Original Article

Low backache in fighter pilots

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ABSTRACT

Back and neck injuries are commonly associated with high, rapid onset and sustained +Gz. It remains a potential hazard that +Gz forces, such as those encountered during aerial combat, aerobatics or centrifuge exposures, could result in significant acute spinal injury and that chronic exposure could result in degenerative disease in severely stressed areas. It is difficult to decide if certain skeletal abnormalities, lifestyles or age predispose an individual to spinal injuries/cervicalgia or low backache during high-sustained +Gz. Nine cases of low backache in fighter pilots resulting in their loss of flying category for varying periods of time, are discussed. Magnetic Resonance imaging (MRI)/CT scan of the spine helped in definitive diagnosis in these cases. Role of MRI/CT in investigation of spinal injuries in fighter pilots is discussed.

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KEYWORDS : High-sustained +Gz (HSG), Cervicalgia, Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Prolapse Intervertebral Disc (PIVD)

The exposure to high-sustained +Gz stress is a necessity today in view of the capability of modern generation fighter aircraft and the requirements of air combat tactics. These aircraft are capable of not only very rapid +Gz onset (upto 10-15 G/s), but also capable of sustaining high +Gz (>7+Gz) for 15s or more.

Back and neck injuries are commonly associated with high, rapid onset and sustained +Gz. It remains a potential hazard that +Gz forces, such as those encountered during aerial combat, aerobatics or centrifuge exposures, could result in significant acute spinal injury and that chronic exposure could result in degenerative disease in severely stressed areas. It is difficult to decide if certain skeletal abnormalities sedentary life styles older age group predisposes an individual to spinal injuries/cervicalgia or low backache during high-sustained +Gz.

Nine cases of low backache, not due to trauma or post-ejection, in fighter pilots reporting to IAM for review/recategorisation and their disposal are discussed in this paper.

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Case 1

A 30-year old fighter pilot, with 820 h of flying experience, sustained compression fracture DV-12 following ejection from a Mig-23 BN aircraft in Feb 99. He was upgraded to full flying category in Oct 99 with the recommendation of Annual Review at IAM coinciding with Annual Medical Examination. On annual review in IAM in Feb 2000, he was again downgraded to a restricted flying category as the pilot developed lower backache after he resumed flying. The backache was only present after sorties involving higher +Gz levels. His MRIs in Feb 99 and May 2000 showed old compression fracture DV-12 with normal posterior elements. During review in IAM in May 2000, he was asymptomatic and clinically NAD including Neurological & Spinal examination. His centrifuge and human engineering evaluation were also normal. In view of the pilot's symptom of backache following the sorties involving +Gz manoeuvres, his flying restrictions continued for 24 weeks with the advise of the next review with medical and executive report.

Case 2

A 38 yr old fighter pilot, with 2360 flying hours with majority of them in a Jaguars aircraft, reported as a case of low backache with sciatica left onset Sep 1999. MRI scan done in Nov 99 showed straightening of lumbar lordosis $L_{2-3}L_{3-4}$ & L_{4-5} disc dessication, L_{4-5} & L_5S_1 disc bulge compromising spinal canal. He was managed conservatively and was observed in non-flying medical category for six months. During his review in May 2000, he gave a history of being asymptomatic for the past 5 months and was not on any medication. Clinically NAD. X-ray Lumbosacral spine (AP & Lat) on 24 Apr 2000 revealed no bony lesion and IV disc spaces normal. His centifuge evaluation was normal and was upgraded to a restricted flying category for 6 months.

Case 3

A 29 year old fighter pilot, with 700 flying experience, developed low backach 99 while carrying out normal duties. M done in Jun 99 showed PIVD L_5-S_1 level managed conservatively and was taken o for six months wef Sep 99. During his r Jun 2000, he still complained of stiffne lower back at rest & mild pain in the b exertion. There was no radiation of pain i since the last two months. Neurological exa revealed no sensory deficit or paraspinal spasm. SLR-Rt 75°, Lt 60°. Tenderness at L (7 Jun 2000) : moderate posterior central paracentral disc herniation at L_5S_1 level effecting the epidural fat and indent traversing nerve roots (L>R). In view symptomatic state of the flyer, neurologic and MRI findings, he was recommend continue in the non flying medical categ

Case 4

A 29 year old transport pilot with 20 total flying experience developed low back Aug 99, during the QFI course while pilo in Kiran aircraft. CT scan done in Dec 99 PIVD L_5-S_1 level. He was managed conserv and placed in nonflying medical cat wef During his review in Jun 2000, he was asympto since the last review. Clinically and engineering evaluation revealed no abnorma view of the asymptomatic state of the fly his transport background and normal findings, he was upgraded to restricted category for 24 weeks. Fit for transport aircra to be. Next review in IAM with a medical from AMA and executive report on flying a a fresh CT/MRI Lumbosacral spine.

