

A Retrospective Analysis Of Musculoskeletal Disabilities in Military and Civil Aircrew

Gp Capt Narinder Taneja*

ABSTRACT

Musculoskeletal disabilities are a cause for concern in aircrew as they can critically affect return to flying duties. Analysis of nature and cause of musculoskeletal disabilities can provide insight that could assist in developing preventive and therapeutic intervention programs. The purpose of this study was to analyze musculoskeletal disabilities among military and civil aircrew in India. The Institute of Aerospace Medicine (IAM) is responsible for centralized evaluation of military and civil aircrew with any musculoskeletal disability. We analyzed musculoskeletal disabilities among aircrew who were evaluated at this Institute from 2000-2006. A total of 626 aircrew (civil=39, military=587) were evaluated during the above period. Majority of the military pilots (38%) were from the fighter stream. A large number of the military pilots were less than 30 years of age whereas the reverse was true for civil pilots. Musculoskeletal injuries affecting the spine constituted 39% (n=297) of the disabilities followed by upper (29.1%, n=220) and lower limbs (23.0%, n=174) respectively. Of the spinal disabilities, compression fractures and degenerative disease of the disc were the leading disabilities (39.7%, n=118) followed by fracture of the spine in 30% (n=88). Road traffic accidents accounted for almost a quarter of the injuries (23.7%, n=132). The findings provide insight into the nature of musculoskeletal disabilities among military aircrew. Implications for preventive and therapeutic strategies are elaborated. The possible reasons for the differences observed in various groups are discussed.

IJASM 2008; 52 (1) : 8-13

Keywords: Musculoskeletal disabilities, Aircrew, Thoraco-lumbar fractures, Interventions.

Military aircrew are group of screened and selected individuals who undergo rigorous and expensive flying and military training. However, they are as susceptible to musculoskeletal injuries caused by falls at home or work, road traffic accidents (RTA) and sports, as is the general population. Unfortunately, they may be more susceptible to musculoskeletal disabilities by virtue of being in military aviation. Various studies have suggested that military fighter and helicopter aircrew may be more prone than non-aviators to develop musculoskeletal disabilities involving the spine [1, 2, 3]. Moreover, the nature of combat jet flying perpetually carries the possibility for emergency escape from a disabled aircraft. Such escape can cause musculoskeletal injuries, in particular to the spine and limbs. Civil aircrew are an equally costly human resource of an aviation

organization. Any time lost on account of such disabilities has financial implication for both the pilot as well as the organization. Safe and early return thus remains the key here too.

Studies exist documenting the incidence and nature of backache among aircrew of different aircraft [1, 2, 3]. Studies have also documented the causes and possible remedial measures for backache among helicopter aircrew [2, 4]. Notwithstanding these, there has been no published study on the nature of musculoskeletal disabilities and their causes in military aviators as a group. The only reference to the significance of

**Senior Medical Officer, Air Force Station Bagdogra*

Date of Submission : 11 Jan 2008

Accepted for publication : 29 May 2008

musculoskeletal disabilities comes from studies on long-term disabilities among commercial pilots [5] and military aviators [6]. A preliminary study carried out in the Indian Air Force (IAF) had been published earlier but had covered a smaller period and had covered only IAF aircrew [7]. There has been no study on the nature of musculoskeletal disabilities among civil aircrew or aircrew from the Army and Navy. The purpose of this study was to analyze the cause of musculoskeletal disabilities among military and civil aircrew in India.

Methods

Case records of each aircrew reporting for evaluation is prepared by the aerospace medicine specialist, which is maintained at the Department of Human Engineering, Institute of Aerospace Medicine (IAM). These records were accessed and information for all aircrew who had been evaluated for musculoskeletal disabilities from the year 2000-2006 were included for analysis. The data comprises of aircrew who had a musculoskeletal disability that was severe enough to cause them to be placed in the non-flying medical status. As per existing guidelines, they would necessarily undergo an evaluation at IAM before being considered for flying duties. Depending on the clinical and human engineering evaluation, the disposal of these aircrew could range from temporary non-flying, restricted or full flying or even permanent non-flying medical status. Their eventual disposal had no bearing on the inclusion in this study.

