Pulmonary Fat Embolism in Aircrew Fatalities

Wg Cdr SK Adaval*, Gp Capt GN Kunzru† and Maj RN Verma‡

Abstract

FINDINGS on 305 autopsies conducted on aircrew fatalities have been studied. Histological sections from lungs were available in 182 cases which have been reviewed to determine the incidence of pulmonary fat embolism and to correlate its occurrence with some aetiological factors. It is observed that only 25% cases showed evidence of pulmonary fat embolism. Probable factors for this low incidence have been discussed and significance of this finding in accident investigation has been highlighted.

Introduction

Embolic process encountered in the lungs has been used as an evidence of antemortem trauma since long [1-4]. Inspite of doubts expressed by Lehman and Moore[6], trauma to fat depots remains undoubtedly the major cause of such episodes.

Gauss[4] emphasised that rupture of fat cell envelope, tearing of veins and increased local pressure are essential pre-requisites for entry of fat into the veins. To this, however, most important factor of competent circulation has to be added.

Though a large number of workers have studied this interesting phenomenon[3,10,12,13,15] the real impetus was provided by Armstrong et al[1] who brought out the importance of this finding in aircraft accident reconstruction while reporting on Comet disasters.

Subsequently, Hickey and Stembridge[5] and Mason[7,8,9] made a comprehensive study of incidence of pulmonary fat embolism in relation to aircraft accidents and highlighted its significance in aircrash investigation.

Present study has been undertaken with a view to ascertain incidence of fat embolism in the lung tissue as encountered during autopsies conducted on aircrew of the IAF, and to compare our findings with those of other workers.

Material and Methods

A retrospective study has been carried out on material pertaining to 305 autopsies conducted on aircrew between 1962 and 1968. All types of fatal aircrashes during this period were included in the study irrespective of condition of bodies and circumstances of accidents. Dossiers including autopsy reports, histopathological sections and narratives of accident details were prepared and studied. It was observed that histological sections of lungs including frozen sections stained with Sudan III were available in only 182 cases. The same were reviewed for evidence of fat embolism and findings were graded according to Mason's classification. Data thus compiled were evaluated in relation to extent of trauma.

Results

Occurrence of pulmonary fat embolism in 182 cases, graded according to Mason's classification, is shown in Table I.

TABLE I

Occurrence of pulmonary fat embolism

Grade	Description	Number	Percentage
0	No emboli seen	136	74.7
1	Emboli found after some search	22	12.0
2	Emboli easily found	18	9.9
3	Emboli present in large number	6	3.3
4	Emboli present in fatal concentration	NIL	0 0

Total autopsies – 305 ; Lung tissue available 182 cases

* Classified Specialist in Pathology, IAM, IAF, Bangalore-560 017.

† Senior Adviser in Pathology and officer Commanding, No. 5 Air Force Hospital, c/o 99 A. P. O.

‡ Classified Specialist in Pathology, M H, Bhopal.

Types of injury causing death were classified as disintegration, multiple injuries, head injuries only, spinal injuries only and burns associated with bony injuries. Incidence of pulmonary fat embolism from each group is shown in Table II.

TABLE II

Incidence of pulmonary fat embolism and types of injuries

Sl. No.	Types of injuries	No. of cases studied	No. of cases showing embolism
1	Disintegration	22	Nil
2	Multiple injuries	128	42 (32.8%)
3	Head injuries	18	1 (5.5%)
4	Spinal injuries	1	Nil
5	Burns with associated bony injuries	13	3 (23.0%)
	Total	182	46

In the series of 46 positive cases, survival in terms of seconds, minutes and hours was known on basis of other circumstantial evidence in 18 cases. In such cases, assessment of bone marrow embolism was also made. The results are shown in Table III.

TABLE III

Fat and bone marrow embolism vis-a-vis survival time

Survival	Number	Fat embolism with grades	Bone marrow embolism
In seconds	9	9 (grade 1)	5
In minutes	1	1 (grade 2)	1
In hours	8	8 (grade 3)	Nil

Discussion

It is observed from Table I that fat emboli were present in 25% of total cases (grades 1, 2 and 3 only). Comparison of our results with those of other workers is shown in Table IV.

