Light Aircraft Crash – A Case Analysis of Injuries

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Abstract

Background: As air travel increases and the number of commercial and non-commercial flights rises, so does the number of aircraft accidents. The improved safety standards of the aviation industry result in a growing number of survivors of aircraft crashes, but there are no management guidelines for the treatment of these survivors.

Objectives: To present our experience in treating five survivors of a light aircraft crash that occurred in August 1995 near Jerusalem.

Results: All five survivors sustained vertebral column injuries, which was the only injury in most of the survivors. We discuss the mechanism of injury.

Conclusions: Investigation of injuries' pattern in survivors of aircraft crash is important for establishing management protocols in trauma centers.

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Transportation disasters have become one of the main factors contributing to mortality and morbidity in our era [1]. Air travel is a major mode of transportation; however, although the risk of death per kilometer traveled in a modern aircraft is lower than in other transportation modes, the sudden loss of hundreds of lives has a much greater impact in the media than a similar number of victims killed on the roads.

The injury pattern for several aircraft disasters has already been analyzed. Three of the most famous cases were the Continental Flight 1713 in Denver Colorado in 1987 [2], the Courvair 340/580 in Norway in 1989 [3], and the Boeing 737-400 crash during an emergency landing on the M1 Motorway at Kegworth between Leicester and Nottingham in Britain in 1989 [4]. With the number of commercial and non-commercial flights increasing we may face an increase in the number of flight accidents. Pilot characteristics [5,6] and medical factors affecting the pilot [7] have already been emphasized as factors contributing to aviation accidents. However, advanced safety standards executed by staff [8] as well as the passengers' equipment may lead to rising numbers of survivors. Another reason for further data collection, according to the survivors' injuries pattern, is to be better prepared for such events in order to improve patients' outcome.

Methods

Accident description*

On 18 August 1995 a light single engine aircraft, model PA-32-R-300 Lance, crashed a short time after take-off from Atarot international airport near Jerusalem. On board were the pilot and five passengers. The plane crashed after falling from a height of approximately 100 feet, about 10 seconds after the landing gear was retracted. While crashing, the cabin of the aircraft was at an angle of approximately 20^{o} above the horizon, which means that the rear part of the aircraft initially made contact with the ground. Later on, the front of the aircraft hit a large rock on the right side that rotated the aircraft to the right before finally stopping.

Injury analysis

Figure 1 shows the position of the passengers in the aircraft. At the moment of the crash, the pilot and the passenger sitting next to him were equipped with a three-point lap and shoulder harness system, while the other four passengers had lap belts only. The two middle seats (of the six passenger seats) were facing backwards.

One passenger (N.R.), a 55 year old woman, sustained a severe closed head injury but no other injuries. She was found unconscious, and was brought intubated to our trauma unit. Brain computerized tomography revealed subdural and epidural hematomas. Brain death was determined 24 hours after admission. No autopsy was performed, but her liver, kidneys and heart were harvested for transplantation with no evidence of thoracic or abdominal trauma.

The pilot (K.Z.) was transferred to another hospital in Jerusalem. The other four passengers were admitted to our trauma unit. All five survivors sustained vertebral fractures. Table 1 summarizes the passengers' injuries. The fatality was the only passenger without apparent spine injury. None of the passengers suffered abdominal trauma, pelvic fractures or fractures of long bones.

Discussion

Aircraft accidents are the main cause of transportation disasters causing death and severe injuries in the last decade [9]. The chances of survival in a crash due to a standard failure or explosion at a high altitude are negligible [3]. However, crashes predominantly occur on take-off or landing [2,10]. During landing the aircraft's speed is relatively low (100–150 mph). When the crash is not complicated by explosion or fire this fact may result in a significant number of survivors [2]. Other factors that may influence the severity of the crash are shown in Table 2.

The mammoth efforts invested in the airline industry towards safety may contribute to an even higher percentage of survivors in

* The accident was investigated by Mr. U. Dayan, a certified investigator of civil aircraft accidents in the Israeli Civil Aviation Administration.

Table 1. Passengers' injuries

No.	Name	Gender	Age	Injury	A-O Class	Neurologic status	Treatment
1 – the pilot	K.Z.	M	53	Burst fracture L1 Burst fracture L4	B-1 A-3	Paraplegia L1	ASF plating T12-L2 PSF (Pedicle screw fixation) T11-S1
2	Z.M.	M	58	Flexion distraction injury T12-L1	C-2	Complete paraplegia L1	Decompression PSF (Pedicle screw fixation) T11-L2
3	N.U.	M	59	Burst fracture L4 Burst fracture L5	A-3 A-3	Intact	Non-operative
4	N.R.	F	55	Severe closed head trauma, subarachnoid + subdural hematomata		GCS -3	Hyperventilation. Died
5	Z.T.	F	54	Burst fractures T12, L1, compression fracture T11	A-3 A-3 A-1	Mild left leg weakness	Decompression PSF (Pedicle screw fixation) T8-L2
6	K.O.	F	53	Burst fractures T6, T7, compression fractures T10-T11	A-3 A-1	Intact	PSF (Pedicle screw fixation) T3-T10

The first two, the pilot and the passenger sitting next to him, were wearing a three-point lap and shoulder harness. (The other four passengers had lap belts).
ASF = anterior spine fusion, PSF = posterior spine fusion, GCS = Glasgow Coma Score.

