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Neck loads and posture exposure of helicopter pilots during simulated day and night flights

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ABSTRACT

This study investigated neck loads and neck postures experienced by Canadian Forces (CF) helicopter pilots during routine simulator day and night flights. During the night flights pilots' helmets were equipped with night vision goggles (NVG) which have been implicated in the increase of neck pain amongst pilots. Pilot's postures were determined from video recordings of their flight missions to: (1) identify the neck postures assumed during day and night flight missions, and (2) determine the amount of biomechanical cervical spine loading experienced during these flights. Neck postures and peak and cumulative cervical kinetic loading were significant different ($P < 0.05$) between day and night. During night flights the percentage of work cycle spent in mildly flexed posture increased significantly from 43% during day flights to 74% during night flights. As well, cumulative reaction compression values significantly increased from 583 kN s to 694 kN s. The biomechanical results lend support to previous physiological investigations of NVG use and further justify the need for guidelines associated with NVG use.

Relevance to industry: The research highlights the biomechanical demands on the neck resulting from wearing a helmet with added weight from night vision equipment. The results have direct implication to military and commercial operators required to wear night vision equipment or added weight to the head.

1. Introduction

Neck pain among military pilots is a recognized concern in the air force community. Approximately 80% of Canadian helicopter pilots have reported experiencing pain related to flying the CH-146 Griffon helicopter, and 70% of pilots reported experiencing neck pain during actual flights (Adams, 2004). Similar findings have also been reported in Swedish (57%) (Ang and Harms-Ringdahl, 2006) and Australian (29%) (Thomae et al., 1998) militaries. Helicopter pilots need to visually scan the perimeter of their aircraft on a constant basis resulting in frequently tilting and turning of the head in awkward, non-neutral positions. Successful night flying requires pilots to wear night vision goggles (NVG) which greatly decrease peripheral vision. NVG use has also been associated with heightened neck pain in pilots (Weistra, 2001). For some pilots, the resultant neck pain is a debilitating condition impacting their job performance and quality of their lives. Wickes et al. (2005) reported that between 6 and 10% of the helicopter aircrew surveyed from the Royal Air Force had been temporarily relieved of flight duties (i.e. "grounded") at some point in their careers. Furthermore, these groundings resulted in 12–30 work days lost within the preceding calendar year as a result of neck pain.

The demands for operational effectiveness during flight missions has increased and modern technology, such as night vision goggles and head's up displays (HUD) are now required elements of the Canadian Forces (CF) pilot's head gear (Adams, 2004). The equipment is mounted anteriorly on the helmet and displays are positioned in front of the pilot's eyes. The majority of the NVG mass is concentrated in the display (Knight and Barbar, 2007) and some pilots counteract this imbalance by using a counterweight (CW) situated posteriorly at the base of their helmet. NVG and CW increase the mass of the helmet from 14 N to 36 N. This added weight alters the center of gravity of the pilot's helmet (Knight and Barbar, 1994). The empirical evidence of the counterweight effect is equivocal. Harrison et al. (2007c) reported less metabolic and hemodynamic stress to the trapezius musculature during NVG flights when pilots wore counterweights. Knight and Barbar (1994) and Winters and Peles (1990) reported an increase in sternocleidomastoid

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