Comparison reveals lowest incidence of 25% in our series while total number of cases studied is quite significant. One of the reasons for lower occurrence could be inclusion of deaths by disintegration in our series, this being an unselected random study of total number of aircrash faralities. Lower incidence could also be due to small amount of lung tissues studied. We have observed that in many instances, though lung tissue was available in plenty, the amount either received for histological purposes

TABLE IV

Incidence of pulmonary fat embolism as reported by some authors

Year	Authors	Occurrence %	Source
1931	Vance[12]	62	164 injury cases
1941	Robb-Smith[10]	81	115 accident deaths
1950	Wyatt and Kho[15]	100	30 traumatic deaths
1955	Armstrong et al[1]	67	18 aircraft accident deaths
1956	Scully[11]	90	110 Korean battle casualties
1958	Hickey & Stembridge[5]	51	236 aircraft accident deaths
1962	Mason[7]	72	102 aircraft accident deaths
1968	Mason[8]	58	298 aircraft accident deaths
Present series		25	182 aircraft accident deaths

or actually processed was restricted to only two to four histological blocks. However, in later period (1970-1976) more literature on the subject was available and awareness to search larger volumes of lung tissue increased. This led to the procedure of studying large number of random blocks from lung tissue. Sampling error, therefore, cannot be eliminated from this study.

Mason[7] has emphasised that the degree of pulmonary fat embolism depends not so much on the amount of marrow space opened up or fat traumatised as on the time available for its production. This time is largely governed by the competence of circulation which in turn varies with extent and site of trauma in different accidents. It is, therefore reasonable to assume that in those series of accidents where survival after injury was prolonged viz. parachute and ejection accidents, the incidence of positive findings will be more. Probably same factor brought down the incidence of fat embolism in Mason's series from 72.5% to 59.7%.

Too frequent an occurrence and prohibitive speed of fat emboli have been main objections to their application in aircrash investigation. However, if only higher grades (grade 2 to 4) are considered, these limitations are minimised to a great extent.

Mason's study of 400 total cases shows 37.25% incidence of grade 2 to 4 fat emboli[8]. Hickey and Stembridge[5] find 49% incidence of 'moderate' and 'marked' embolisation. Our findings, (Table I) when reduced to only grade 2 to 4 emboli, show a lower incidence of 13.2%. However, in 18 cases shown in Table III where survival in terms of seconds, minutes and hours was known on basis of certain other circumstantial evidences, results indicate increased severity of fat embolism with greater survival time.

Classification of injuries in broad groups as shown in Table II has not revealed any additional information. Absence of emboli in disintegration group is understandable. Lower incidence of 5.5% in 'head injury only' group can be due to concurrent injury to brain with consequent cessation of circulation. Caldwell and Huber[2] held that spine was more productive of fat embolism than tibia but in a single case of death due to 'spinal injury only' in our series, fat embolism was absent. There was no case of acute decompression shock in this series. All cases of burns had associated multiple bony injuries and therefore burns alone as contributory factor could not be segregated.

No attempt was made to correlate the incidence of positive bone marrow emboli in all cases as the essential pre-requisite of examining a large number of random blocks of lungs was not fulfilled in many previously documented cases. From investigative aspects of aircraft accidents, bone marrow emboli have no special advantage over fat emboli if only grade 2 or more severe fat emboli are considered.

Conclusions and Recommendations

Histological examination of a large number of random blocks from lungs for evidence of significant fat embolism is an essential feature of investigation on traumatic deaths. In aircrash fatalities, more importance is to be given to moderately positive cases (grades 2 to 4), where competence of circulation and survival time can be assessed with some degree of certainity. Early retrieval and processing of large amounts of lung tissue are necessary for better results. Awareness of this useful finding on the part of investigating Squadron Medical Officer and Pathologist will help in minimising false negative results.

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