

CLINICAL OBSERVATIONS ON THE SPINE IN EJECTED PILOTS

By

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INTRODUCTION

In co-operation with the Medical Service of the Swedish Royal Air Force an investigation has been made into the condition of the spine in aviators who have rescued themselves by catapult ejection. The investigation was instigated by reports from various sources that even successful ejections not infrequently caused back injuries (Royal Swedish Air Force: Report 1952, Montagard & Picamoles 1956, Fabre 1959). In some Air Force circles the stresses to which the spine is exposed have been considered so great that special examinations have been called for. Thus, some countries are reported to subject their jet pilots to a preselection roentgenographic examination of the spinal column. Applicants with roentgenographic changes considered to have clinical significance are rejected.

MATERIAL

All 55 pilots who during the period from 1957 through 1960 have made their escape by catapult ejection were included in the investigation. This consisted in eliciting the subjects' history with regard to earlier back trouble and present symptoms, thoracolumbar roentgenography, including a tomographic examination, followed by physical check-up, in cases where this appeared motivated carried out at the Orthopaedic Department.

The technical problems connected with type of aircraft, ejection seat or ejection mechanism will be presented separately. (Nachemson & Laurell).

The age distribution of the pilots is shown in Table 1. Of the total number of 55, 52 belong to the age group between 20 and 35 years.

TABLE 1
Age distribution of ejected pilots.

Age	Number of pilots
20-25	38
26-30	8
31-35	6
36-40	2
41-45	1

VERTEBRAL FRACTURES

Fractures were demonstrated in 14 of the subjects included in this series, in one case dating from before the accident in question. In all cases the injuries involved the vertebral bodies in the form of a more or less severe compression. In 5 cases the injuries affected only one vertebra. Table 2 shows the levels involved in these cases, which on the whole agree with those encountered in other types of accidents.

TABLE 2
Level of single vertebral fractures.

Th	5
Th	6
Th	12
L	2
L	2

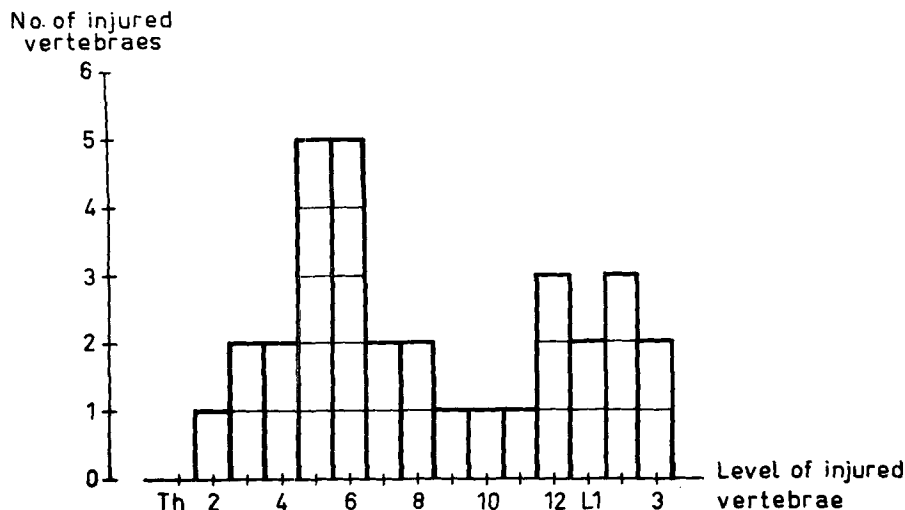
Eight patients showed multiple fractures, whose distribution appears from Table 3.

TABLE 3
Levels of multiple vertebral fractures.

Th 11, Th 12
Th 3, Th 4, Th 5, Th 12, L ₁ , L ₂ , L ₃
Th 2, Th 3, L ₁
Th 6, Th 9, L ₃
Th 5, Th 6, Th 7
Th 8, Th 10
Th 4, Th 5, Th 6, Th 8
Th 5, Th 6, Th 7

The fracture incidence and their distribution over the various levels is illustrated by the Table 4.

TABLE 4
Incidence, distribution and level of vertebral fractures.



