Original Article

Radiological Spinal Abnormalities Amongst Aspiring Pilot Candidates

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1190 young asymtomatic males reported to IAM IAF for initial medical evaluation over a 6 year period (1986-1991). 737 (61.9%) of these were found to have some radiological defect in their spines. The common malformations noted were congenital (513 candidates; 43.1%), degenerative changes (148; 12.4%); and deviations of the spine from normal curvatures (76; 6.3%). Congenital anomalies and the degenerative changes were seen most frequently in the lumbar spine, while the curvature abnormalities were more frequent in the thoracic region. Radiological spinal defects were a cause of rejection for flying training in 182 (15.2%) candidates. Of the rejectees, 10.1% had degenerative changes, while 4.9% had congenital anomalies, and 0.2% showed curvature abnormalities. It is pertinent that asymptomatic spinal defects may in fact compromise spinal integrity in the current high +Gz scenario faced by the military aviator as a consequence of introduction of new generation fighter aeroplanes.

Keywords : deformities; spine; X-Rays

An elaborate medical evaluation is required prior to accepting aspiring candidates for flying training in the services. This includes an X-Ray surveillance of the spine to exclude spinal deformities and abnormalities, both congenital and acquired[1] The human spine is subjected to various stresses during flight, and at the time of ejecting from an aircraft. More recently it has been noted that the incidence of spinal injuries at the time of ejection from fighter aircraft is on the decline (35.2% during 1960-80 to 27.5% during 1980-87)[2]. However, the introduction of new generation fighter aircraft has created a high +Gz environment which is causing an increase in the incidence of cervical spine trauma in flight[3,4] - a problem which was hitherto negligible. A pre-existing spinal defect is likely to pre-dispose the spine to injuries in such circumstances[5]. Helicopter flying also induces backache amongst pilots[6,7]. It is possible that micro-traumatic mechanical factors induced by low frequency vibrations contribute to this by lowering the pain threshold[8]. Therefore, pre-existing spinal deformity which may aggravate incidence of pain in such circumstances, will be a handicap.

Gupta et al[9] had made an early attempt to highlight the problem of spinal deformity at entry. They reported an incidence of 5% deformity of the spine in their group, while others report a much higher incidence[10]. In this study we report on the spectrum of radiologically detectable spinal anomalies in 1190 male aspiring flyers.

Material and Methods

For this study, we retreived and reviewed the X-Ray reports on the spinal columns of 1190 male candidates who had reported to IAM IAF during the period 1986-91 for initial medical examination for their flying fitness. The candidates were from two types of cadres-those who appeared for entry into the NDA (n=804; mean age 17 ± 0.7yr SD) and those who were direct entrants (DE) to various flying courses (n=386; mean age 21.5 ± 1.25 yr). All these candidates were asymptomatic at the time of medical assessment.

The X-rays included antero-posterior and lateral views of the cervical, thoracic and lumbo-sacral spines. The assessment of the thoracic spine was therefore not dependent upon the standard chest X-Ray (PA view) on which an earlier study[9] had drawn its conclusions.

Results

Review of the X-ray reports revealed that 737 (61.9%) demonstrated spinal anomalies (Table I) . Of these 182 (15.2%) were considered unfit for flying duties. The distribution of anomalies amongst these candidates as per the two subgroups (NDA and Direct entry [DE]) is also tabulated.

Table-I : *Total number of anomalies and the number declared unfit- both absolute value and percentage.*

Sl No.	Groups	Total Cases	Spinal Anomalies	%	Unfit Cases	%
1.	NDA	804	564	47.3	142	11.9
2	Direct Entry	386	173	14.5	40	3.3
TOTAL		1190	737	61.9	182	15.2

The spinal anomalies detected were further classified into three main groups (Table II). Congenital anomalies (n=510) were the most frequent.Amongst these, spina bifida was most commonly seen, and was followed by sacralisation/lumbarisation defects (Table III).