Case 5

A 32 yr fighter pilot, with 1950 h of total flying experience including 180 h on Mig-29, developed low backache with sciatica -left (onset Nov 99). CT scan done in Jan 99 showed general disc bulge at L_{4-5}. Disc protrusion indenting thecal sac. He was managed conservatively and given a non-flying status wef Mar 2000. During his review in Jun 2000, his symptoms of mild backache with pain radiating down the left leg were still persisting. Neurological exam revealed tenderness at L_{4-5} with paraspinal muscle spasm and restriction of spinal movements. SLR-bilateral 75°. FTD-30 cm. Since the pilot was symptomatic, he was not subjected to aviation stresses like vibration or centrifuge evaluation. In view of the persistence of the pilot's symptom of backache and CT-scan findings, he was recommended to continue in the lower medical category for another six months.

Case 6

A 45 yr old fighter pilot with total flying experience of 2400 h including 700 h on Mirage 2000 developed backache in 91 and was observed in non-flying category till Jun 96. He was diagnosed as PIVD L_5-S_1 based on MRI findings done in May 1995. He was placed in restructed medical cat (P) wef Dec 96 with recommendation for change over to transport/helicopter only. He was reviewed at IAM in Jun 2000 for upgradation to fighters on request by the officer since he was asymptomatic for the last 2 years. Clinically there was no spinal deformity/tenderness/muscle spasm and movements were full and free. During the centrifuge evaluation, the pilot went into G-LOC three times at 6G, probably due to no flying for the last 5 years. Hence complete evalution of the spine under high sustained +Gz could not be done. His latest MRI revealed a moderate bulge at L_5-S_1 level indenting thecal sac at this level and partially compressing lateral recess bilaterally. Disc degeneration and degenerative end plate changes were seen at this level. In view of the degenerative changes on MRI and inability to evaluate spine under high +Gz due to low +Gz tolerance, pilot was not made fit for the fighters.

Case 7

A 29-year old fighter pilot, with 820 h of flying experience, developed lower backache in late 1994 but reported in Aug 96. He developed radiation of pain to right lower limb in Nov 97, which became severe in Mar 99 when he was grounded. MRI in Mar 99 showed minimal PIVD L_{4-5}. During review in Feb 2000, he was asymptomatic except for mild pain on prolonged standing. He had curtailed his outdoor sports due to the pain. MRIs in Feb 2000 shows minimal disc bulge at L_{4-5} level. His symptoms of radiation of pain towards right lower limb did not corroborate with the MRI findings of minimal disc bulge. Clinical and human engineering evaluation including vibration run was within normal limits. He was placed in a restricted flying category for 24 weeks with the advice of not to fly high +Gz sorties.

Case 8

A 30 yr old transport pilot with 2800 h of flying experience developed low backache with left sciatica in Jan 2000 while flying Kiran aircraft during QFI course. MRI scan revealed mild posterior bulge - L_{4-5} mildly indenting thecal sac. He was observed in non-flying medical category for six months. During his review in Nov 2000, he was asymptomatic with no neurological signs. He was upgraded to restricted flying medical category, fit for transport aircraft only, for another six months.

Case 9

A 30 yr old Mirage 2000 pilot with 890h of

flying experience sustained contusion - cervical spine while playing games in Dec 96. MRI Cervical Spine revealed loss of cervical lordosis with minimal annular bulge at C_{3-4} level. He was observed in non-flying medical category for six months and finally upgraded to full flying category in Jan 98. The pilot developed severe low backache & neck pain in May 99 while flying an aerial combat manoeuvre in Mirage 2000. MRI scan revealed annular bulges at L_{3-4} & L_{4-5} levels minimally indenting thecal sac. He was observed in non-flying medical category for nine months. During his review in Sep 2000, he was asymptomatic with no neurological signs. He developed severe neck pain at +5Gz during centrifuge evaluation. Post-run evaluation revealed neck spasm. Since the pilot was not able to tolerate the lower +Gz run, he was again placed in non flying medical category for another six months.

Discussion

The most common morbidity on exposure to the high +Gz environment is due to cervical and lower spinal injuries. The aircraft's enhanced ability to produce abrupt onset High-G loads, as well as to sustain them at higher levels, presents an additional stress to the spine. If the head weighs 3.5-5 Kg with 1.8-2.2 Kg of headgear added; static load equivalents of 48-65 Kg are generated at 9 G at the cervical spine level itself and much more at the level of thoraco-lumber region. Fighter aircraft operate in dynamic environment that often requires a nearly constant vigil of all sectors surrounding the aircraft. Abrupt +Gz loading in a defensive or offensive maneuver frequently applies a significant load to the cervical and lower spine, in direction other that axial or neutral. This, in turn, can cause loss of head control or failure of a musculoskeletal component of the spine. It has been noted that flexion and extension injuries are produced at approximately 50% of the loads, which cause axial compression failure.

