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Original Article

Incidence and anatomic location of fractures resulting from static line parachuting in the Greek Army Forces: A retrospective study

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Abstract

Objectives: The incidence and patterns of parachuting fractures were investigated in Greek Armed Forces and compared to those of other studies in an attempt to assess the safety of parachuting. **Methods:** Data of 26.429 military static line parachute (SLP) jumps on 4019 paratroopers were collected by the official archive of the Greek parachuting military school during a 2 year period. **Results:** The total number of fractures was 55 in 26.429 SLP jumps. The overall rate was 2,1 fractures per 1000 descents. The fracture rate for the recruits, within the 18-30 year old group (5,3 fractures per 1000 jumps) was significantly higher (P<0,0005) than for the officers, the 30-60 year old group (1,1 fractures per 1000 jumps). Ankle fractures were the most common, accounted for 47,3% of the cases. Fracture - dislocation of the shoulder might be the new "paratroopers's fracture", which was encountered in 14,5% of the cases. **Conclusion:** We conclude that our data compares favorably with other studies except for higher rate of ankle fracture. It is recommended that a parachute ankle brace (PAB) should be worn by all paratroopers, especially those with lack of experience.

Keywords: Parachute, Paratrooper, Parachuting fracture, Ankle brace

Introduction

Military static line parachuting (SLP) is one of the main activities performed in Hellenic Armed Forces. A static line is a cord attached between the aircraft and the jumper's Deployment Bag (D-Bag), which contains the canopy. As the parachutist falls from the aircraft the static line becomes tight and pulls the D-Bag out of the container on the jumper's back. The static line and D-Bag stay with the aircraft as the jumper goes down, and is pulled back into the aircraft by the dispatcher. Without its D-Bag, the canopy should distend as the jumper continues to descend. Actually, the jumper drags the parachute placed on his back, so the canopy is forced to open and inflate by the wind. However, given the difficulty of the task, it may be accompanied by several injuries. Patients suffering injuries from parachuting are a significant burden for military hospitals. Indeed, many of them require surgical treatment, lengthy rehabilitation and may face future disability. To our knowledge, this is the first retrospective study of this kind , which has ever been conducted at a national level in the Greek Military.

Our purpose was to study the incidence of fractures after SLP and also to assess their anatomical distribution, in comparison with other studies and to assist in improving the safety of parachuting, in accordance with the protective equipment proposed by international literature.

Materials and methods

26.429 military static line parachute jumps were performed and appraised in Hellenic Armed Forces from 4 May 2015 to 4 April 2017. All descents were made using the same parachuting military uniform with a protective

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helmet and military boots from a height of 850-1000 feet at wind speeds no more than 10 knots.

The total number of parachutists was 4019. Of them, the officers were 2819 (70,1%), (>5 jumps in the past) and the rest (29,9%), the recruits, who were jumping for the first to fifth time [Table 1] (The basic training course requires 5 SLP jumps to become a paratrooper). They were both men and women. All injured parachutists were given first aid on the drop zone and then they were transported to the local military hospital for further examination, where the diagnosis of the injury was made and recorded. Data were collected by the official medical archive of the Greek parachuting military school (based on hospital's diagnosis), located in Aspropyrgos of Athens, Greece.

Statistical analysis

Data were expressed as mean±S.D for quantitative variables and as percentages for qualitative variables. Statistical analysis was performed using the Chi-square test. All tests were two-sided, a p-value of <0.05 was used to denote statistical significance. All analyses were carried out using the statistical package SPSS vr 17.00 (Statistical Package for the Social Sciences, SPSS Inc, Chicago, Ill, USA).

Results

The total number of fractures was 55 in 26.429 static line parachute jumps during the past two years. The overall rate was 2,1 fractures per 1000 aircraft exits. Most of the injured were the recruits, who suffered 32 fractures (58,2%) in 6000 SLP jumps, compared to the officers, whose fracture incidence was 23 fractures (41,8%) out of 20429 SLP descents. The fracture rate was 4.8 higher for recruits (5,3 fractures per 1000 jumps) than for officers (1,1 fractures per 1000 jumps) and this difference was statically significant (P<0,0005) [Table 1].

Furthermore, the vast majority (96,4%) of the injured paratroopers were men [Table 2], due to the short number of women who participated. Figure 1, shows the type of fracture and the anatomical location.The most common fracture/anatomical location was the unilateral ankle fracture, which accounted for 26 cases (47,3%). Twenty four of them (92,3%) , occurred on lateral malleolus and two were bimalleolar ankle fractures (7,7%) [Table 3]. No fracture was recorded for medial malleolus and talus. 8 out of the 24 lateral malleolus fractures (33,3%) were treated conservatively and the rest surgically including the two bimalleolar ankle fractures.

