Effects Of Cervical Spine Rehabilitation In Fighter Pilots: A Literature Review

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Abstract

Years of training, practice and unique skills are required for a Fighter pilot to perform demanding and challenging operations in technologically cutting-edge aircraft. To provide a concise overview of physical fitness, muscle cross-sectional area (CSA) and Gz exposure and their interaction in fighter pilots. A search of PubMed, CINHAL, Google scholar database was conducted to find relevant studies pertaining to fighter pilots, cervical spine and biomechanics. A total of 6 articles were included in the review. Exercise included stretching, ROM exercises, Acupuncture, Aerobic exercises, finger-pressure massage, resisted isometric exercises. This study provides an up-to-date overview of the current literature on the ‘Effects of cervical spine rehabilitation in fighter pilots’.

Keywords: Cervical spine, Fighter pilots, Gravitational force, Rehabilitation, Neck injuries.

INTRODUCTION

Years of training, practice and unique skills are required for a Fighter pilot to perform demanding and challenging operations in technologically cutting-edge aircraft. The aircraft teams perform fighter missions; hence, coordination is essential for the fruitful outcome of missions.1 Pain and discomfort in pilot's neck are common symptoms. During flying the cervical spine is often exposed to high Gravitational-Forces in a combination of rotation, lateral flexion, and neck extension.2 Many contributing factors have already been identified in the aetiology of flight-related neck pain: the number of flight hours, age, neck strength, head position and movements, sitting posture, and helmet.3 The maximum significant number of acute cervical uneasiness incidents was described in a Japanese study, where 89% of Japanese Air Self-Defence Force F-15 pilots reported muscle pain related to flying. The frequency of neck complaints among Swedish high-performance fighter pilots varies between 29–37%.4 Degenerative cervical disk changes are seen in high-performance aircraft pilots when Magnetic resonance imaging (MRI) studies are performed compared to the control group. Electromyography investigations show that pilots exposed to high G-forces over repeated, short periods use close to 100% of their neck extensor muscle strength.5 Physical therapy involves various muscle training exercises, manual therapy like cervical manipulations, and elastic bands for strengthening neck flexor and extensor muscles.6 G-induced neck injuries are a potential hazard to high-performance aircraft pilots. Therefore, the primary purpose of the current study is to determine possible differences in the cervical range of motion, neck position sense, and neck muscle strength between pilots with and without neck pain.

METHODOLOGY

Design
Narrative Review of Literature

Search Strategy
The search was conducted in the electronic data basis of PubMed, science direct, google scholar, SCI-HUB, and Medline Cochrane library since 2007 using the following terms ‘cervical rehabilitation’, ‘fighter pilots’ ‘physiotherapy management’, ‘physical performance’ and ‘assessment of the cervical spine rehabilitation in fighter pilots. Studies not included in the full-text article were unavailable, if it was published in any language other than English or if the study was not performed on humans.

Search Criteria
The search yielded 26 studies of which 13 were relevant to the study and included in the review throughout the review additional sources were sought to clarify the issue, and from this search articles specifically addressing the effects of cervical spine rehabilitation in fighter pilots were included. In addition, the reference list from published original and review articles was searched manually to identify other eligible studies.
Inclusion Criteria
The study included the narrative review if they were.
• Diagnosed with cervical injury or deformity.
• Exercise given for both controlled and observational studies.
• Pilots, including both males and females.
• Examined health-related outcomes.

Exclusion Criteria
The study was excluded from narrative review if they were.
• Undiagnosed pilots.
• Other spinal regions like the thoracic and lumbar.
• Any invasive intervention in the cervical region.

CERVICAL PAIN AMONG FIGHTER PILOTS AND TYPES
Cervical pain among fighter pilots is high compared to the general population. It has been reported that fighter pilots have a higher prevalence of flight-related neck injuries than pilots of other fixed-wing aircraft. Furthermore, the primary aircraft type has been reported to be an independent predictor for clinically significant neck pain. Higher aircraft performance (G-capability) has been coupled with increased neck injury prevalence. Its symptoms vary depending on the aircraft category, the age of the pilot, and the survey period. Neck pain is more common during training than in operational flying. Occupying a two-seat jet trainer’s back seat (flight instructor’s position) has also been associated to a higher severity of neck pain. When all neck disorders among BAF and RNLAF F-16 pilots were divided into non-flight-related and flight-related neck pain, it was found that 77% of the pilots who had experienced neck pain revealed that their complaints began when flying fighters. Among these pilots, 46% of the complaints were about direct inflight pain, and 54% of the protests had started (between 10 min and three h) after a flight.

TYPES
G-related disorders are often divided into acute and chronic flight-related neck pain. It has been proposed that the most common reasons for acute injuries are ligamentous injury or muscle strain. Disc protrusions and annular tears in the intervertebral discs due to intense high-performance flying have also been observed. Inflight neck injuries have been reported to lead to acute soft tissue injuries and fractures (compression fractures and the spinous process fracture) in the cervical spine. Acute inflight neck traumas (fractures and soft tissue injuries) occur in the lower part of the cervical spine (C4-7) or the associated discs.

