

## NECK MUSCLE ACTIVITY DURING SHORT DURATION IMPACTS

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### INTRODUCTION

Helmet-mounted systems, such as night vision goggles and helmet-mounted displays, are designed to enhance pilot performance; however, they may also affect pilot safety during ejection due to the change in helmet inertial properties. The effects of variable helmet weight and bracing ability on subject response during impact are unknown. A useful tool for investigating the mechanics of bracing and the relationships to helmet weight and impact acceleration is electromyography (EMG). In addition, EMG can be used to establish the relationship between the potential for neck injury and the force exerted by the neck muscles due to bracing. Two recent studies were conducted at Wright Patterson Air Force Base (WPAFB) to investigate the effect of helmet weight and subject bracing on human response during impact. A better understanding of the relationship between bracing and injury potential can be used to develop detailed instructions for pilots during their training to reduce their injury potential through proper positioning and bracing in the event of an ejection.

### METHODS

The methodology for collecting EMG data during short duration acceleration experiments was developed during a -Gx (frontal) impact study on the Horizontal Impulse Accelerator (HIA) at WPAFB. Male and female volunteer subjects, 10 of whom were instrumented with EMG sensors, participated with the approval of an Institutional Review Board (IRB). The MyoMonitor Portable EMG system from DelSys recorded the data separately from the rest of the response measurements, which included head and chest acceleration, belt loads and seat loads. Helmet weights ranged from 0 lb (no helmet) to 4.5 lbs, and acceleration levels were 6, 7, 8 and 10 g. The muscles of interest were those that play a major role in neck position and stability: the upper trapezius and sternocleidomastoid (SCM). Phillips et al. examined the characteristic changes in the EMG data from these muscles that was associated with isometric muscle fatigue [1]. Past research, however, does not quantify timing and level of muscular activation during short-duration impact events. The sensors were placed on the right and left upper trapezius and SCM, over the belly of the muscles.

The collection of EMG data continued during a study that examined neck muscle strength and response during vertical impact with a variable weighted helmet. Male and female volunteer subjects participated in this study on the Vertical Deceleration Tower (VDT), also located at WPAFB. Anatomical landmarks were used for consistency of sensor placement, on the right and left upper trapezius and SCM. An on-board data acquisition system was employed to easily record and synchronize the EMG data with other acceleration and load data. Maximum Voluntary Contractions (MVC) data were collected for each subject before the experiment. Helmet

weights were 3.0, 4.0 and 5.0 lbs, with acceleration levels of 6, 8 and 10g.

### RESULTS AND DISCUSSION

EMG data were collected for 29 of the HIA tests. Root Mean Squared (RMS) time histories of the EMG voltage were calculated for each successful data collection. RMS amplitude analysis indicated that, in general, the muscular strain increased with increasing -Gx acceleration levels. Activity of both muscle groups was synchronized, by their RMS values, with head and neck motion. It was demonstrated that in fact the neck muscles can respond quickly to the short-duration impacts. Furthermore, the EMG system was able to collect these changes during the impact.

No muscle activity was observed in the SCMs during the -Gx pre-impact bracing period, while measurable muscle activation occurred in the trapezius. This was to be expected since the bracing required of the subjects is that of an isometric extension action and the SCMs primarily act in flexion. The neck muscle activation level generally increased when heavier helmets were worn (Figure 1). This was expected since the bracing levels were similar and the heavier helmet would require higher activation levels to keep the head stable and prevent head rotation during impact.

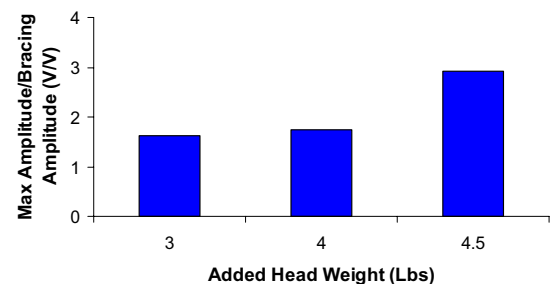


Figure 1. Increase of Trapezius activity with change in helmet weight during 8b impacts

### CONCLUSIONS

A method of collecting neck muscle activity data from the trapezius and SCM during short-duration impact experiments was successfully developed. EMG can be used to determine the activation timing of the muscles and to estimate the force produced by the muscles in a dynamic environment. This study showed that the muscles in the neck can and do react during the short time of these impacts. Because of these facts and this unique research, further studies are warranted to establish a relationship between potential for neck injury and muscle force.

### REFERENCES

1. Phillips CA, et al. Quantitative Electromyography: Response of the Neck Muscles to Conventional Helmet Loading, *Aviation, Space, and Environmental Medicine*, May 1983.