Parachuting injuries: a retrospective study of 43,690 military descents

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Abstract. Although it is considered to carry some risk, parachuting is a popular activity practiced by civilians and military personnel. Great majority of injuries are related to mistakes in technique. Objective of this study is to present incidence, locations and risk factors of skeletal injuries occurring in 43,690 static line and free fall military jumps. Data of jumps and parachute-related injuries were collected prospectively, evaluated statistically by using chi-square test and logistic regression. There were 353 injuries in 43,690 parachute jumps (8.07 injuries per 1000 aircraft exits). Injury rate was 3.2 times higher in static line group than free fall group. This difference was statistically significant. Fifty-five percent and 100% of parachutists were carrying combat equipment; 95% and 100% of injuries were occurred during landing in both groups, respectively. Incidences of ankle injuries were 21.9% and 27.3% in static line and free fall parachuting.

As a conclusion, static line military parachutists are more prone to injuries. Most of the parachute-related injuries are landing injuries. Carrying heavy combat equipments is an important factor affecting injury rates. Ankle is the typical and most vulnerable site which can have a negative effect on individual career of the parachutist.

Keywords: parachuting, parachuting injuries.

Military parachuting is an activity which has been practiced commonly since it became popular during and after World War II. It is a quite popular activity practiced by civilians, too. In military; parachuting is a fast and effective way of transporting large number of troops [1,2] and in civilian; it is popular for recreation [3-7].

Jumping out from an aircraft and landing with a parachute is considered to have some risk. Results of parachuting injuries can range from such as ocular problems [8] or pectoral muscle ruptures [9] to deaths [10]. However parachuting is not as dangerous as is believed, the great majority of injuries are related to bad technique and preventable [11,12].

These potential injuries can be reduced by understanding risk factors as well as giving parachutists an intensive training. Better equipment and applying basic principles during practice are also important issues in prevention of injuries. Eventually, the decrease in injury rates will help to reduce the cost of medical treatment.

The objective of this study is to report the incidence, locations and risk factors of skeletal injuries occurring in static line and free fall military parachuting.

Materials and methods

A total of 43,690 military parachute jumps were performed and evaluated. While 39,553 (90.5%) of the descents were static line parachuting (SLP), the other 4,137 (9.5%) were free fall parachuting (FFP). All jumps were made using the same parachute design from an altitude of 800-1000 feet at wind speeds of less than 10 knots.

All parachutists were male. The equipment used during descents was standard military uniform with a protective helmet and mid-calf boots. The combat equipment weighed up to 35 kg when carried.

Any injury sustained by a parachutist from the time of leaving the aircraft until the end of landing was considered to be parachute-related injury (PRI). All injured parachutists were transferred immediately to the military hospital, examined physically;
x-rays and other diagnostic procedures were performed as needed.

Injuries were classified into mainly two categories as major and minor. Head and neck injuries, dislocations, knee ligament and meniscal injuries and fractures were considered to be major. Contusions, strains, sprains and other injuries such as minor skin cuts, abrasions etc. were considered to be minor. Incidence, category and location of the injuries, age of parachutists and equipment used during descents were also assessed.

Data were collected prospectively and evaluated statistically by using chi-square test and logistic regression.

**Results**

Total number of injuries was 353 in 43,690 parachute jumps. There was no fatal injury. The overall rate of PRI was 8.07 injuries per 1000 aircraft exits.

Three hundred-forty two injuries were recorded in 328 personnel in SLP and 11 occurred in FFP. The rate of PRI was 8.6 injuries per 1000 aircraft exits in SLP and 2.6 injuries per 1000 aircraft exits in FFP. Injury rate was 3.2 times higher in SLP than FFP and this difference was statistically significant (chi-square; $\chi^2=16.016$, p<0.0001 and logistic regression; ODDS= 3.272, CI 95%, 1.793-5.969).

**Injuries of SLP:** The most vulnerable site of the injury was the ankle, with a total of 75 injuries (21.9%). Incidence increased up to 146 (42.9%) when foot injuries were considered as well. The second most vulnerable site of injury was upper extremity with 50 injuries (14.6%). Spine and back followed upper extremity with 43 (12.6%) and head-neck with 21 injuries (6.1%). More than half of the injuries were related with lower extremities with a total of 187 (54.7%). Two hundred-twenty (64%) of 342 injuries were minor; whereas 122 (36%) were major. Eighty of (23.4%) all injuries were fractures. Two hundred-eighty four injuries (83%) occurred in age group of 20-29 and 58 injuries (17%) in age group of age 30 and over. The relative risk of injury was higher for younger parachutists. Parachutists were dressed up with heavy combat equipment during 188 (55%) of 342 injuries, and during the rest 154 injuries, with standard military uniform. Fourteen (4.1%) of injuries occurred during exit from the aircraft, as 3 (0.9%) were during descent and 325 (95%) were during landing. Ninety-seven (28.4%) of total 342 patients were hospitalized and 245 (71.6%) were treated on outpatient basis.