Although back pains were reported by all those who had incurred vertebral fractures, it was remarkable that the symptoms as a rule were fairly mild and that the majority did not consider themselves sufficiently incapacitated to warrant bedrest. Routine roentgenography disclosed 29 of the total number of 32 fractured vertebrae. The cases where tomography was instrumental in establishing the final diagnosis involved only minor injuries. The value of the tomographic examination consisted in a more accurate visualization of the extent of the area involved by the fracture. A fourth of all injuries merely consisted of a central depression of the upper endplate. (Fig. 1, Fig. 2, Fig. 3).

ADDITIONAL FINDINGS

As additional findings of the roentgenologic examination, the following were disclosed:

Spondylolisthesis	3 cases
(in all cases involving L 5)	
Vertebral osteochondritis	4 cases
Schmorl's nodules	4 cases
Old vertebral fracture	1 case
Disk degeneration	1 case
Haemangioma	1 case

(Fig. 4, Fig. 5).



Fig. 1.

Small compression fracture in a 21-year-old pilot. Very slight pain for a few days. Complete recovery.

One of these patients combined changes indicative of Scheuermann's disease with a spondylolisthesis involving L 5. One of the patients with Schmorl's nodules showed multiple fractures of Th 6, Th 9 and L 3. In none of the cases could any indication be found that the disorders dating from before the accident had been aggravated by the stress of the ejection. Neither had these pilots experienced any discomfort during their earlier training or service, which had made large demands on their physical stamina. All of them were able to return to active service immediately following their escape from the wrecked aircraft.

FOLLOW-UP EXAMINATION

All pilots included in the above series were in the course of the year 1961 given a check-up to determine their effectiveness and physical fitness for their work as jet pilots. As one of the most recently injured pilots owing to a simultaneously incurred femoral fracture has not yet returned to active service, he has been omitted from this report.

The period of follow-up is set down in Table 5.

Fig. 2.

Tomography of a 23-year-old pilot. Th 8 and Th 10 are compressed. The deformation of Th 10 was merely in the centre of the vertebral body and was only seen by tomography.



TABLE 5
Follow-up period

Period of follow-up	Number of cases
3-4 years	8
2-3 years	11
1-2 years	20
less than one year	15

All flyers, including those with vertebral fractures, had returned to active service as jet pilots. In one case the period of disability lasted one year, due to back pains in the thoracic region. This patient was found to have an extremely strong compression of Th 6 and a pronounced gibbus. He is now on active service again. For the other 11 patients the period of disability ranged from 0 days to 4 months, or 2 months on an average. With the exception of the one case reported above, other injuries incurred simultaneously (Table 6) do not appear to have influenced the period of recovery from the fractures of the vertebrae.

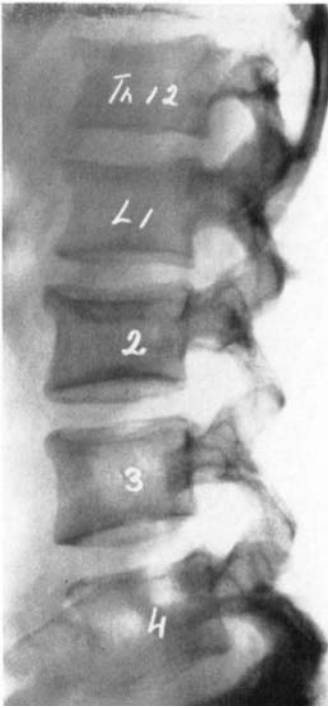


Fig. 3.

Roentgenogram of multiple fractures involving Th 10, L 1, L 2 and L 3 in a 21-year-old pilot. Three months after injury flying jet again without any symptoms from the back.

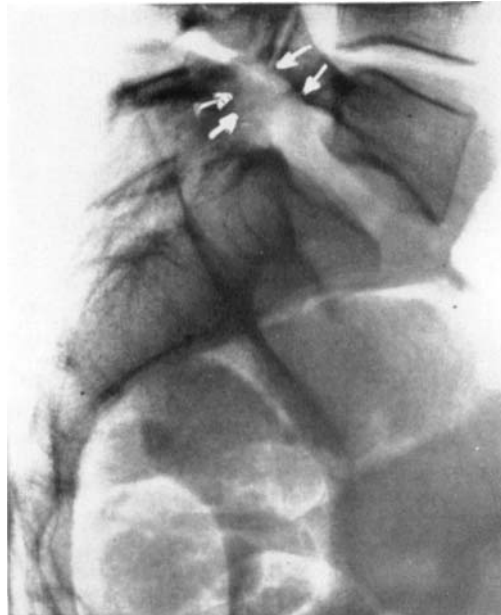


Fig. 4.

