swedish, Turkish civilian and military journal articles
- Revealed a very systematic, standardized and organized guidelines for military parachute training and programs as well as a discussion of injuries sustained

Civilian/Military Parachute Injuries

- Military Training
- As noted in the Bricknell and Craig study, the military jump injuries during the daytime hours were only 1.78/1000 jumps while the civilian rate was 3.78/1000 jumps (civilian injuries vary between 2-4%)
- However, the military rate increased to 5.78 if night time 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

Civilian/Military Parachute Injuries

- The US military airborne training (jump school) involves three weeks of a step-wise progression (ground week, tower week, jump week)
- From the class room to the final test of multiple jumps in various conditions and airplane including during 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
- 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

Civilian/Military Parachute Injuries

- On the other hand, the US civilian parachute training guidelines and training 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

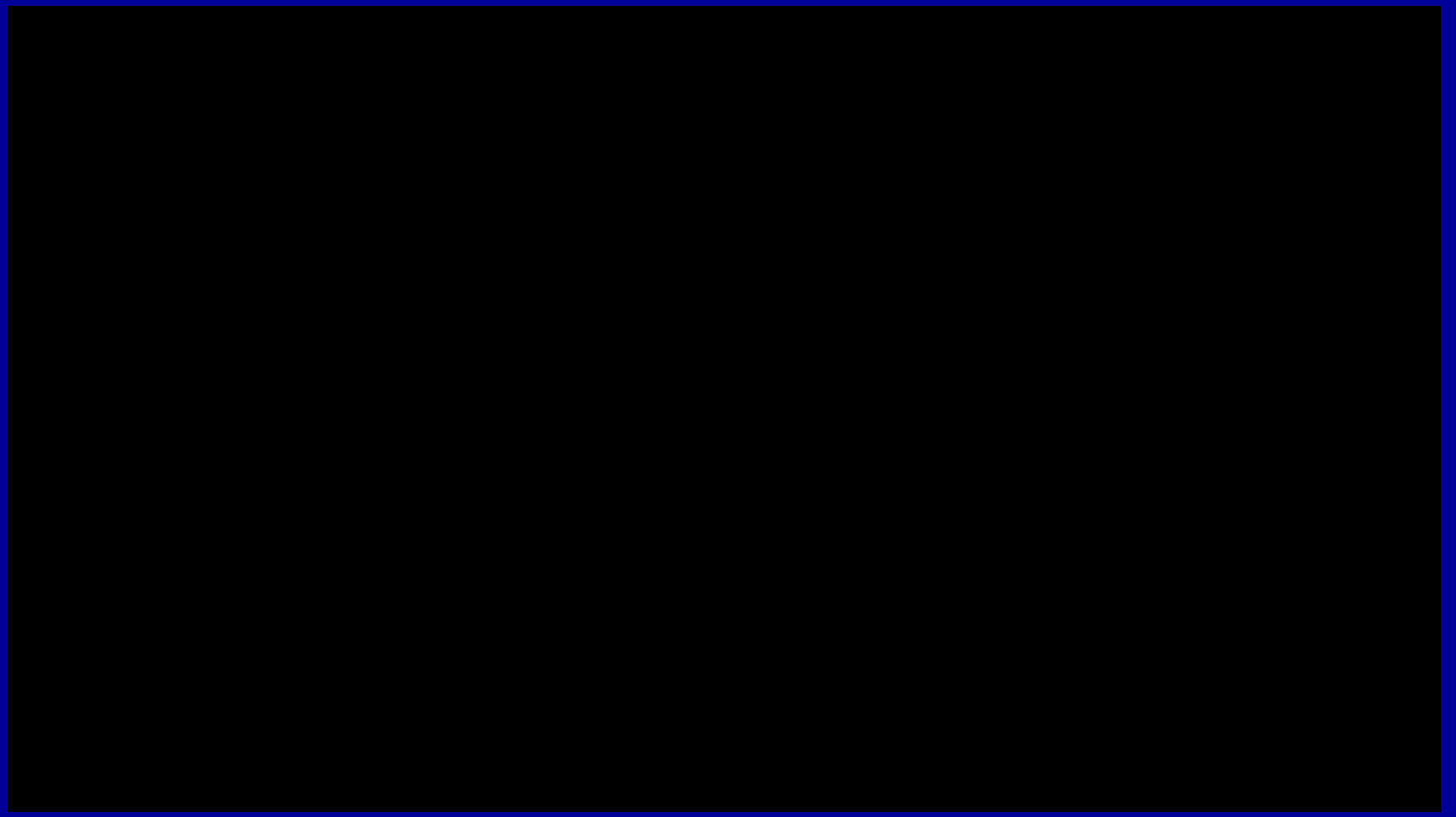
Civilian/Military Parachute Injuries

- 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
- Major military airborne operations date back to World War II but most recently in both Operation Enduring Freedom and Operation Iraqi Freedom

