

# THE EFFECT OF MUSCLE ACTIVATION LEVEL ON THE WRIST AND ELBOW ACCELERATION RESPONSE FOLLOWING SIMULATED FORWARD FALLS

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## INTRODUCTION

Injuries to the upper extremity resulting from a forward fall are prevalent among the elderly, in-line skaters and the general workforce. The attenuating effects of the soft tissues to the effects of the impact reaction force may be dependent on the level of forearm muscle activation at impact [1]. The purpose of this study was to identify the effect of different levels of isometric forearm muscle activation on the acceleration responses at the wrist and elbow joints following a simulated forward fall.

## METHODS

A seated human pendulum simulated the flight phase of a forward fall, such that the extended upper extremities of 28 (15 male, 13 female) participants impacted 2 vertically mounted force platforms on the proximal palmar soft tissues.

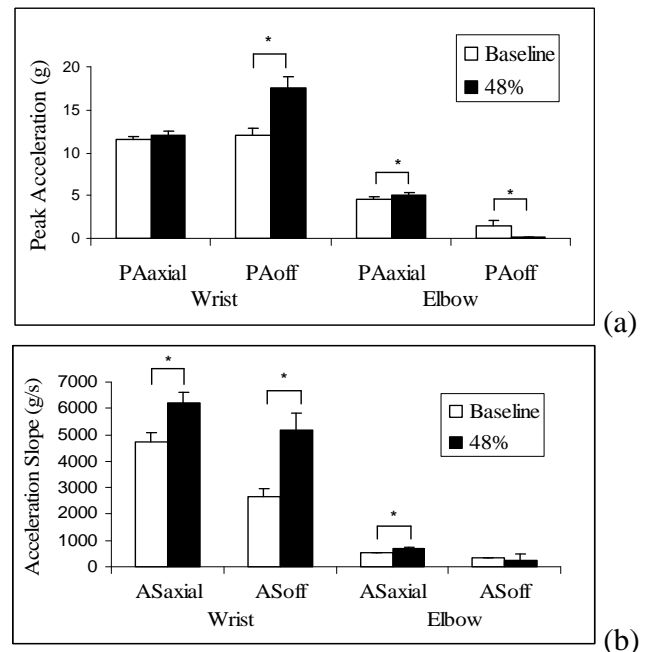
Two tri-axial accelerometers measured the impact response (peak acceleration (PA), acceleration slope (AS), and time to peak acceleration (TPA)) of the right wrist (radial styloid) and elbow (olecranon process) in the axial (parallel with the long axis of the forearm) and the off-axis (normal to the long axis) directions. EMG was recorded from the right flexor and extensor carpi ulnaris (FCU, ECU). Participants were asked to isometrically contract the ECU at 4 levels of MVE (baseline (12%), 24%, 36% & 48%) during impacts at velocities and forces of 1.0m/s and 0.5 BW, respectively. Wrist and elbow angles were maintained throughout the duration of the impact at 30°-40° of extension and 0° flexion (fully extended), respectively.

## RESULTS AND DISCUSSION

Acceleration responses increased over the range of muscle activations, with significant differences ( $p < 0.05$ ) found between baseline and 48%. At the wrist,  $AS_{axial}$ ,  $PA_{off}$  and  $AS_{off}$  increased by 34% (2084 g/s), 40% (6 g), and 50% (2500 g/s) from baseline to 48% MVE, respectively (Fig. 1). At the elbow, axial acceleration variables increased by an average of 16% over the range of muscle activation levels, whereas the off-axis variables decreased on average (e.g.  $PA_{off}$  decreased by 93%). FCU activation increased proportionally with the increases in ECU activation, reflecting significant co-contraction during the impacts.

The results presented here suggest that as the ECU muscle activation increased there was a subsequent increase in the forearm segment stiffness and axial acceleration responses at the wrist and elbow (i.e. increased shock transmission). This agrees well with comparable studies of the lower extremity [2, 3]. This effect appears more evident at the elbow, due

perhaps to the proximal distribution of the ECU muscle mass. The individual roles that the forearm muscles play with respect to attenuating impact shock is not understood to date and is the focus of future research efforts.



**Figure 1.** Differences between the baseline and 48% MVE for PA (a) and AS (b) at the wrist and elbow in the axial and off-axis directions (\*  $p < 0.05$ ).

Muscle activation of the intrinsic hand muscles may also have an effect on the stiffness of the palmar soft tissues, as is evident in the off-axis acceleration responses at the wrist. Furthermore, increased antagonistic (FCU) muscle activation during impact may be an attempt to increase joint stability; suggesting that an optimal stiffness/stability relationship may exist to minimize impact initiated injuries.

## CONCLUSION

Increases in forearm stiffness via increases in muscular activation were thought to result in increased axial acceleration responses at the wrist and elbow. Developing strategies to reduce the negative effects of these shock waves through the forearm via modifications to joint and segment stiffness may help offset any potentially injurious effects resulting from impact.

## REFERENCES

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