![Figure 1: Study selection flow chart](image-url)
REVIEW OF LITERATURE

1. In a study by Tuomas Honkanen et al the effects of physical fitness, Gz exposure and cross-sectional muscle area (CSA) and their interface with fighter pilots’ spinal disorders and resulting flight duty limitations (FDL) are explored. The results exhibited an association between an isometric back endurance test and physical activity-related LBP. Considerably lower shoulder and neck muscle EMG activity at high Gz levels noted in Pilots with experience in flying high-performance aircraft (HPA) and pilots with no experience in HPA flying had a higher passive G-tolerance. Spinal disorder-induced FDL was not associated Gz exposure during the early career. Thus, the causes and development of spinal disorder-induced FDL are multifactorial. This study shows that pilot candidates who have better muscular endurance and a background in competitive sports are less likely to become under FDL due to neck and back problems in the future.6

2. Similarly Ohlander U et al concluded that, Low Back Pain (LBP) can be mitigated or even completely avoided if the individual possesses sufficient endurance in their trunk muscles. In a fighter pilot however, the causes of LBP can be attributed further towards the flight related mechanics. More sensitive, accurate and flight duty-related physical fitness tests, along with relationships between head movements and FDL, should be studied in particular.3

3. Veerle De Loose et al, aimed to determine possible differences in the cervical range of motion (CROM), neck position sense, and neck muscle strength between pilots with and without neck pain. The author screened for different motor skills so that deficits could be detected and retraining programs could be implemented when necessary. According to the results, individual retraining programs might reduce neck pain; therefore, a well-instructed training program to maintain a proper active CROM should be implemented. Future studies should investigate the effectiveness of this kind of program. There were no significant differences between healthy pilots and those with neck pain concerning neck muscle strength and position sense.7

4. Azusa Kikukawa et al, conducted a case study based on the air force pilots on F-15 Eagle. They surveyed 129 F-15 pilots from different air bases using a questionnaire. The occurrence rate of musculoskeletal problems in various types of aircraft was analysed according to the pilots' flying experience. Of the surveyed pilots, 89.1% reported muscle pains related to flying. The "checking six" position was the most common posture at the time of injury, followed by the "forward bend." Consistent muscle training was found to be effective in preventing injuries in fairly 62% of the study population. The study also brings attention to the significant impact of these flights on the physiology of the pilots gradually converting them into pathologies.4

5. The study by Burton et al, aimed to examine cervical muscle response to moderate +Gz force. This was achieved by the measurements taken through the Multi-Cervical Rehabilitation Unit and EMG. Specifically, the activated of sternocleidomastoid and erector spine muscles were evaluated during simulated flight training. The results showed that the posture of the neck along with activation and the onset of fatigue are important factors that contribute to the higher risk of injuries.9

6. Ång et al, conducted a case study in which 5 experienced fighter pilots twice flew a standardised 2.5-h program in a dynamic flight simulator; one session with NVG and one with standard helmet mockup (control session). Each session commenced with a 1-h simulation at 1 Gz followed by a 1.5-h dynamic flight with repeated Gz profiles varying between 3 and 7 Gz and including aerial combat manoeuvres (ACM) at 3-5 Gz. Large head-and-neck movements under high G conditions were avoided. The muscles of the anterior neck, upper and lower posterior neck, and upper shoulder were simultaneously measured using an EMG. It was found that Helmet-mounted NVG equipment showed excessive neck muscle activity, suggestive of increased muscle strain as a result of increased neck loading. The participants also informed about the increasing neck discomfort during sustained combat flights. Significant results portray evidence for increased risk of neck strain due to increased mechanical loading in sustained G manoeuvres.13

DISCUSSION
Fighter pilots are typically with a unique musculoskeletal profile. The cervical load exhibits ROM, Strength changes, which appear to manifest from adaptation from imposed demands. This may have been in response to the pilots continually working against +Gz to maintain a neutral head and trunk position during flying maneuvers where the head and trunk were in an extended position.3,9,10 The pilots entered flight training with strong healthy neck. Due to their initial strength levels a large increase between baseline and post-testing would not have been as likely.

Secondly, fighter aircraft pilots seem to suffer more from flight-related LBP, but +Gz exposure is not an independent risk factor for a limitation to fly. Risk factors of spinal disorder -induced FDL should be investigated further.3,11

CONCLUSION
In this manuscript, we have attempted to provide the reader with information regarding the rehabilitation of this unique patient population. No general preventive program exists that will suit all pilots; therefore, an individualized program should be introduced. Future research should evaluate the effectiveness of the implemented interventions. Several countermeasures are discussed in this manuscript related to the cervical pain among fighter pilots. The rehabilitation program for these patients must be well designed and progressive in nature with each phase consisting of specific goals and exercise. By following this approach, we believe the success of reducing pain in pilots will be improved.

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REFERENCES