22-year-old pilot ejected with 20 g. Roentgenogram taken after the rescue showed spondylolisthesis of L 5 with marked ventral displacement of the vertebral body. No complaints of back ache either before or after the ejection.

Fig. 5.

Tomogram of the spine from a 22-year-old jet pilot. Th 8 and Th 9 were interpreted as vertebral osteochondritis — Scheuermanns disease. The picture was taken 2 days after ejection with 20 g. No symptoms.

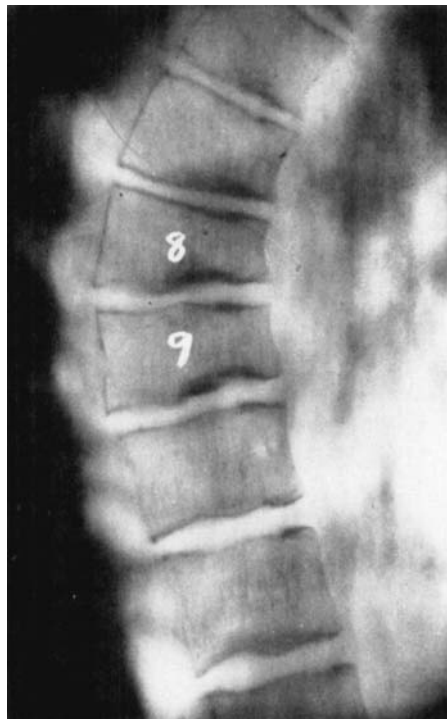


TABLE 6

Simultaneously found injuries.

Distorsio pedis	4
Luxatio humeroscapularis	1
Fractura femoris	1
Fractura sacri	1
Fractura sterni	1

Tests carried out by the Royal Swedish Air Force have shown that the pilots with back injuries after their recovery and following a training program, could tolerate forces of up to 7 g. While none of those recovered from back injuries have had to escape from a wrecked aircraft a second time, one of the pilots was found to have an old vertebral fracture involving Th 7. Like the others, he had during the ejection been exposed to approximately 20 g without ill effects on his back. There is reason to believe that the healed fractures will successfully withstand the high forces to which they may be exposed in case of a second ejection.

Defects in the form of spondylolisthesis, Scheuermann's disease and Schmorl's nodules had neither before nor after the accident caused any pain or other incapacitating symptoms.

As part of the follow-up examination, the personnel included in this series were questioned about low back or sciatic pains experienced either before or after the ejection. Nine in all reported to have suffered from short bouts of low back pain or sciatica.

Five pilots reported low back pain before the ejection. Four of them had experienced the same kind of symptoms again after the accident. In their opinion the catapult ejection had not aggravated their earlier symptoms in any way, nor had the frequency of the discomfort increased. It appears, therefore, as though low back pain and sciatica need not be a reason for rejecting a pilot suffering from either of these conditions from active jet service.

Four of the 13 pilots who had incurred fractures reported symptoms suggestive of low back pain. On the whole, their discomfort has taken the form of pain brought on by physical exertions other than the type required for their performance as pilots. As a rule, the back symptoms have manifested themselves in connection with sports or other more or less civil activities.

S U M M A R Y

During the period from 1957 through 1960, 55 pilots of the Swedish Royal Air Force have rescued themselves by catapult ejection.

The entire group has formed the subject of an orthopaedic evaluation, which included roentgenologic and tomographic examination.

Thirteen of the subjects, or 27 per cent, were found to have incurred vertebral fractures. The injuries invariably consisted of compression fractures of the vertebral bodies. In 5 cases the damage involved only one vertebra, whereas 8 cases showed multiple injuries.

Both with regard to the frequency of the injuries and in the distribution of the levels involved, the middle part of the thoracic spine dominates. The injuries have in no case caused neurologic disorders. All injured jet pilots were able to return to active service after a convalescence of 2 months on an average.

Secondary findings disclosed by the roentgenologic examination were spondylolistheses, defects indicative of Scheuermann's disease, Schmorl's nodules, one case of haemangioma, degeneration of a single disk, and an old vertebral fracture which had healed. In none of these

cases does the ejection appear to have resulted in symptoms of injuries which might be connected with the above defects.

Five pilots had occasionally experienced low back pain prior to the catapult ejection. In none of these cases were the symptoms aggravated after the ejection.

