The Journal of Emergency Medicine, Vol. 41, No. 5, pp. 513–519, 2011

0736-4679/$ - see front matter

ELSEVIER

doi:10.1016/j.jemermed.2011.02.001

Selected Topics: Prehospital Care

CERVICAL COLLARS ARE INSUFFICIENT FOR IMMOBILIZING AN UNSTABLE CERVICAL SPINE INJURY

MaryBeth Horodyski, EDD,* Christian P. DiPaola, MD,† Bryan P. Conrad, PHD,* and Glenn R. Rechtine, II, MD†

*Department of Orthopaedics and Rehabilitation, University of Florida, Gainesville, Florida, and †Department of Orthopaedics, University of Rochester, Rochester, New York

Reprint Address: MaryBeth Horodyski, EDD, Department of Orthopaedics and Rehabilitation, 3450 Hull Road, University of Florida, Gainesville, FL 32607

☐ **Abstract—Background: Cervical orthoses are commonly used for extrication, transportation, and definitive immobilization for cervical trauma patients. Various designs have been tested frequently in young, healthy individuals. To date, no one has reported the effectiveness of collar immobilization in the presence of an unstable mid-cervical spine. Study Objectives: To determine the extent to which cervical orthoses immobilize the cervical spine in a cadaveric model with and without a spinal instability. Methods: This study used a repeated-measures design to quantify motion on multiple axes. Five lightly embalmed cadavers with no history of cervical pathology were used. An electromagnetic motion-tracking system captured segmental motion at C5–C6 while the spine was maneuvered through the range of motion in each plane. Testing was carried out in intact conditions after a global instability was created at C5–C6. Three collar conditions were tested: a one-piece extraction collar (Ambu Inc., Linthicum, MD), a two-piece collar (Aspen Sierra, Aspen Medical Products, Irvine, CA), and no collar. Gardner-Wells tongs were affixed to the skull and used to apply motion in flexion-extension, lateral bending, and rotation. Statistical analysis was carried out to evaluate the conditions: collar use by instability (3 × 2). Results: Neither the one- nor the two-piece collar was effective at significantly reducing segmental motion in the stable or unstable condition. There was dramatically more motion in the unstable state, as would be expected. Conclusion: Although using a cervical collar is better than no immobilization, collars do not effectively reduce motion in an unstable cervical spine cadaver model. Further study is needed to develop other immobilization techniques that will adequately immobilize an injured, unstable cervical spine. © 2011 Elsevier Inc.**

This research received support from a grant from NOSCAE, Southwest Medical Foundation, Dallas, TX, and Aspen Medical Products, Irvine, CA.

☐ **Keywords—cervical injury; immobilization; cervical collars; prehospital care; trauma**

INTRODUCTION

Use of cervical collars is an established technique for extrication, transport, and immobilization of the patient with a suspected cervical spine injury. Multiple studies have compared the relative effectiveness of these orthoses in the prevention of spinal motion. A study by Richter et al. evaluated orthoses for a C1–2 instability using a cadaver with an unstable injury and radiographic measures (1). Other studies have used radiographic or video techniques to measure restriction of motion in healthy individuals with no instability (2–6). The effectiveness of collar immobilization has been indirectly evaluated in other studies involving cadavers and induced instabilities (7–17). In each of these studies, collars were used in an attempt to reduce spine motion during one or more transfer techniques. The purpose of this study was to determine the extent to which the cervical

RECEIVED: 21 January 2010; FINAL SUBMISSION RECEIVED: 8 June 2010;
ACCEPTED: 13 February 2011

spine is immobilized by cervical orthoses in a cadaveric model with and without a spinal instability.

METHODS

Five lightly embalmed whole body cadavers were utilized for this study. Lightly embalmed cadavers have the same soft tissue flexibility as fresh cadavers, but the minimal embalming allows them to be used for a longer time (18). A Liberty motion analysis device (Polhemus, Inc., Colchester, VT) was used to capture motion relative to the C5 and C6 vertebral bodies. This level was chosen because surveys of spinal injuries in sports report that a greater number of catastrophic cervical injuries occur in the lower cervical spine (19). The soft tissues overlying the anterior cervical spine were resected to allow for rigid attachment of sensors to the anterior vertebral bodies of C5 and C6. The Liberty system uses a transmitter of an electromagnetic field to measure relative motion between the sensors with embedded orthogonal coils that detect position and orientation. This technique has been described previously in several of our publications (8,9,12).

