Aircraft Ejection Injury Patterns and Trends I. A. F. - 1957 to 1972

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Analysis of Ejection injuries for various types of aircraft in use in I.A.F. is presented for a period of fifteen years. 28.6% of the total ejections were fatal. All the five cases of through canopy ejections were fatal. Injuries are further analysed as spinal and non-spinal and the data given.

The first of the aircraft equipped with ejection seat to be introduced in I. A. F. was Vampire T-55. This aircraft was put into I.A.F. use in 1953. Later the same year Toofani (Oregon) fighter was also introduced. First ejection in I.A F. took place on 3 April 1957 from a Toofani (Oregon) when the pilot found that he could not recover from a spin. Inclusive of this ejection there have been total 147 ejections till November 1972. As a matter of interest in ejection pathology, the authors undertook to review all the ejections for patterns and trends of injuries sustained by the ejectees. The data was collected from records available at Flight Safety Directorate.

The computed yearwise survival rates versus total ejections for all aircraft are given in Table I. It shows that 100% successful ejections took place in the years 1957, 1958, 1963 and 1966. The lowest survival rate of 37.5% prevailed in 1960.

With the introduction of different types of high performance supersonic aircraft, despite two of them having ground level ejection capabilities the survival rate since 1968 has shown a downward trend. Nevertheless, it could be observed that ejection survival rate of 1971, despite the December operations, was 69.2%, better than six other years of the 16 years reviewed. This was also the case when a survival rate of 84.6% was obtained in 1965. The final fatality rate for all the years is nearly 29%, i.e. about twice the figures in RAF and USAF. The principal cause has been ejecting out of seat ejection envelope due to delay in initiating ejection even when available time was more than 20 seconds.

There were 5 cases of through canopy ejection (Table II). None of them survived because the aircraft canopy and the ejection seats were not meant for this purpose. Except for the ejection from Vampire T-55, other 4 cases were inadvertent in nature. The former was a voluntary action on the part of the pilot as canopy could not be jettisoned while the aircraft was in unrecoverable spin. The central rigid canopy

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member fouled against the seat, generated rotary forces that caused fractures of the pelvis and sacrum during the ejection phase. The drogue container had been damaged on impact against the canopy plexiglass. However, death was caused because the R/T cord had wound about the neck. It is of interest to note that

TABLE—I

Yearwise survival rate (All aircraft)

Year	Ejections	Successful	Survival %	Fatality %
1957	1	1	100	0
1958	3	3	100	0
1959	6	3	50	50
1960	8	3	37.5	62.5
1961	4	3	75	25
1962	8	5	62.5	37.5
1963	6	6	100	0
1964	9	7	77.7	22.3
1965	13	11	84.6	15.4
1966	7	7	100	0
1967	10	9	90	10
1968	12	8	66.6	33.4
1969	12	8	66.6	33.4
1970	11	8	72.7	27.3
1971	26	18	69.2	30.8
1972	11	5	45.5	54.5
Overall	147	105	71.4	28.6

neither the skull nor the cervical vertebrae were fractured. All the other cases suffered skull and cervical vertebrae fractures.

Survival Rate and Serious Injuries

Aircraftwise analysis of the survival rates and serious injuries is given in Table III.

Fatality rates in both Toofani and S-22 have been alarmingly high. Causative factors in both have been different; nevertheless delayed ejection has been the principal cause. In Toofani the lengthy pre-ejection drill followed by manual operation of rip cord have had the effect of accentuating the delay factor. In S-22, despite ground level capabilities for the ejection seat, the pilots delayed ejection as has been the trend in IAF generally. High mortality rate in Hunter aircraft also is noticeable for generally the same reasons. The aircraft with least mortality rate among the ejectees and also the least serious injury rate is found to be the Mystere. Survival rate has been 95%. One case of mortality is due to technical defect in the aircraft. Ejections from the Canberra have been too few to place reliance on the mortality rate figures, yet the fact of two mortalities in one aircraft emergency having taken place due to ejection almost at deck level has been brought out in the proceedings of the inquiry board.

Non-spinal Injuries

Twelve cases out of 105 successful ejections (11.4%) suffered various types of minor and major non-spinal injuries during phases of ejection, descent and parachute deployment. (See Table IV)

TABLE—II

Inadvertent/Accidental Through canopy ejections

Aircraft	Year	Number	Principal injuries	Outcome
Hunter	1959	1	Fracture skull	Fatal
Gnat	1961	1	Fracture skull, lacerated wound neck, open wound chest and abdomen.	Fatal
Toofani	1962	2	Fracture cervical vertebrae	Fatal
Vampire T 55	1968	1	Fracture symphysis pubis, separation right sacroiliac joint, linear fracture along the right sulcus sacrum. Fracture C7 left transverse process, separation of C7 from T1. Section of the cord.	Fatal

TABLE—III

Survival and serious injury rates (Aircraft wise)

Aircraft	Total ejected (N1)	Fatal	Survival (N2)	PERCENTAGES Survival	N1 Fatal	N2 No injury	N2 Serious injury	N2 Seriously injured	N2 Not injured
Vampire	7	1	6	85.7	14.3	83.3	16.7	1	5
Toofani	15	7	8	53.3	46.7	87.5	12.5	1	7
Mystere	20	1	19	95.0	5.0	84.2	15.8	3	16
Gnat	23	6	17	74.0	26.0	64.7	35.3	6	11
Hunter	32	12	20	62.5	37.5	60.0	40.0	8	12
Marut	3	0	3	100.0	-	33.3	66.7	2	1
Type 74	2	0	2	100.0	-	-	100.0	2	0
Type 77	20	6	14	70 0	30.0	28.6	71.4	10	4
S-22	21	7	14	66.7	33.3	42.9	57.1	8	6
Canberra	4	2	2	50.0	50.0	-	100.00	2	0
Total	147	42	105					43	62
Accumulated percentages		28.6%	71.4%					41.0%	59.0%

