Vertebral Fractures in Gnat Ejections

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Abstract

VERTEBRAL fractures constitute the most serious medical problem associated with a successful ejection. Cervical vertebral fracture is of particular importance as it causes a pilot to be permanently unfit for ejection seat aircraft. Three cases of cervical vertebral fractures after ejection from Gnat aircraft are reported. The causative factor has been head-neck flexion during ejection. Problems of postural inadequacies in Gnat aircraft have been discussed and recommendations made.

Introduction

Ejection seat is a significant life saving device in military aviation. The paramount consideration continues to be saving life but ejection injuries have attracted wide probing and research. Vertebral fractures constitute the most serious medical problem associated with successful ejection. Of all the vertebral fractures involvement of cervical/upper thoracic vertebrae is a catastrophe.

The incidence and frequency of vertebral fractures in successful ejections in IAF has been described by Verma[4]. Vertebral fractures in Gnat ejections are of particular interest and have been reviewed in this paper. Probable mechanism of such fractures and remedial measures are suggested.

Incidence and frequency of Vertebral Fractures

The incidence and distribution of fractured vertebrae in successful ejections in IAF is shown in Table I. It is of interest to note that in Gnat ejections the vertebral injuries are confined to C4–C5 and T4 only.

Vertebral fractures in Gnat-ejections

There have been three cases of spinal injuries in Gnat ejections (Tables II & III).

Case No : 1

Pilot 'A' was flying a Gnat aircraft on an air test sortie. Two minutes after take off at 8000 ft. AGL fire warning light came on, along with oil pressure failure doll's eye turning white. He carried out emergency drill with no improvement in the situation and decided to eject. From the time emergency was noticed till he ejected about 45 seconds lapsed. He had enough time to transmit his intention to eject, align properly and pull his visor down. As he was about to pull the overhead blind firing handle (OBFH) he heard an RT call "confirm ejecting". He left the OBFH, reached for 'press to transmit' (PTT) button and acknowledged the call in affirmative. In the meantime the aircraft was going out of control. He again reached for the OBFH and pulled it. He recollects that the visor knob was obstructing smooth operation of OBFH. As he pulled the handle the head was flexed due to the obstruction caused by the apron of the OBFH. He was sitting in seat position 2, one notch higher than appropriate for his sitting height for operational reasons.

He sustained fracture C4 and C5 vertebrae with paresis of upper arms. He was grounded for 2½ years and declared permanently unfit for ejection seat aircraft. He is now a helicopter pilot.

Case No : 2

Pilot 'B' was flying Gnat aircraft and practising forced landing. He noticed fumes in the cockpit. He had ample time at his disposal once he decided to eject. He aligned properly and used the OBFH.

He sustained fracture T4 vertebra. He was declared permanently unfit for ejection seat aircraft and is now a transport pilot. On review at IAM he was also found to have sitting height 2.5 cm more than the maximum permitted for Gnat aircraft.

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Case No. 3

Pilot 'C' flying Gnat aircraft had inflight fire. He ejected at 25000 ft. He remembers having pulled the canopy jettison handle with one hand and pulled the OBFH with the other.

He sustained fracture C5. He was declared permanently unfit for ejection seat aircraft and is now a transport pilot.

Mechanism of injury

Incidence of spinal injuries during ejection is increased by :

(a) Amplification of ejection forces

(b) Postural inadequacy

In Gnat aircraft, Folland light weight seat Type 2G is installed. The ejection gun is designed to impart an ejection velocity of 60 feet per second and a peak acceleration of 20 g. A contoured fibre glass (rigid) personal survival pack is used with a thin cushion on top, thus excluding any acceleration overshoot. It is unlikely that spinal fractures of the above cases have been contributed by the amplification of ejection forces.

In the cases described, the injuries are most likely due to postural inadequacy, on account of neck flexion. The fulcrum for total neck flexion lies between T5 and T4 vertebrae[2] thus making this region more vulnerable.

Problem of postural inadequacy in Gnat aircraft

The cockpit is small and relatively cramped. Maximum sitting height permitted is 90 cm after a cockpit test. The restrictions are based on clearance from canopy, ease of reaching OBFH and visibility of air speed indicator (ASI). Due to the seat incline it is accepted by many pilots that if correct seat position is chosen (a) over the-nose visibility is grossly restricted and (b) eye alignment with the gun sight is easily lost under positive 'G' due to head flexion. Therefore many pilots prefer to sit higher than the position corresponding to their sitting height, which leads to a situation, where the OBFH is considerably below the level of the bonedome.

In extreme cases (tall pilots) it is known that clearances accepted are a compromise with the ideal situation even when the individual is seated in the lowest seat position. Fouling of canopy by the visor knob under certain flight conditions has also been reported. Obviously in such cases use of OBFH will either load the vertebral column or cause neck flexion. Visor knob is instrumental in worsening the situation under such conditions.