Testing was first performed on the intact spine (some superficial dissection was necessary to place the sensors). The primary outcome measurements were ranges of motion (flexion, extension, lateral bending, and rotation) occurring in the cervical spine. Range of motion (ROM) testing was repeated for the three collar conditions: a one-piece extraction collar (Ambu® Perfit, Ambu Inc., Linthicum, MD), a two-piece collar (Sierra Universal Collar, Aspen Medical Products, Irvine, CA), and without a collar. The order in which collar conditions were tested was randomized using a computerized random number generator.

The collars were applied by an orthopedic spine surgeon and certified orthotist. Gardner-Wells tongs were affixed to the skull and used to apply force to assess the movements of flexion, extension, lateral bending, and rotation. Using the tongs, the cadaver's head was placed in the neutral anatomical position. The spine surgeon began the application of force to move the head in one of the motions being tested. The cadaver's head was returned to the neutral position between trials. During testing, a third researcher (certified athletic trainer) stabilized the shoulders and upper torso to ensure that the measured motion was at the cervical level and not confounded with extraneous movements. The fourth researcher was the biomedical engineer responsible for controlling the Polhemus system.

The Polhemus system was used to capture segmental motion at C5–C6 while the spine was manually maneuvered through the ROM in each plane. A spring scale was used to measure a secondary outcome measure, which was the amount of force required to reach the extremes of the ROM. Data were recorded on a personal computer using custom LabVIEW software (National Instruments Corporation, Austin, TX) at a rate of 240 Hz.

After testing in the intact condition, a global instability was then created by an orthopedic spine surgeon at the C5–C6 level by sectioning the supraspinous and interspinous ligaments, the facet capsules, the posterior longitudinal ligament, the anterior longitudinal ligament, and the intervertebral disk through an anterior and posterior surgical approach. The movements (flexion, extension, lateral bending, and rotation) were then repeated and the ROM was recorded for the three collar conditions on the unstable spine. All movements were repeated twice for each cadaver. A repeated-measures analysis of variance was performed to analyze the following conditions: collar use (three levels: one-piece collar, two-piece collar, no collar) and instability (2 levels: intact and unstable). The Bonferroni adjustment was used because multiple comparisons were analyzed.

RESULTS

For all measures except extension, there was significantly more motion in the unstable state than the intact state (flexion, $p = 0.013$; right bending, $p = 0.022$; left bending, $p = 0.008$; right rotation, $p = 0.024$; left rotation, $p = 0.002$) (Figures 1–6). Extension measured in the unstable spine was greater than in the stable spine, but was not statistically different ($p = 0.59$) (Figure 2). In the unstable spine, the amounts of motion occurring in the one-piece, two-piece, and no-collar tests were not significantly different; however, the collars restricted motion better than no collar for five of the six conditions (Tables 1–6). The exception was left bending (Figure 4), where slightly more motion was measured when the one-piece

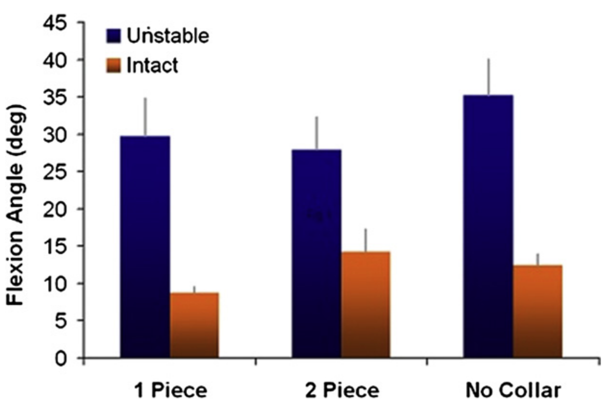

Figure 1. Degrees of flexion possible in intact and unstable cervical spines during bed transfer were significantly different ($p = 0.013$). Values are mean and error bars show standard deviation. Differences between collar conditions were not statistically significant.