TABLE — IV

Non spinal injuries (Survivors)

Injury Types	Total	Face F	Face N	Face C	Face L	Neck	Chest	Groin	Long bones of upper limb O	Long bones of upper limb H	Long bones of upper limb R	Hip Joint
Abrasions Contusions etc.	15	1	1	1	2	7	2	1				
Fracture	4								1	2	1	
Dislocation	1											1
Total	20			5		7	2	1		4		1

LEGEND - F - Forehead
N - Nose
C - Chin & Cheeks
L - Lips
O - Olecranon
H - Humerus
R - Radius

One case sustained fracture of left radius and dislocation of left hip joint as a consequence of spontaneous activation of ejection seat on impact. This pilot survived as there were neither any other injuries nor post crash event of fire. The ejection seat rose up but could not leave the aircraft due to structural distortion of the guide rails and beams.

Aircraftwise distribution of the non-spinal injuries is given in Table V.

Spinal Injuries

Occurrence of injuries to spinal column, as a result of ejection, among the survivors is common to all the aircraft. Spinal injuries are caused due to problems of postural inadequacy and ejection force amplification. The incidence of spinal injuries in our series is shown in Table VI.

On overall considerations for all the aircraft the well known fact of propensity to injury of thoraco-lumbar junction (T 12–L1) is established as nearly 50% (49% in actual). Aircraftwise, however, there are interesting features with respect to Hunter, Type-77 and S-22. Both Hunter and S-22 have an upward spread of fractures while Type-77 has a downward spread. The spread in Hunter ejections is significant upto T10 while that of S-22 extends upto T8. Weakness of T 12 in Type 77 ejections can be seen clearly as also in the case with Hunter aircraft, while that in S-22 is almost the same for T8 through L1. L3 was never fractured in any of the ejections. In the case of the Gnat T4 was fractured alone in one ejection. This lonely fracture is due to neck flexion during ejection in this case because the fulcrum of total neck flexion lies between T3 and T4 (Latham 1957).

Incidence of simultaneous multiple fractures in an ejection is not a matter that can be brushed aside light heartedly. The vertebrae of the spinal column have very

TABLE—V

Aircraft wise contribution of non-spinal injuries

Injury Types	Aircraft contribution				
	Type 77	Hunter	Vampire	Marut	S 22
Abrasions Contusions etc.	2	8	4	—	1
Fractures	2	1	—	1	—
Dislocation	1	—	—	—	—
Total	5	9	4	1	1

important functions of weight bearing and mobility in normal life of an individual. Granting a complacent approach to fractures of single vertebrae, one would or should find it very difficult to adopt the same attitude towards multiple vertebral fractures in the same individual at the same time. Simultaneous multiple vertebral fractural tendency in ejections from an aircraft should direct the attention of the authorities to the fact that they are always due to some inherent lacks in the pilot's ability (not always within his control) to assume correct posture prior to ejection. These factors could be design defects of the seat, seat harnessing system as brought out by Levy (1964). The incidence of simultaneous vertebral fractures in five aircraft types in our study is shown in Table VII.

Without taking recourse to statistical expositions we can see from Table VII that the propensity to fracture of T12 was greater in Hunter aircraft and also that all cases except one involved this verte-

TABLE—VI

Frequency of fractures of individual vertebrae (Survivors)

Vertebrae	Upper Nos. / Survivors	AIRCRAFT TYPES								Lower Nos. injured (Spinal)	Total	Percentage
	6 Vampire	8 Toofani	19 Mystere	17 Gnat	20 Hunter	3 Marut	2 T-74	14 T-77	14 S-22	2 Canberra	105	
	1	0	3	3	7	1	2	6	7	2	32	30.3
C1											0	—
C2											0	—
C3											0	—
C4			1	1							2	3.63
C5			1	2	1		1				5	9.09
C6											0	—
C7											0	—
T1											0	—
T2											0	—
T3											0	—
T4				1							1	1.82
T5									1		1	1.82
T6										1	1	1.82
T7											0	—
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											0	—
L4					1			1			2	3.63
L5								1			1	1.82
TOTAL		0	4	4	17	1	2	7	17	2	55	99.9

TABLE—VII

Simultaneous vertebral fractures

Aircraft	Case No. in the manuscript	Simultaneous vertebral fracture combinations	Remarks
Mystere	54	C4 – C5	One combination out of 3(33.3%)
Hunter	27	T11 – T12 – L1	All the spinal injury cases suffered simultaneous multiple vertebral factures (100%)
	28	T11 – L1	
	29	T11 – T12	
	31	T12 L1	
	34	T12 L1	
	55	T10 T12 L1	
	90	T12 L4	
S-22	39	T9 L1	Six out of seven spinal injury cases suffered multiple simultaneous fracture (85.7%)
	41	T12 L1	
	42	T5 T9	
	44	T8 – T12 – L1	
	46	T11 – T12	
	47	T8 T10 – L1	
Type-77	16	T9 – T12	One out of six (16.6%)
Gnat	100	C4 – C5	One out of three (33.3%)

bra. Also it is noticed that all cases of spinal injury in this aircraft followed simultaneous multiple vertebral fracture pattern. The significant spread upwards of L1 in S-22 series right upto T5 indicates a profound tendency to state of spinal malposture. In an early survey of S-22 ejections it has been brought out that in fact this was the case as all the subjects above the sitting height stipulated for seat position No. 1 were sitting in position for reasons of expediency. This was their abnormal position and hence probably the fractures.

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