We categorized aircrew (pilots) as those from the fighter, transport or helicopter stream. Aircrew, other than pilots (e.g., flight gunners, flight engineers, navigators etc.) were grouped in an 'others' category whereas cadets (Pilots still under basic training) were grouped separately as 'cadets'. Pilots from the civil stream were categorized as 'civil'. Comparison of incident rates between groups

was not possible due to non availability of total number of aircrew in each category. Student's chi square test was used for statistical analysis. Level of significance was taken as 'p' value < 0.05.

Results

A total of 626 aircrew (military=587, civil=39) were evaluated at IAM for musculoskeletal disabilities during this period. There was no statistically significant distribution of any particular category of aircrew in the period covered under this study. Most of the aircrew (38%) were from the fighter stream. Helicopter and transport aircrew constituted 22.4% and 13.1% respectively. Non-pilot aircrew and cadets comprised 12.9% and 5.3% of the sample respectively. Non-pilot aircrew and cadets comprised 12.9% and 5.3% respectively. (Table 1). Civil aircrew constituted 6.2% of the total data.

Approximately 51% of the fighter aircrew with musculoskeletal disabilities were less than 30 years of age. While 48.7% and 47.8% of the transport and the helicopter aircrew were in this age group respectively. The difference in age groups was statistically significant ($\chi^2 = 222.04$, $p < 0.001$, $N = 610$). In contrast only 26.3% of the civil aircrew were less than 30 years of age.

The disabilities have been categorized depending on the anatomic location. Of the 626 aircrew, 113 had two disabilities each, 30 had three each, 5 had four disabilities each, 5 had four disabilities each; thus yielding a total of 755 musculoskeletal disabilities.

Of the disabilities affecting the lower limbs, bones of the leg (tibia/fibula) constituted almost a third of the disabilities ($n = 43$, 34.1%) followed by ankle and foot injuries in 29% ($n = 37$). Knee joint including the patella was affected in 20 aircrew. Femur and pelvis were involved in 23 cases. Small

Table I: Details of age, cause and nature of musculoskeletal disabilities

Variable	Fighter (n=242)	Transport (n=78)	Helicopter (n=140)	Cadets (n=33)	Civil (n=39)	Others (n=81)
Age						
Mean	30.96	31.77	31.40	22.28	38.67	32.37
SD	6.4	6.25	5.28	4.28	9.92	6.12
<20 yr	0	0	0	4	0	0
21-25	47	11	23	27	4	9
26-30	76	27	44	0	6	23
31-35	71	22	47	0	3	32
36-40	29	10	16	0	13	12
>41	18	8	10	1	12	5
Cause						
RTA	43	27	32	1	9	21
Ejection	62	0	0	2	0	1
Aircraft	5	4	33	1	2	13
Sports	32	13	9	14	4	13
Gradual	38	18	34	1	4	8
Other	30	10	18	8	16	15
Aircraft Related	8	2	3	0	0	2
Region						
Head&Neck	16	3	13	2	2	12
Upper Limb	73	32	45	15	13	42
Ribs	4	3	1	0	1	0
Lower Limb	62	20	40	13	16	23
Spine	145	39	77	3	15	18
Others	4	2	1	0	0	0

bones of the hand constituted another 28% (n=46). Shoulder joint was involved in 23 cases.

A statistically significant difference was observed between the body region involved and the stream of the aircrew. While 47% of the fighter aircrew had spinal disabilities, this region was affected in 43.5% and 39.9% of the helicopter and transport aircrew respectively. Spinal disabilities were lowest among the others group (18.9%) and cadets (9.9%). These properties become much more significant when spinal injuries due to ejection are excluded in aircrew from fighter stream.

Of the spinal disabilities, radiologically confirmed degenerative disease of the disc was the

leading diagnosis in 39.7% (n=118) of the aircrew followed by fracture of the vertebra in 29.9% (n=88). A total of 190 discs were involved in these aircrew. Of these 180 discs, (73%) were of the lumbosacral region, followed by 23.7% (n=45) in the cervical region. In the lumbosacral region, disc involvement was predominantly in the L4/L5 (n=69) and L5/S1 region (n=53) whereas in the cervical region, maximum disc disease was observed at C5/C6 (n=22) level followed by C4/C5 disc (n=10).