The injuries incurred as a result of the catapult ejection have been of a mild character. It would seem, therefore, that the technical solution of the ejection escape must be regarded as acceptable, considering the seriousness of the situation in which the pilot finds himself on being forced to abandon his aircraft.

ZUSAMMENFASSUNG

Während des Zeitraumes von 1957 bis 1960 haben 55 Piloten der königl. schwedischen Luftwaffe sich mittels Katapultausstossung gerettet.

Die ganze Gruppe wurde einer orthopedischen Auswertung, die auch eine röntgenologische und tomographische Untersuchung mit einschloss, unterzogen.

Dreizehn der Untersuchten, oder 27 %, hatten Wirbelbrüche erlitten. Die Verletzungen bestanden immer in Kompressionsbrüchen der Wirbelkörper. In 5 Fällen war nur ein Wirbel beschädigt, während 8 Fälle vielfache Verletzungen zeigten.

Sowohl hinsichtlich der Häufigkeit der Verletzungen als auch deren Höhenverteilung herrscht die mittlere Brustwirbelsäule vor. In keinem Falle haben die Verletzungen neurologische Störungen verursacht. Alle verletzten Düsenflugzeugführer waren im Stande nach einer Rekonvaleszenzzeit von durchschnittlich zwei Monaten zum aktiven Dienst zurück.

Nebenbefunde anlässlich der röntgenologischen Untersuchung waren Spondylolisthese, Veränderungen die auf Scheuermanns Erkrankung hinwiesen, Knorpelknötchen, Hämangiom (ein Fall), Degeneration einer einzelnen Zwischenwirbelscheibe und eine alte, geheilte Wirbelfraktur.

In keinem der Fälle scheint die Ausstossung Symptome oder Verletzungen zur Folge gehabt zu haben, die mit den oben erwähnten Defekten in Zusammenhang gebracht werden können.

Fünf Piloten hatten gelegentlich Kreuzschmerzen vor der Katapultausstossung. In keinem der Fälle wurden die Symptome nach der Ausstossung verschlechtert.

Die infolge von Katapultausstossungen entstandenen Verletzungen waren von leichterer Art. Es scheint daher, besonders wenn man den Ernst der Situation in Betrachtung zieht, in der sich der Pilot befindet, wenn er gezwungen ist sein Flugzeug zu verlassen, dass die technische Lösung des Entkommens durch Ausstossung als annehmbar angesehen werden kann.

RESUME

Durant la période qui s'est écoulée entre 1957 et 1960, 55 pilotes des forces de l'Aviation Royale suédoise ont utilisé l'éjection par catapulte pour sauver leur vie.

Leur groupe a formé le sujet d'une estimation orthopédique comprenant un examen radiographique et tomographique.

Treize des sujets, soit 27 %, avaient des fractures vertébrales. Les lésions consistaient invariablement en fractures de compression des corps vertébraux. Dans 5 cas, le dommage ne portait que sur une seule vertèbre, alors que dans 8 cas, il y avait des lésions multiples.

Tant en ce qui concerne la fréquence de ces lésions que leur distribution dans les niveaux de la colonne vertébrale, c'est la partie centrale des vertèbres dorsales qui est le plus souvent atteinte. Les lésions n'ont dans aucun cas causé des troubles neurologiques. Tous les pilotes souffrants ont été en mesure de reprendre du service actif après une convalescence de deux mois en moyenne.

Parmi les trouvailles secondaires dévoilées par l'examen radiographique, on a constaté des spondylolisthèses, des déficiences indiquant la maladie de Scheuermann, des nodules de Schmorl, un hémangiome, une dégénération d'un seul disque et une ancienne fracture vertébrale guérie.

Dans aucun de ces cas, l'éjection paraît avoir provoqué des symptômes ou des lésions qui puissent être mis en rapport avec les cas précités.

Cinq pilotes avaient occasionnellement ressenti des lombalgies avant l'éjection par catapulte. Dans aucun de ces cas, les symptômes se sont trouvés aggravés après l'éjection.

Les lésions dues à l'éjection par catapulte ont eu un caractère bénin. C'est pourquoi, il semble que la solution technique du sauvetage par éjection puisse être considérée comme acceptable si l'on tient compte de la gravité de la situation dans laquelle le pilote se trouve lorsqu'il est forcé d'abandonner son avion.

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