Table 2. Factors influencing severity of crash*

No.	Factor	Influence
1	Speed	Direct ratio
2	Weight of aircraft	Direct ratio
3	Angle of ground touch	Direct ratio
4	Ground characteristics	Soft ground (sand) may absorb part of the crash energy
5	Aircraft body structure and design	Determines aircraft's ability to absorb crash energy
6	Natural obstacles at crash site (trees, lake, etc.)	

* According to the Israeli Civil Aircraft Administration.

the future. In addition, the modern traumatologist may face survivors of other "air-vehicles" that may crash, like ultralights and hot air balloons [11].

Our study analyzed a light aircraft crash where five of the six passengers survived, sustaining severe vertebral column injuries. In four of the five survivors this was the only injury; one patient (Z.T.) also had a sternal fracture and a rib fracture.

By drawing an oblique line through the aircraft body [Figure 1], we can divide the passengers into two groups. Group A comprises the severely injured passengers (one dead, the other two paraplegic), whereas in Group B the injuries were less severe. The passengers who were sitting at the front on the right-hand side of the plane (Group A) received most of the crash energy because of

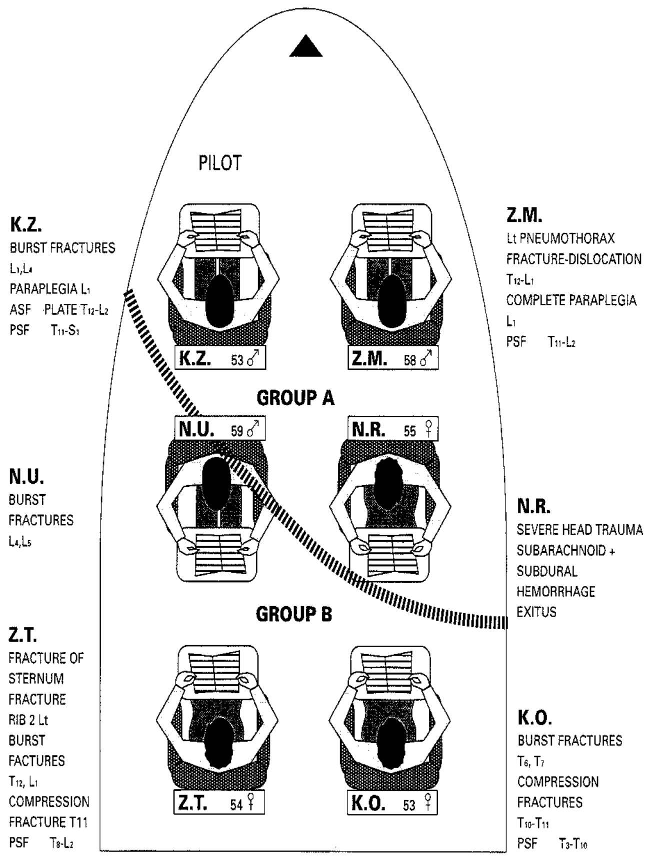

Figure I. Sitting position of the passengers in the aircraft
PSF = posterior spinal fusion

the collision with the rock on this side. The pilot and the passenger sitting next to him wore a three-point lap and shoulder harness. The third member of Group A (N.R.) was sitting facing backwards. The three passengers in Group B wore lap belts only. Their injuries were less severe, and none of them had significant neurologic sequelae.

These findings contrast with the conclusions of Lillehei and Robinson [2] and others [4], who identified the three-point lap and shoulder harness system, and sitting facing backwards, as protecting factors in injuries resulting from the Continental flight crash. It seems that in the case described here, these protecting factors were inadequate in the face of the high energy collision with the rock on the right-hand side of the plane, which proved to be the most significant factor for injury severity in the various passengers.

As previously mentioned, the landing gear was already retracted during the accident, so the crash energy was transmitted directly to the passengers, through the body of the aircraft from the bottom going upwards along the axial skeleton. This fact explains the vertebral column injuries in most of the passengers. As in our case, vertebral column injuries are relatively common among victims of airplane crashes [3], survivors of crashes [2,4], and among military pilots ejecting from their aircraft [12]. Surprisingly, in our study there were no injuries, usually common in such instances, like blunt abdominal trauma, severe chest trauma, pelvic fractures and limb fractures [2,3].

Finally, much attention should be paid to the transferring of survivors of such crashes to a well-equipped trauma center. The high percentage of vertebral column injuries emphasizes the need for a center with an experienced orthopedic and neurology staff. Additional data on light aircraft crash survivors' injury may improve our understanding on expected injury patterns in these circumstances.

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