Fracture of the spinal vertebra was seen in 88 aircrew. They had a total involvement of 153 spinal vertebrae. Maximum number of fractures was seen at T12 (18.9% n=29) and L1 (15.7%, n=24) followed by T11 (n=12).

Causes for various disabilities included ejection, aircraft accident/crash landings, RTA, sports, domestic falls and injuries from fireworks and train accidents. RTA accounted for almost a quarter of the injuries whereas sports injuries accounted for 15%. Of the aircrew who were involved in ejection, one third (n=33, 32.8%) were less than 30 years of age. Disabilities of degenerative and chronic nature such as spondylosis and degenerative disc disease were labeled as being of gradual onset and accounted for musculoskeletal disabilities in 18.5% (n=103) of the aircrew.

As a proportion, RTA injuries caused the maximum musculoskeletal disabilities among the transport aircrew (36.5%, n=27) followed by fighter (28.7%, n=21) and civil aircrew (25.7%, n=9). Of all the injuries sustained by cadets, sports injuries were responsible in 53.8% cases (n=14). These differences were statistically significant. Among fighter and helicopter aircrew, ejection and crashlandings were the cause of 28.4% (n=62) and 25.8% (n=33) of the injuries in their respective streams.

All the pilots from the Army were helicopter pilots (n=13), as Indian Army does not operate any transport aircraft. From the Navy, majority were from the helicopter stream (n=23, 57.5%) followed by transport (n=11, 27.5%). Spinal disabilities were the major disability among both army and naval aircrew, comprising of 12 and 27 disabilities respectively. Of the spinal disabilities in both the groups, degenerative disease was the leading spinal disability.

Of the 39 civil pilots in the data, majority were more than 35 years of age (n=25, 64.1%) and had a total of 47 disabilities. RTA accounted for injuries in almost a quarter of these aircrew (n=9, 23.1%). Disabilities affecting the lower limb (n=16) and spine (n=15) were the leading cause. Spondylosis

and degenerative disc disease constituted majority of the spinal disabilities.

Discussion

Musculoskeletal injuries and disabilities assume significance in modern day society for variety of reasons. Firstly, large number of musculoskeletal injuries are caused by trauma, especially (RTA). Besides having a significant financial impact they constitute an important cause for morbidity and mortality. In 1998, they accounted for 216,859 and 49,304 deaths in India and United States (US) respectively [8]. Secondly, musculoskeletal disabilities generally entail a prolonged course of treatment and recovery is often not complete. Thirdly, a variety of psychosocial factors can affect recovery from musculoskeletal disabilities not only among aircrew, but even in the general population. A recent study had brought out that spinal disabilities, in particular of traumatic origin, were most likely to exhibit delayed recovery [9]. That study had also shown the possible benefits of focused rehabilitation in recovery [9]. Fourthly, musculoskeletal disabilities can be an important cause for loss of trained manpower. This happens when significant residual functional impairment jeopardizes safety at work both for the individual and the organization.

This study of the pattern of musculoskeletal disabilities among military and civil aircrew in India presents interesting findings. While no other published study is available for comparison, the results themselves in isolation provide insight into possible preventive and rehabilitative strategies. Due to lack of information on the total number of aircrew in each stream, it is difficult to comment upon the prevalence of musculoskeletal disabilities in each category. Aircrew from the fighter stream were however younger than the transport and helicopter aircrew. Spinal disabilities comprising of fracture of the spinal vertebrae and disc disease

constituted almost two fifths of the disabilities among these aircrew. Some role of high-G accelerative stress in early degenerative disc disease has been postulated. Hamalainen et al have suggested that frequent exposure to +Gz may lead to "premature disk degeneration" [1]. Similar findings have been published in other studies [10].

Helicopter aircrew have attracted aeromedical attention because of their occupational exposure to whole body vibration and the ergonomics of helicopter cockpit. Studies estimate the incidence of low backache among helicopter aircrew ranging from 21-95% [1, 3, 4]. The higher incidence of low back pain in helicopter pilots may possibly be due to degenerative disc disease resulting from posture of the helicopter pilot during flying, workload and vibration transmitted by the seat [3, 4]. This however, needs further research.