**Injuries of FFP:** There were only 11 injuries and ankle was the most affected site with 3 (27.3%) injuries. Spine and radius fractures followed ankle with a number of 2 (18.2%) injuries respectively. One (9.1%) shoulder contusion, 1 (9.1%) shoulder dislocation, 1 (9.1%) chest contusion and 1 (9.1%) knee sprain occurred in this group. There were 6 (54.5%) minor, 5 (45.5%) major injuries and 4 (36.4%) of 11 injuries were fractures. Four of 11 (36.3%) injuries were in age group of 20-29 and 7 of 11 (63.7%) in 30 and over. Contrary to the results of SLP, injury risk was higher for older parachutists in the FFP. All 11 injured parachutists were dressed up with combat equipment when they got injured. All of the 11 (100%) injuries occurred during landing in this group. Two (18.2%) parachutists were hospitalized whereas 9 (81.8%) got medical treatment on outpatient basis.

**Discussion**

Overall rate of parachuting injury, 8.07 injuries per 1000 aircraft exits, was found to be consistent with previous reported injury rates for military parachuting. Incidence of injuries in military practice ranges from 0.22% to 0.89% in literature [13-20]. Bricknell et al. reported an average number of 5.61 injuries per 1000 jumps in their literature review of military parachuting [1].

In our study, minor injuries were more frequent than major injuries in both groups. 28.4% of the patients in SLP and 18.2% in FFP were hospitalized because of major injuries. Our hospitalization rate is also similar to that reported by Lowdon et al. as 23.5% [21].

The reason why injury rate was higher in SLP than FFP (8.6/2.6 injuries per 1000 jumps) can be explained with higher experience of parachutists of FFP. In our study groups, free fall parachutists were more experienced than static line group personnel in terms of more previous jumps and this resulted in lower injury rate. This result is also consistent with the one reported by Ekeland et al. They reported that in a military basic parachuting course, first jumps were the most hazardous ones [17].

Younger parachutists were more prone to injuries in SLP since they had less experience. As a contrast, in FFP, the number of injuries was higher in age group of 30 and over. This difference can be explained with the changes in general physical conditions of the personnel with aging. Larger groups of parachutists must be investigated to make a clear conclusion about the effect of age on
injury rates since the total number of injuries in this group was 11. However age is an important factor affecting on injury rates, there are some confusing reports in literature. Ekeland et al. suggested that injury risk in parachuting increased with age in their study [17]. On the other hand, the parachutists in 30 and older age group had 50% less injury rates than the 18-29 age group in study of Craig et al [14]. According to the authors of this study, this was probably due to more experience and the ability of senior personnel to choose the type of airborne operation they participated in with greater freedom than junior personnel.

Ankle injuries account for 30-60% of all parachuting injuries [3,6,17,19,22]. The most vulnerable site of injury was ankle in study groups, 21.9% and 27.3% respectively. The incidence increased up to 42.9% with addition of foot injuries in SLP. Most of the ankle and foot injuries were related to improper parachute landing fall, which could absorb the effects of impact to the ground. Ankle injuries are usually caused by landing sideways. Landing on an irregular surface, strong side winds and a poor parachute landing fall usually place too much body weight on one of the foot causing injury [22]. If toes are pointed, the landing force is transmitted through metatarsals, which may cause a fracture [1]. Pope et al. and Amoroso et al. conducted clinical studies to decrease the incidence of ankle injuries and they both reported that incidence of ankle injuries could be reduced by using special ankle braces with no increase in risk for other injuries [23-25]. Special attention must be paid to prevent the ankle mortise injuries as they have a higher relative frequency among other types of injuries and treatment required for these ankle injuries may become a significant medical problem.

It can be seen in our previous study that most injuries affect lower extremities with the ankle most injured site and followed by back, arm, shoulder and chest [1]. Considering injury rates by severity and by categories are essential in planning the emergency medical services for military parachuting.

The weight of the equipment carried by parachutist was another factor that affected the injury rates. More than half of the injured personnel were carrying heavy military equipment during descents. In the study of Farrow et al., it was suggested that carrying combat equipment greatly increased injury rate in military parachuting [26]. This is due to greater velocity under the canopy, increased oscillations caused by the combat equipment and harder landing of parachutists with greater sideways drift.

In our study, 95% of the injuries in SLP and 100% in FFP occurred during landing. It is well known that the majority of parachuting injuries occur during landing. Strong side winds which cause side-to-side swinging of parachutist; irregular terrain and a mistake in landing technique usually increase the shock of landing. When a parachutist hits the ground, he is subjected a downward force from gravity, sideways force from wind and possibly a rotational force if he is spinning. The combination of these forces and mistakes in technique are the common reasons of landing injuries. [1,11].

Since we used only a few variables affecting the injury rates, this study has some limitations in evaluating the injury rates in military parachuting. Other variables such as wind speed, temperature, one-door/multi-door exits, day/night jumps, features of dropping zone, height/weight of parachutist etc. are other important factors, which must be evaluated during such a study.

As a conclusion, parachuting is not as dangerous as is believed, although it has some risk of morbidity. Static line parachutists are more prone to injuries. Experience has a positive effect on decreasing the injury rate while aging has a negative effect. Most of the PRIs are landing injuries. Carrying heavy combat equipments is another important factor increasing injury rates. Ankle is the most vulnerable site for parachutist and these injuries can have a negative effect on the career of parachutist. Great attention must be paid to avoid ankle injuries and encouraging the wear of ankle braces during routine exercises especially at the very beginning of free jumps could be a reasonable approach to the solution of this particular problem.

References