Paragliding injuries*

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Regulations controlling the sport of paragliding were issued in April 1987 by the German Department of Transportation. The growing popularity of this sport has led to a steady increase in the number of associated injuries. This study presents the incidence, localization and degree of injuries associated with paragliding documented in Germany, Austria and Switzerland.

The 283 injuries suffered by 218 paragliders were documented in the period 1987–1989: 181 occurred during landing, 28 during starting procedures and nine during flight. The mean patient age was 29.6 years. There were 34.9% spinal injuries, 13.4% upper extremity injuries and 41.3% lower limb injuries. Over half of these injuries were treated surgically and in 54 instances permanent disability remained.

In paragliding the lower extremities are at greatest risk of injury during landing. Proper equipment, especially sturdy footwear, exact training in landing techniques as well as improved instruction in procedures during aborted or crash landings is required to reduce the frequency of these injuries.

Keywords: Paragliding, hang-gliding, paragliding-related injuries, treatment

Paragliding is defined as a sport using a single seater, non-motorized, flexible aircraft that is steered aerodynamically and able to start from ground level without requiring a free-fall phase. On 15 April 1987, the then Federal Republic of Germany passed guidelines regulating the sport of paragliding.

The paraglider, an advanced form of the parachute, consists of an upper and lower sail, with 'ribs' dividing it into numerous separate compartments that are stabilized by air pressure. With the help of two steering lines attached to the rear corners of the 'chute, accurate manoeuvres are possible. Paragliders are easily transportable, cheap forms of aircraft that are experiencing growing popularity.

The spread of paragliding has led to an increase in associated injuries. In the documentation centre in Braunschweig, Germany, a twofold increase in paragliding-related injuries was documented between 1987 and 1989.

The goal of the collective study by *Gesellschaft für Orthopädisch-Traumatologische Sportmedizin* (GOTS) was to analyse the dangers, frequency of injury, typical injury patterns and possible preventive measures related to the sport of paragliding.

Figure 1. Age distribution of injuries associated with paragliding (n = 218)

Patients and methods

During the period 1 January 1987 to 31 December 1989, 218 cases of injury suffered during paragliding were documented with the help of a standardized questionnaire in Germany, Austria and Switzerland. The mean age of the patients was 29.6 years, with the youngest being 15 and the oldest 59 years of age. The age distribution is shown in Figure 1; 37 were women and 181 men.

The questionnaire included information regarding the flight phase during which the injury occurred, patient data, type and site of injury, treatment and final results.

Results

Twenty-eight injuries were suffered during take-off, of which an abandoned start was the cause in 17 instances. In only nine cases did the injury occur during flight, usually through contact with high-tension wires, trees or cliff walls. The majority of injuries were suffered during planned or emergency landings – affecting 181 paragliders (83%).

Of the 218 reported cases, 159 (73%) patients suffered single injuries, 59 (27%) multiple injuries. A total of 283 injuries were documented, two of which

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(one head trauma, one fracture-dislocation of the cervical spine) resulted in death.

The lower extremities were affected in 41.3% of the cases, 34.9% had spinal involvement and 13.4% were localized in the upper extremities. The most frequently involved region was the ankle joint, making up for 60 reported injuries or 21.2% of all injuries. Injuries of the calcaneus were reported in 5.7% of all accidents (eight fractures, one bilateral) and one contusion. The knee was involved in only eight injuries (five ligamentous, two fractures of the tibial plateau and one soft tissue injury).

Spinal injuries include 61 fractures of the lumbar spine with ten associated neurological complications, one fracture-dislocation with neurological problems, and two contusions. The thoracic spine was involved in 27 instances (25 fractures, combined with paraplegia in three cases, and two contusions). Of the five

Table 1. Site, type and neurological complications of spinal injuries ($n = 99$)

Site	Type	<i>n</i>	Complications
Cervical spine	Fractures	4	One death
	Fracture-dislocations	1	
Thoracic spine	Fractures	25	Three neurological complications
	Fractures	25	
Lumbar spine	Contusions	2	Ten neurological complications
	Fractures	61	
	Fracture-dislocations	1	
Sacrum	Contusions	2	One neurological complication
	Fractures	3	

Table 2. Involvement of the upper extremity

Acromioclavicular joint separation	1
Shoulder dislocation	5
Rotator cuff injuries	2
Fracture-dislocation of the elbow	2
Elbow soft tissue injuries	2
Combined fractures of radius and ulna	2
Distal radius fractures	13
Carpal fractures	4
Metacarpal fractures	4
Thumb	3
Total	38

Table 3. Number and type of ankle injuries associated with paragliding and their treatment ($n = 60$)

	Type of injury		
	Ligamentous	Fractures	Fracture-dislocations
Treatment			
Conservative	11	4	—
Operative	19	14	12
Total	30	18	12

injuries of the cervical spine, the one fracture-dislocation of C1–2 was fatal, while the other four fractures did not show neurological involvement (Table 1).