Cadets as a group assume significance as any long-term musculoskeletal disability can jeopardize their flying career. Injuries sustained during sports accounted for almost 51% of their disabilities and these predominantly affected the extremities. Aircrew during their younger days are naturally more actively engaged in competitive sports than their senior counterparts [11].

Majority involvement of L4/5 and L5/S1 disc among aircrew having disc disease corroborates findings in published literature that disc disease is maximum at this level in the lumbosacral spine. Maximum cervical disc lesions were present in the C5/6 region. It has been postulated that under high-G environment, weight of the aircrew helmet-head assembly significantly stresses the cervical spine, and C5/6 had been documented to be the most vulnerable to injury [1, 10].

Compression fracture of the spinal vertebra is a known and accepted risk during ejection. The

thoraco-lumbar junction is most vulnerable to such forces, In the present analysis, 34.6% of the spinal fractures involved T12-L1 vertebrae and corroborate findings of earlier studies.

Musculoskeletal disabilities subsequent to RTA accounted for almost a quarter of the total musculoskeletal disabilities. They are significant cause of morbidity/mortality and a burden on the health care resources of the country, including the Armed Forces. There have been concerted efforts by the medical and administrative communities in the armed forces to enhance awareness about the use of protective safety equipment. Additionally, an in-depth study of the circumstances surrounding RTA such as tiredness or fatigue on part of the driver, non-use of seat belts, alcohol use or speeding on poorly maintained roads can provide valuable information to design preventive intervention programs.

Notwithstanding the significant benefits of a preliminary study such as the present one, certain important information was not available for analysis. In the absence of a standardized format, opinion writing is individualized and thus the information available from each opinion varies. As a result, certain information of statistical importance is not available in all records e.g., flying hours, age at onset, mode of onset, type of aircraft involved etc. Towards obviating this drawback, a feedback proforma has been standardized. This proforma will be completed by all aircrew on arrival before being seen by the specialist and will be attached to the case sheet. This will ensure that the basic information related to the aircrew is available for future analysis.

Conclusion

This study provides a big picture of the nature of musculoskeletal disabilities that affect military

and civil aircrew in the country. It also highlights the causes for such injuries. A detailed follow-up analysis of variables associated with the disabilities such as period of unfitness for flying duties, nature of therapeutic services availed/available, role of physiotherapy, causes for grounding besides specific features of each cause factor and aircrew and aircraft details will provide a comprehensive database on which future decision making policies can be based.

Conflicts of interest: None identified.

References

1. Hamalainen O, Vanharanta H, Blogui R. Degeneration of cervical intervertebral disks in fighter pilots frequently exposed to high +GZ forces. *Aviat Space Environ Med* 1993; 64:692-6
2. Hensen OB, Wegstaff MD. Low back pain in Norwegian helicopter aircrew. *Aviat Space Environ Med* 2001; 72 161-4.
3. Bowden T. Back pain in helicopter aircrew: *Aviat Space Environ Med* 1987;58:461-7.
4. Aigh R, Backache in Chetak crew and suggested ergonomic improvements in aircraft seat design. *Aviation Medicine* 1983;27:123-30.
5. Band P, Deschamps M, Fang R, et al. Long term disability rates in a cohort of Air Canada pilots. *Aviat Space Environ Med* 1998; 69:1137-40.
6. Hoiberg A, Blood C. Age specific morbidity among Navy pilots. *Aviat Space Environ Med* 1983; 54:912-918.
7. Taneja N, Pinto L. Taneja LJ. Diagnostic categories among 232 military aircrew with musculoskeletal disabilities. *Aviat Space Environ Med* 2005; 76:581-5.
8. Injury: A leading cause of the global burden of disease. [Cited on February 06, 2005]. Available from :<http://www.safecarguide.com/exp/statistics.html>
9. Taneja N, George CS. Psychosocial factors affecting recovery in aircrew with musculoskeletal disabilities. IAM Department Project No IAM/195/2004.
10. Kikukawa A, Tachbana S, Yagura S. G-related musculoskeletal spine symptoms in Japan Air Self Defence Force F-15 Pilots. *Aviat Space Environ Med* 1994; 65: 269-272.
11. McCrary BF, Van Syco DL. Permanent flying disqualifications of USAF pilots and navigators (1995-1999) *Aviat Space Environ Med* 2002;73:1117-21.