

# NECK MOTION DUE TO THE HALO-VEST IN PRONE AND SUPINE POSITIONS

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## INTRODUCTION

The halo-vest orthosis, introduced in 1959 by Perry and Nickel [1] to treat scoliosis or neck muscle paralysis, has been used since then to treat a variety of cervical spine injuries including Jefferson, odontoid, facet, and compression fractures. Previous clinical studies have suggested snaking motion due to the halo-vest during activities of daily living may lead to inadequate healing or nonunion. Snaking motion is defined as rotation in opposing directions throughout the cervical spine.

The objectives of this study were to evaluate motion of the injured cervical spine with normal halo-vest application and vest loose in the prone and supine positions.



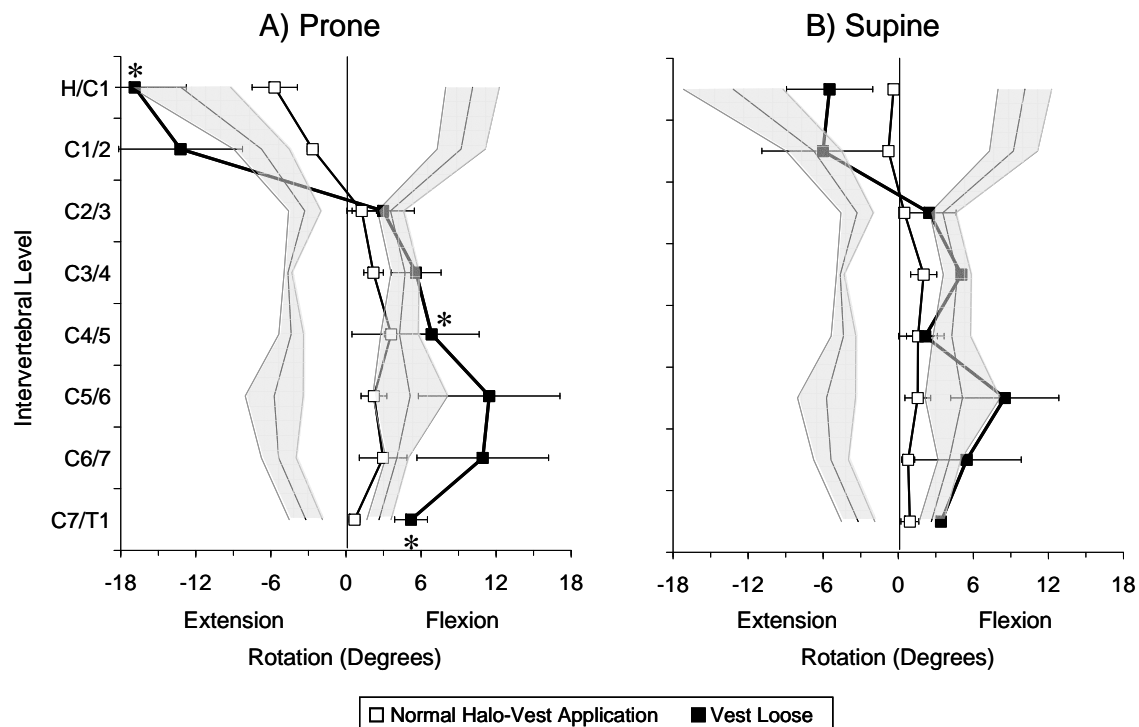
**Fig. 1.** Photograph of the Human Model of the Neck (HUMON) with the halo-vest. Motion tracking flags were fixed to the head, cervical vertebrae, and pelvis.

## METHODS

The halo-vest was applied to a Human Model of the Neck (HUMON), which consisted of a cervical spine specimen (n=4) mounted to the torso of an anthropometric test dummy and carrying a surrogate head (**Fig. 1**). HUMON was transitioned from prone, to upright, to supine with the halo-vest applied normally and with the vest loose. Average peak spinal motions were computed in the prone and supine positions and contrasted with the physiologic rotation range, obtained from the intact flexibility test, and statistically compared ( $P<0.05$ ) between normal halo-vest application and vest loose.

## RESULTS AND DISCUSSION

Snaking motion of the neck was observed in the prone and supine positions, consisting of extension at head/C1 and C1/2 and flexion at the inferior spinal levels (**Fig. 2**). The largest peak motions were generally observed in the prone position. The intervertebral rotation peaks generally exceeded the physiologic range throughout the cervical spine due to the loose vest in the prone position. Significant increases in the extension peaks at head/C1 ( $16.9^\circ$  vs.  $5.7^\circ$ ) and flexion peaks at C4/5 ( $6.9^\circ$  vs.  $3.6^\circ$ ) and C7/T1 ( $5.2^\circ$  vs.  $0.7^\circ$ ) were observed in the prone position due to the loose vest, as compared to normal halo-vest application. Axial separation was observed at all spinal levels due to the halo-vest, consistent with tensile load that has been observed clinically in halo-vest patients.



**Fig. 2.** Average peak rotations of spinal levels head/C1 through C7/T1 in **A)** prone and **B)** supine positions with normal halo-vest application and with the vest loose. The physiologic rotation range (average  $\pm$  1 SD) is indicated in grey shading for flexion and extension. Significant differences ( $P < 0.05$ ) in average peak motion between normal halo-vest application and vest loose are indicated with asterisks.

## CONCLUSIONS

1. The halo-vest was applied to a Human Model of the Neck, consisting of an injured cervical spine specimen mounted to the torso of an anthropometric test dummy and carrying a surrogate head. The model was used to evaluate neck motion patterns due to the halo-vest in the prone and supine positions and to evaluate the effect of vest loosening.

2. Average peak head/T1 rotation remained within the physiologic limit however the loose vest caused significantly greater head/T1 anterior shear and axial separation in the prone position, as compared to normal halo-vest application.

3. Snaking motion of the neck was observed in the prone and supine positions, consisting of extension at head/C1 and C1/2 and flexion at the inferior spinal levels.

4. In the prone position, the loose vest caused intervertebral rotation peaks which generally exceeded the physiologic range with significantly greater extension at head/C1 and flexion at C4/5

and C7/T1, as compared to normal halo-vest application.

5. The present results underscore the importance of proper vest fit and continued monitoring of strap tightness to reduce snaking motions of the neck in those treated with the halo-vest.

## REFERENCES

1. Perry et al. J Bone Joint Surg Am 1959;41-A:37-60.

## ACKNOWLEDGEMENTS

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