The upper extremities were involved in only 38 (13.4%) of all cases (Table 2).

The relatively low number of head injuries, 15 in all, consisted of seven cases of concussion (one fatal), four fractures and four soft tissue injuries.

The majority of injuries were treated surgically (Figure 2): ankle 75%, calcaneus 56%, spinal 30%. Treatment of the 60 ankle fractures and ligamentous injuries are shown in Table 3.

The outcome in regard to return to athletic activity (Figure 3) shows an almost 70% return to paragliding.

Operative treatment ($n = 158$)

Figure 2. Form of treatment of injuries associated with paragliding ($n = 283$)

Figure 3. Status following injuries associated with paragliding ($n = 218$)

Discussion

Owing to the relative novelty of the sport of paragliding, few injury studies have been carried out. Lang¹ (Austria) and Reymond² (Switzerland) pointed out that a majority of all injuries occurred during the landing phase primarily as a result of forceful landings caused by the pilot's inability to adjust to abrupt changes in the thermals and wind conditions, as well as technical errors during this phase of flight. These problems are frequently accentuated by uneven terrain, unexpected obstacles and forced land-

ings in unfamiliar areas. In contrast to our results, Geyer³ showed in his study of 48 paragliding-related injuries that 38% of the trauma occurred during take-off and only 32% during landing.

During the landing phase, large axial compression forces bear on the paraglider on ground contact. This predisposes to compression fractures of the thoracic and lumbar spine and calcaneus. Ankle injury is due to a combination of compression and rotation forces such as pronation/supination. This frequently causes combined injuries (Table 3)¹. These injuries can occur during take-off as well as landing and inappropriate footwear is at least partly responsible.

Injuries during flight are usually due to sudden changes in wind or thermal patterns, leading to crashes into cliffs, trees or other obstacles. These crash landings led to a large number of the soft tissue injuries, some severe fractures of the skull and upper extremities as the pilot tried to protect himself.

We disagree with Geyer³, who does not believe in a typical paragliding injury. Our results show that the injuries seen in paragliding are typically of the spine, the ankle joint and the calcaneus. This is in contrast to hang-gliding, in which the associated injuries, as reported by Tongue⁴ from California, are to be found in 31% of the cases in the upper extremities, in 23% in the lower extremities and in only 17% of the instances in the spinal column. Mang⁵ reported 106 injuries associated with hang-gliding, of which 25 resulted in the death of the pilot. In comparison, only two deaths were documented in this series of 218 paragliding injuries, but there were 14 neurological complications associated with these spinal injuries, showing the perils of paragliding.

A report from the *Arbeitsgemeinschaft Deutscher Querschnittszentren*, a German organization of spinal trauma centres, covering injuries leading to paraplegia in the period from 1981 to 1989, revealed that 11 such injuries were associated with paragliding, 14 with hang-gliding and 12 with parachuting. The

majority of the paragliding injuries were localized in the lumbar spine. In hang-gliding trauma, seven each involved the cervical and thoracic spine, while the lumbar spine was not affected.

The axial compression loading injuries can be reduced by improved knowledge of the terrain and better landing techniques. Trauma of the ankle joint caused in this way can only be reduced by the use of sturdy shoes that enclose the whole joint, as has been previously recommended by other authors^{1-3,6}. Additionally, the paraglider should be required to wear protective gloves and a helmet. He should not be permitted to start until practical lessons, especially in the form of flight and landing practice, and theoretical training, which should include a comprehensive study of winds, thermal principals and local conditions, have been successfully completed.

We conclude that injury rate and severity can be reduced by improvements in training and equipment. One study⁶ has shown that the more experienced pilot has a more daring flight style and is more likely to take risks.

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Announcement

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