Role of overhead blind firing handle :
Forced head Flexion

Face blind was designed to afford (a) wind blast protection and (b) prevent head flexion during the early phase of ejection. The onus of keeping the head fully back is with the pilot at the time of pulling the OBFH. Should the head be flexed or flexion be forced at the time of pulling the OBFH, no amount of effort on the pilot's part is of any avail in keeping the head back on the head rest. If the crest of the bonedome is high, on pulling the OBFH the friction between the face blind and the bonedome will result in head being pulled forward and down, even though the pilot re-positions his head on the head-rest. The travel of the face blind over the helmet tends to catch upon the visor knob which further aggravates the head flexion. This is a significant consideration as neck flexion will pre-dispose injury to vertebrae from C4 to T4 level. In Gnat aircraft in the cases reported face blind handle has thus been responsible for inducing head-neck flexion and consequent vertebral fractures.

Prevention

There has always been a controversy[1] regarding which handle to use OBFH or SPH, (fig. 1). OBFH initiation provides protection to head and face and head restraint during ejection. Whenever speed is high and retention of helmet/mask is essential, as at high altitudes, use of this handle is advantageous. The disadvantages are :

Pilot sitting high in relation to OBFH may flex his head to locate, extract and pull the handle.

Pulling the OBFH may cause friction between the face blind and helmet and would induce forced flexion of head.

The face blind may catch on the visor knob which will further aggravate the head flexion.

TABLE I

Frequency of fractures of individual vertebrae among survivors of ejections (Aircraftwise)

Aircraft type	Vampire	Toofani	Mystere	Gnat	Hunter	Marut	T-74	T-77	S-22	Canberra	Total	Percentage
Survivors	6	8	18	17	20	3	2	4	14	2	105	
Spinal injuries	1	—	3	3	7	1	2	6	7	2	32	30.3
C4	—	—	1	1	—	—	—	—	—	—	2	3.63
C5	—	—	1	2	1	—	1	—	—	—	5	9.09
T4	—	—	—	1	—	—	—	—	—	—	1	1.82
T5	—	—	—	—	—	—	—	—	1	—	1	1.82
T6	—	—	—	—	—	—	—	—	—	1	1	1.82
T8	—	—	—	—	—	—	—	—	3	—	3	5.45
T9	—	—	—	—	—	—	—	1	2	—	3	5.45
T10	—	—	—	—	1	—	—	—	2	—	3	5.45
T11	—	—	—	—	3	—	—	—	2	—	5	9.09
T12	—	—	1	—	6	—	1	3	3	—	14	25.45
L1	1	—	1	—	5	1	—	—	4	1	13	23.63
L2	—	—	—	—	—	—	—	1	—	—	1	1.82
L3	—	—	—	—	—	—	—	—	—	—	—	—
L4	—	—	—	—	1	—	—	1	—	—	2	3.63
L5	—	—	—	—	—	—	—	1	—	—	1	1.82
Total	1	—	4	4	17	1	2	7	17	2	56	99.95

TABLE II

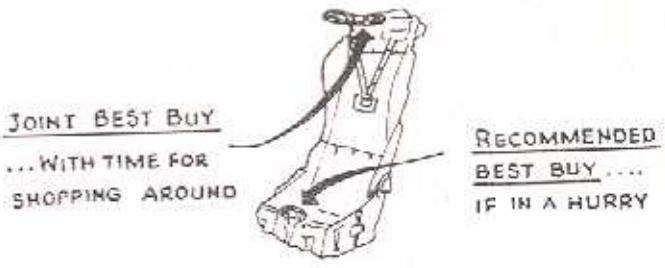
Data on Gnat ejections in IAF : 1957–72

Total ejected 23	Fatal 6		
	Successful 17	No injury 11	
		Serious injury 6	Spinal 3
			Non-spinal 3

TABLE III

Spinal injury

Case No.	Handle used	Body alignment	Injury	Disposal
1	OBFH	YES	C4,C5	Permanently unfit for ejection seat aircraft
2	OBFH	YES	C5	
3	OBFH	YES	T4	Fit for transport/ Helicopter only



Which Handle ?

FIG. 1

Once the head is flexed, pilot cannot reposition the head on the head rest due to a loading by the face curtain.

Overhead handle touching the bone dome causes distraction in flight.

Visor has to be kept down prior to ejection. High positive 'G' or injury prevents use of over head handle.

When canopy is jettisoned OBFH flutters and hits the bone dome.

Advantages of the seat pan handle (SPH) are :

Easy to reach, even under high G conditions.

Does not cause head/neck flexion. Statistics do not show any increased incidence of back injuries when SPH is used.

Quicker method of ejection initiation.

Specially suitable for ejection initiation in certain conditions of flight eg : spin, low speeds.

Recommendation

It is recommended that in Gnat aircraft the OBFH be removed, leaving SPH as the only means of initiating ejection. Thus there will be a uniform ejection drill for all emergencies thereby reducing the delay in initiation of ejection. Incidence of cervical vertebral fractures can be possibly eliminated. It may be mentioned that the Ajeet aircraft (MB seat) has only seat pan handle - an appropriate choice to make the ejection safe.

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