Table-II : *Major groups of anomalies and the distribution of X-ray findings with the percentage unfitness .*

Anomalies	Total Cases	Percentage (Total)	Percentage (Unfit)
Congenital	510	42.8%	4.90%
Degenerative/ Trauma	148	12.4%	10.00%
Postural	79	6.6%	0.25 %

Table-III : *Various congenital anomalies on X-ray*

Anomalies	Total No	Percentage	Total Unfit	Percentage
Spina Bifida	270	22.6%	20	1.6%
Rudimentary Cervical Rib	64	5.4%	Nil	Nil%
Sacralisation/ Lumbarisation	140	11.9%	29	2.5%
Prominent Tr Process C-7	26	2.1%	Nil	Nil%
Block /hemi Vertebrae	6	0.5%	6	0.5%
Occipitisation Of Atlas	4	0.3%	4	0.3%
Total	510	42.8%	59	4.9%

In the degenerative diseases/past trauma group the Schmorl's nodes were the most frequent (Table IV). A substantial number (n=64) had evidence of previous trauma in the form of compression fractures-either single or multiple-at various levels. None of the subjects remembered a positive history of past trauma which could have supported these findings. Out of the 84 candidates whose X-rays indicated degenerative spinal disorders, 78 were considered unfit. Also 42 of the 64 candidates with radiological evidence of trauma were declared unfit. Eventhough the above two groups together formed only 12.4% (Table II) of the total spinal anomalies, they constituted the maximum percentage of rejectees (65.9%).

Table-IV : *Distribution of Various Degenerative Anomalies / Past Trauma And Percentage of Rejectees .*

Anomalies	Total No	Percentage	Total Unfit	Percentage
Schmorl's Nodes	40	3.4%	34	2.9%
Spondylolysis	26	2.1%	26	2.1%
Schouermann's Diseases	11	0.9%	11	0.9%
Spondylolisthesis	7	0.6%	7	0.6%
Past Trauma	64	5.4%	42	3.5%
Total	148	12.4%	120	12.4%

The postural defects (Table V) were constituted by a loss or exaggeration of the normal lordosis; scoliosis; and kyphosis. In this group, there were 79 candidates, but only 3 were made unfit.

Table-V : *Distribution of various postural anomalies with percentage unfitness .*

Anomalies	Total No	Percentage	Total Unfit	Percentage
Scoliosis	76	6.35%	3	0.25%
Loss Of Cervical Lordosis	3	0.25%	Nil	Nil

Regional distribution of the 3 types of spinal anomalies observed is given in Fig 1. The lumbar region was maximally affected by congenital and degenerative anomalies, whereas postural changes were more frequent in the thoracic zone.

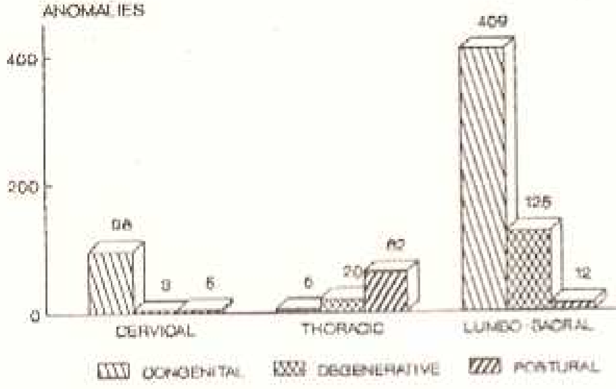

Fig 1 : Comparative Regional Distribution of the three major anomalies

Discussion

This study has revealed that there is a fairly high incidence (61.9%) of spinal anomalies (on radiological surveillance) in apparently normal/healthy/asymptomatic young Indian men. As against this, Gupta et al[9] who had retrospectively studied X-rays of 240 young men who were pilot aspirants, noted an incidence of only 3.8%. This apparently low figure is attributed to the fact that the X-ray reports pertained to the examination of the spine from chest radiographs (standard chest PA). These authors have also reported in the same paper retrospective X-ray findings in two groups of trained pilots/servicemen (n=318) who underwent a radiological spinal surveillance subsequent to their entry into the Armed Forces. If it is considered that these individuals had harboured the defects at the time of recruitment their data could be pooled in order to calculate a more realistic percentage of spinal anomalies. With this, an overall incidence is 50.8%. This figure is lower than the 61.9% noted by us, but is certainly much higher than the 3.8% from Gupta's data in new entrants.