The significance of these injuries a number of cases it may go unrepor aircrew resorting to local treatment wit etc. It is also not known whether these re a precursor to chronic degenerative dise spine. The number of flying hours wast aircrew being off flying due to spinal in high Gz environment is also not know

This problem may assume mo proportion in the future by the introdu helmet mounted electro-optical device would add to the weight of the helmet increase the spinal loading. Spinal injuries acute (soft tissue injury or vertebral occurring in flight or arising from acute l crash or assisted escape) or chronic degenerative disease arising from Gz load injury sustained in aircraft ejection or cr

Incidence of soft tissue cervical in cervicalgia of more than 50% in the fighter has been reported in many studies [2,3] le removal from flight duties for an averag of three days. A survey in IAF [4] amongs flying MiG 29 and Mirage 2000 aircraft rev incidence of cervicalgia of 64% an respectively for the two groups, as compa an incidence of 54% for those flying generation of aircraft (Mig 21). Howeve backache has not been frequently repor

Average age of the subjects in the study was 32.4 years (SD=6.1) and the a flying experience 1705.3 hours (SD = 869.2 study revealed that a staggering 88% of fighter pilots had moderate (grades 3 & 4 degeneration in the C3-4 disc, as compared of controls using low-field magnetic reso (MR) thereby concluding that chronic expo the high +Gz environment can cause cervic degeneration [5].

Four out of nine cases of low backache reported in this study could be directly attributed to the +Gz as the pain started and got aggravated following combat sorties. In the rest of five fighter pilots, cause-effect relationship with high +Gz could not be established. Two cases of spinal fractures due to high-G manoeuvres have been reported earlier in IAF [6]. The first had sustained fracture of D8 and D9 vertebral bodies in MiG 21 aircraft. The fractures were detected on CT scan. Subsequently, the MRI scan done during the evaluation revealed mild indentation of the dural sac, opposite D7-D8. The second aircrew had sustained fracture of the right limb of the spinous process of C5 vertebra while flying MiG-29 aircraft. The fracture was detected on CT scan during review after few months of injury.

Two pilots in the present study were made permanently unfit for ejection seat aircraft; one due to backache following +Gz sorties and the other due to MRI findings and recurrent episodes of acute pain. Two cases were still symptomatic after about a year of the onset and are being observed in non-flying medical category. Other five cases have not reached finality and are being observed in restricted flying category. Only three cases had flown air superiority fighters (Mirage-2000 & MiG-29) capable of high-sustained +Gz (HSG), which is more likely to cause spinal injury.

In a questionnaire survey in Japan Air Self Defence Force F-15 pilots [7], 'checking six' (looking back over the shoulder) was the most common posture that caused pain followed by a 'forward bend' posture, which is necessary for manipulating instruments. The neck was the most common part of the body that was injured regardless of posture. Upper back pain was the second most common at 'checking six', while the lower back pain was the most common in the 'forward bent' posture. This indicates that other parts of the body were also twisted and susceptible to injury in tactical flight manoeuvres. There were 64 (49%) pilots who reported chronic muscle pains that became prominent during high-G manoeuvres.

Two clinical cases of +Gz associated degenerative cervical spinal stenosis caused by dorsal osteophytes in fighter pilots have been reported [8] with the help of MRI. Three cases of bulging cervical discs, detected using MRI, among fighter pilots who exerienced acute inflight neck pain during aerial combat manoeuvres under high Gz forces have been reported [9].

CT scan and/or MRI scanning of spine have been made mandatory in the Indian Air Force following an ejection [10]. These investigations are very useful to highlight and assess details of injuries to the joint-facets, transverse process, articular surfaces, ligamentous support and soft tissue. This information should be correlated with clinical features of ejectee pilot before a final disposal is decided.

The spinal cord is a longitudinal structure and this limits the precision of siting for transverse axial imaging methods such as CT. MRI does not have this limitation because it can easily be applied in any plane, including the optimal sagittal axis [11]. The advantages of MRI are particularly apparent for non-invasive elucidation of myelopathy thought to be of diskogenic origin, and in atypical radicular syndromes or spinal pain. The longitudinal images and display of the intrathecal contents are of particular importance in such cases [11].

Plain X-rays are commonly normal in acute disc prolapse, but there be narrowing of the affected disc or altered alignment of the spine due to muscle spasm. Assessment of lumbar canal stenosis by plain X-rays is subject to many inaccuracies. CT and / or MRI allow much more

reliable assessment of disc prolapse as well as canal stenosis [11]. Eight out of nine cases in the present study had normal X-ray and prolapse of inter-vertebral disc was only diagnosed based on CT/MRI findings. One case had old compression fracture DV-12. The generalized bulging of degenerate discs, which may contain gas, can be distinguished from focal protrusion or prolapse by CT or MRI [11]. MRI produces no harmful radiation, it can safely be repeated as needed and is thus preferable to CT scan. MRI examination would be useful in fighter pilots' periodic medical check-ups in order to reveal acquired degenerative spinal stenosis.

Conclusion

The potential for acute or chronic spinal injury to spine exists within the current operational envelope of present day high performance aircraft. The fighter pilots with persistent and severe symptoms should undergo MRI scan of the spine if the plain X-rays are normal. In the absence of a baseline CT/MRI scan, it is difficult to attribute an observed finding in the post symptom CT/MRI to long-term +Gz stress. Thus MRI baseline scan along with the X-ray of spine should be included during the medical examination of the candidates selected for the flying duties. It will also help in screening out candidates with a congenitally narrow spinal canal for the fighter flying.

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