The second most common injury was the fracture-dislocation of the shoulder (8 cases, 14.5%). Of them, seven were associated with anterior and one with posterior shoulder dislocation. Of the six fractures of shoulder girdle, two occurred on the clavicle, two on the acromioclavicular joint and there were two fractured coracoid process. The rest types of fractures were not more than four cases for each anatomical region (1,8-7,3%). Particularly, the three metatarsal fractures (5,5%) occurred on the third to fifth metatarsal bone. There were also recorded three heel fractures, two tibia fractures and an isolated, oblique, midshaft femur fracture. About the wrist-hand anatomical region (7,3%), there were a distal radius fracture and three metacarpal fractures. Last but not least, there were one compression fracture of the 7th thoracic vertebra (T7) and a coccyx fracture.

	Officers(%)	Recruits(%)	Total
Age (Years)	30-60	18-30	
Number of paratroopers	2819(70,1)	1200(29,9)	4019
Number of SLP jumps	20429(77,3)	6000(22,7)	26429
Number of Fractures	23(41,8)	32(58,2)	55
Fractures/1000 jumps	1,1	5,3	2,1
x^2 value = 39,535 p-value< 0,0005.			

Table 1. Parachuting rates for officers and recruits.

	Number of cases	Percentage
Male	53	96,4
Female	2	3,6

Table 2. Sex of injured paratroopers (n=55).

	Number of cases	Percentage	Location	Number of cases
Unimalleolar	24	92,3	lateral	24
			medial	0
Bimalleolar	2	7,7		

Table 3. Distribution of ankle fractures (n=26).

Discussion

All military paratroopers are selected after vigorous physical and medical examination in contrast to a candidate for recreational parachuting who is expected to have only a good physical condition[1]. We found that almost half of the injured parachutists suffered ankle fractures. Such fractures account for 20-50% of all parachuting injuries in other studies[2-5]. Only Petras AF[6], found a higher ankle fracture rate of 57.7% at an army installation near Womack Army

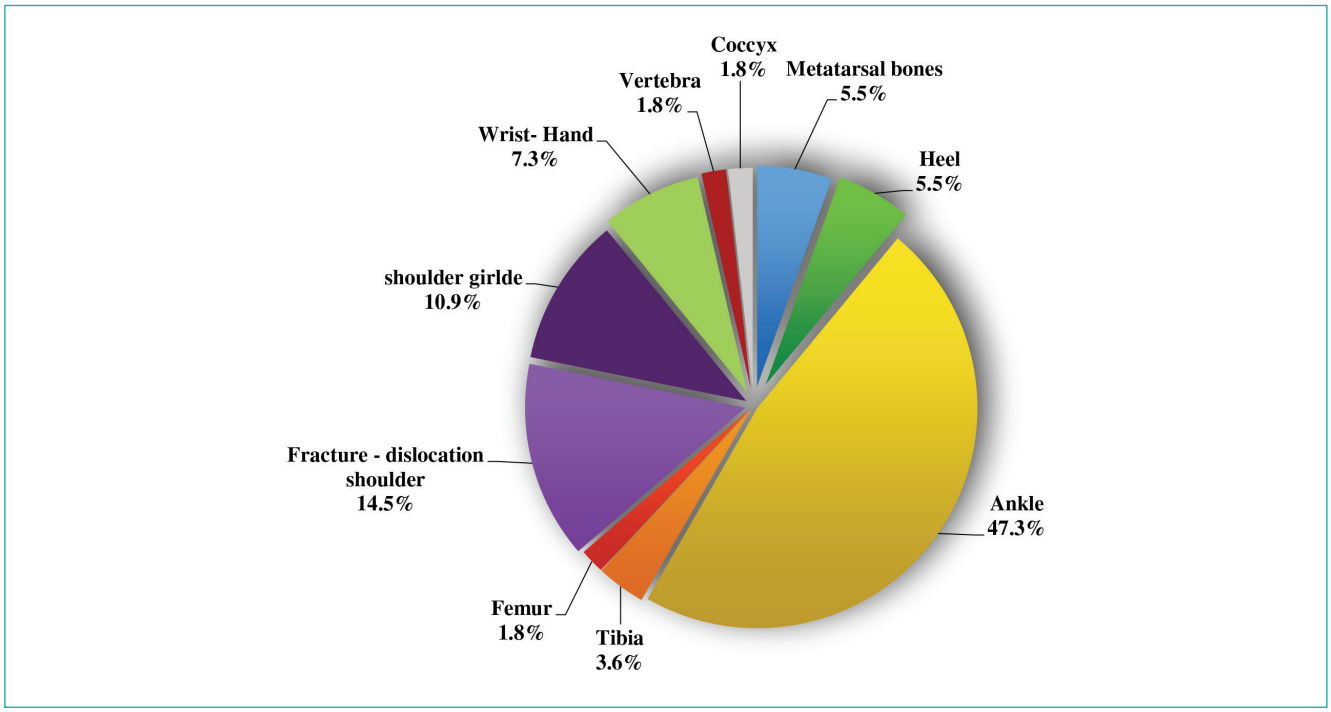

Figure 1. Anatomical distribution of fractures.