Andersen in a recent study[10] has reported that there were 2.27 abnormalities per each X-ray of the spine. When data from the present study is converted to no. of anomalies/X-ray, the incidence is 0.6 anomalies, while when Gupta et al's[9] grouped data is similarly converted, the incidence reads 0.51 anomalies/X-ray spine. In another report[8] Delahaye and Auffret have found that in their 2500 candidates, the incidence of spinal anomalies was 1.55/X-ray. The relatively high figure reported by Andersen could be because he has used more X-ray views at each spinal level in his survey of 232 pilot candidates. Perhaps we too may find a higher/X-ray anomaly incidence if we resort to Andersen's method. Also, an ethnic difference can not be ruled out as both the other studies are on ethnically different population.

When a comparison is made in the findings of this study and the others[8,10], there is a clear difference in the relative incidences of the 3 major spinal anomalies (Table VI). This difference may be attributable entirely to the ethnicity of the subjects studied- Andersen's and Delahaye's being Europeans.

Table-VI ***Comparative incidence of various types of spinal disorders (radiologically) in this study and two other .***

Types Of Anomalies	Present Study	Anderson (1991)	Delahaye & Auffret (1982)
Congenital	69.1%	14.4%	22.7%
Degenerative	20.1%	15.3%	15.9%
Postural	10.7%	70.2%	61.3%

Our overall rejection rate of 15.2% (Table I) is higher than the 10.7% documented by Andersen et al[10]. The no. of X-ray views used by the latter could have helped in a better resolution of the films, helping in a more realistic appraisal of the condition. Therefore, the X-ray interpretation which was considered abnormal enough as a cause of rejection by us, could actually have proved innocuous if more no. of films had been exposed for the region. Delahaye and Auffret[8] have not commented upon the rejection rate of their candidates, even though they have reported extensively on the overall incidence of radiological spinal defects . Also, the type of anomalies which warranted rejection amongst Indian subjects could be attributed to ethnicity.

When the various congenital defects are considered, the commonest (spina bifida at the level of Sacral vertebra1 [SV1] (Table III) is relatively innocuous[8]. However, this anomaly in the upper spinal regions is likely to assume a serious significance because it is associated with a narrowing of the neural canal, and may also be accompanied by a herniation of the meninges[11]. The latter may become exaggerated when such a spine is exposed to high +Gz situations, or to ejection forces, and may result in sudden inflight incapacitation. In our study, we found 20 such individuals (Table III). Sacralisation/lumbarisation (unilateral) affects the geometry of the spine, and increases the torque forces during accelerations with a consequent strain on the spinal column, and a risk of disc herniation above the level of the anomaly[8]. In the present study, there is noticeable incidence of this anomaly (Table III) while 5.6% of the rejectees had only unilateral defects. A bilateral defect does not expose the spine to differential torque, thus rendering such a spine relatively safe[8].

Spinal degenerative anomalies are not compatible with flying. These disturb the normal spinal geometry, and this is likely to be exaggerated on exposure to the ejection jolt, or for that matter to high +Gz in flight. This accounts for the relatively high percentage (65.9%) of this anomaly amongst the rejectees.

Also of importance is the problem of backache during helicopter flying. This is thought to be caused by postural strain induced during flying, and micro-trauma produced by low frequency vibrations in this type of flying[8]. It is postulated that pain threshold could be lowered during such a stress particularly in individuals who have pre-existing spinal trauma or degenerative disorders[8].

In the present series, the lumbar spine is maximally affected (Fig 1). As against this, Andersen et al[10] have 81 subjects with this spinal disorder, of whom 38 are in the thoracic region, 23 in the lumbar region, and 20 in the cervical region, making this distribution quite different to that found by us though the overall incidence of degenerative disorders is not very different (Table VI). The high incidence of cervical spine involvement[10] could be attributed, apart from ethnicity, to the criticality with which this region has been evaluated.

Scoliosis is by far the commonest postural deformity observed in the various studies including the present one. Deviation more than 15° Cobb's angle is generally considered a cause for rejection for flying duties, particularly from the ejection point of view[1,8]. In the current high +Gz environment, loss of cervical lordosis has assumed importance. The cervical spine undergoes considerable dynamic loading during high G manouevres, and this effect is compounded by the heavy headgear (helmet, and the helmet mounted devices)[3,4,11].

In conclusion, it is revealing that there is a noticeable incidence of radiological spinal anomalies in asymptomatic healthy young Indian men. That the present system of whole spine X-ray surveillance has paid dividends is certain. But keeping in view the present high Gz scenario, it may be prudent to examine the spine-particularly the cervical spine, more critically by including some more views while taking the X-ray film.

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