Civilian/Military Parachute Injuries

- Operation Market Garden (A Bridge to Far)

Civilian/Military Parachute Injuries



Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- Military Rates of the Injuries
- Differentiate injuries based on the time of day (night versus day), wind velocity, type of equipment utilized, injury patterns and mechanisms of injury
- Again, severe injury rates requiring hospitalization was over 82% in civilians compared to the military was around 25%

Civilian/Military Parachute Injuries

- Of note, one study 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

Civilian/Military Parachute Injuries

- Several factors are not well described in the literature upon presentation to a medical center include
  - physiological parameters such as post-injury vital signs
  - severity of injury (levels of activation, ISS)
  - cost of care

Civilian/Military Parachute Injuries

- In Arizona, 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 in Eloy, Arizona

Civilian/Military Parachute Injuries

- So, a retrospective study was undertaken to better define the nature of injuries between the military paratroopers and civilian enthusiasts

Civilian/Military Parachute Injuries

- Specific questions to be addressed

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?

Civilian/Military Parachute Injuries

- Retrospective study examined 77 cases of parachute-related injured patients meeting the definition for activation as a trauma patient to Maricopa Medical Center
- MMC is an America College of Surgery Level I Verified Trauma Center in Phoenix, Arizona
- Study was conducted between January 2000 to December 2017

Civilian/Military Parachute Injuries

- The study utilized electronic medical records
- Extracted 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

Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- 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 had 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

Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- 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)

Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- Chi Square test and Fisher Exact test
- 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)
- [No military patients were transferred to a military hospital or Veterans Administrative Medical Center for immediate care after stabilization at the Maricopa Medical Center]

Civilian/Military Parachute Injuries

	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

Civilian/Military Parachute Injuries

	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

Civilian/Military Parachute Injuries

- 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 used for our data
- There were no statistical differences between average ages in years (military 34 versus civilian 37) as well as initial GCS and gender

Civilian/Military Parachute Injuries

- The trauma activations for the military patients were significantly less severe than those of civilian injuries, based on standardized trauma scoring ($p=0.046$)
- 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 ($p=0.004$)

Civilian/Military Parachute Injuries

- 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 disposition to a higher level of care compared to 71% for the civilian cases
- Furthermore, compared to the military group, the **civilian group had significantly more patients with positive alcohol/drug use** (30%) ($p = 0.02$)
- The military had zero

Civilian/Military Parachute Injuries

- The military group had lower ISS compared to the civilian group (p=0.005)
- The military group had a higher initial BP obtained as compared to the civilian group
- The military group had a shorter length of stay in the trauma center after sustaining their injuries compared to the civilian group (p=0.002)
- The military group also had a shorter ICU stay, compared to the civilian group (p=0.04)

Civilian/Military Parachute Injuries

- 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 surgical operations did not significantly differ between the two groups

Civilian/Military Parachute Injuries

- Consistent to the severity and ED disposition, the military group had 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)

Civilian/Military Parachute Injuries

- Patients involved in parachuting accidents who trained in the military, had significantly better outcomes than those having been trained in the civilian sector
- 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 and the US for 3 weeks

Civilian/Military Parachute Injuries

- In addition, in one study, 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

Civilian/Military Parachute 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
- They recommended better training, improved standards for height and weight nomograms for exclusion purposes, and improved equipment and medical insurance

Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- 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
- Reporting is voluntary and not mandatory

Civilian/Military Parachute Injuries

- Civilian jumpers also do not have standard requirements in terms of required physical health before jumping
  - Age
  - Weight
  - Basal metabolic index (BMI)
  - Disabilities
  - Vision
  - 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

Civilian/Military Parachute Injuries

- George H W Bush (41st President of the United States)

Civilian/Military Parachute Injuries

- On the other hand, the military requirements are strict and demanding
- Standards must be met for all paratroopers
- 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 Techniques and Training" (October 2013), for any service participating at the jump school at Fort Benning, Georgia.

Civilian/Military Parachute Injuries

- Nonetheless, it must be noted that the data in our study is limited to only severe post-injury outcomes requiring a trauma center activation / 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

Civilian/Military Parachute Injuries

- The rate of injury changes in combat situations
- Eight out of the top eleven injuries are generally orthopedic related
- In the recent conflicts in Afghanistan and Iraq, the injuries mostly affected the lower extremities or spine

Civilian/Military Parachute Injuries

- 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

Civilian/Military Parachute Injuries

- 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
- 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?

Civilian/Military Parachute Injuries

- These postulates come into question when one examines the very telling results that approximately 1/3 of civilian injured 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 such influences from being inciting factors for injury since not a single parachute injury in the military group tested positive for alcohol or drugs

Civilian/Military Parachute Injuries

- Ideally, further studies, including multi-center studies, are necessary to further delineate the specifics as to why such differences in injury severity occur

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Thank you

Questions?