Community Hospital, in United States. Specifically, he reported a unimalleorar fracture rate of 61%, including 48,8% lateral, 4,9% medial and 7,3% posterior malleorar fractures rates. The corresponding bimalleorar fracture rate was 24,4% in his study. D Dhar[1], found a lower corresponding fracture rate of 35% at the Sultans Oman Parachute Unit. Similar observations were reported by Ellitsgaard[2], among paratroopers in Denmark.

In our study, the fracture-dislocation of the shoulder was the second most frequent injury (14,5%) and as Farrow reported[7], it might have become the new "paratroopers's fracture''. Amamilo SC et al.[4], found a lower corresponding fracture rate of 9,8% in civilians at Thruxton Parachute Club and third most frequent type of fracture in his study. Most of the fracture-dislocations of the shoulder occurred because of strong side winds which resulted in an improper landing of the parachutists, who tried to stop their falling with hands instead of keeping their legs springy at the knee, landing on feet and then throwing their self sideways (known as the Parachute Landing Fall).

Furthermore , our study suggests that the fracture risk in parachuting is higher in young parachutists, most of whom jumped for the first time. This can be explained with higher experience of parachutists over 30 years old. This was also reported by Ekeland et al. in a military basic parachuting course, where the first descents were the most risky ones[3]. Moreover, Vincent et al. concluded that the youngest age group, 20-to 29-year- olds, represented 46% of injured patients[8]. In addition, Craig et al , reported that the parachutists over 30 had about half injuries less than those occurred at the 18- 29 age group in their study[9]. In contrast, Ekeland et al. suggested that parachuting injury rate increased with age in their study[3], probably because of changes in physical conditions of the personnel as getting older. According to the authors of this study, the age factor must be more investigated, so that we can come to a conclusion.

As it is mentioned, in our study , ankle fractures represent of 47,3% cases. The incidence increased up to 58,3% including foot fractures. Most of them, were related to improper parachute landing technique[10-12]. Landing on irregular -rough surface, a poor parachute landing fall and strong side winds usually force parachutists to place more body weight on one foot resulting in injury or fracture[10]. To address the recurrence and negative effect of ankle injuries ,an outside of the combat boots parachute ankle brace (PAB) was developed to decrease the number of ankle injuries .The PAB (Aircast) consisted of a hard plastic outer shell lined with air bladders, which padded the medial and lateral malleoli, to prevent extreme ankle inversion and eversion but allowing plantar flexion and dorsiflexion[13]. Luippold et al. and Schmidt et al., carried out clinical studies to reduce the incidence of ankle injuries and they concluded that PABs can accomplish that with no increase in risk for other injuries[13,14]. Schmidt et al.[13], also

reported that brace wearers had 50% lower ankle injuries than those not wearing a PAB in an Airborne training school. Finally, he highlighted that the use of the PAB could have reduced the rate of ankle fracture from 11% to 4,5% in US Army during Airborne School training in 2002. Moreover, another study showed that ankle sprains were reduced by 85% among 745 soldiers who had worn the PAB at US Army Airborne School[15]. Additionally, in a systematic review of Knapik et al.[16] found that the incidence of ankle fracture was 55% lower among those wearing the brace. Furthermore, Schumacher, J.T.[17], reported 35 ankle injuries, including 9 ankle fractures, without using the PAB in contrary to 9 ankle injuries, including only 3 ankle fractures, using the PAB. On overall, the rate of ankle injuries, particularly fractures and sprains, has been reduced because of the use of the PAB which strengthens the stability of the ankle joint and associated bones and prevents extreme ankle inversion/eversion on ground impact, as well as by increasing sensory consciousness. These and other compatible findings clearly indicate that using the PAB is not only a cost effective innovation that reduces the incidence of ankle injuries/ fractures during military parachuting by about 50%, but also can minimise unnecessary medical expenses[14,16]. Specifically, as Knapik et al. reported, "cost effectiveness analysis estimated that, for every dollar expended on the PAB, a savings of about $7 to $9 could be achieved in medical and personnel costs"[16]. Furthermore, Schmidt et al.[13] calculated that the purchase of the braces was remarkably worthy because a saving of over $800,000 per year was made from hospital care and rehabilitation costs. On the other hand, Knapik et al. noted that the PAB provides lateral support and may be able to decrease ankle fractures owing to extreme lateral movement but not fractures due to perpendicular collisions , those in which the axis of the body undergoes excessive force[18]. Lastly, a study was made to find out where the PAB is most prone to breakage because of its short life expectancy, concluding on the heel strap[19].

In conclusion, ankle is the most vulnerable site for a paratrooper and these fractures can have negative effect on the career of the parachutist [10]. Findings from our study, recommend that parachute ankle brace (PAB) should be worn by all paratroopers[20,21], especially the young ones, who are more prone to injuries. As far as we know , PAB has not been adopted by Hellenic Armed Forces yet. The average cost of PAB in USA is $65 per pair. Last but not least, PAB is cost effective, it will decongest the military hospitals and according to international literature, in turn, can reduce public health expenditure[22].

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