BRIEF REPORT

Motion Within the Unstable Cervical Spine During Patient Maneuvering: The Neck Pivot-Shift Phenomenon

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Background: Cervical extrication collars are applied to millions of blunt trauma victims despite the lack of any evidence that a collar can protect against secondary injuries to the cervical spine. Cadaver studies support that in the presence of a dissociative injury, substantial motion can occur within the occipitocervical spine with collar application or during patient transfers. Little is known about the biomechanics of cervical stabilization; hence, it is difficult to develop and test improved immobilization strategies.

Materials: Severe unstable injuries were created in seven fresh whole human cadavers. Rigid collars were applied with the body in a neutral position. Computed tomographic examinations were obtained before and after tilting the body or backboard as would be done during patient transport or to inspect the back. Relative displacements between vertebrae at the site of the injury were measured from the Computed tomographic examinations. The overall relative alignment between body and collar was assessed to understand the
mechanisms that may facilitate motion at the injury site.

Results: Intervertebral motion averaged 7.7 mm _ 6.8 mm in the axial plain and 2.9 mm _ 2.5 mm in the cranial-caudal direction. The rigid collars appeared to create pivot points where the collar contacts the head in the region under the ear and where the collar contacts the shoulders.

Discussion: Rigid cervical collars appear to create pivot points that shift the center of rotation lateral to the spine and contribute to the intervertebral motions that were measured. Immobilization strategies that avoid these neck pivot-shift phenomena may help to reduce secondary injuries to the cervical spine. The whole cadaver model with simulation of patient maneuvers may provide an effective test method for cervical immobilization.

Cervical extrication collars are applied to millions of blunt trauma victims, with the intent of protecting the occipitocervical spine in the rare event of a severe injury.1 There is evidence that collars can restrict motion of the head when applied to healthy, uninjured volunteers.2 However, there is no evidence that collars can effectively protect against secondary injuries to the vital structures of the neck in the presence of a severe dissociative injury.2 Preliminary evidence suggests that collars do not protect the unstable spine during patient transfers.3–5 A recent whole human cadaver study documented the separation that can occur between cervical vertebrae when an extrication collar is applied in the presence of a severe dissociative injury.6 The prior whole cadaver study only considered one aspect of spine immobilization protocol, the initial effect of collar application to a prone body aligned on a back board.6 However, during patient transport, transfers, and tilting the patient to examine the back, a wide range of motions can occur. Collars are specifically intended to protect the spine during motions associated with these patient maneuvers. The purpose of this study was to provide additional data to better understand the biomechanics of cervical immobilization with collars during patient maneuvers and to identify strategies that may help to achieve more effective immobilization technology.

MATERIALS AND METHODS

Seven fresh whole human cadavers were obtained through the anatomic gifts program at the Department of Anatomy, Baylor College of Medicine. They were kept in a refrigerated state (2°C) before use and examined at room temperature after cessation of rigor mortis, when their neck motion was indistinguishable from that of asymptomatic live volunteers.7–9 None of the cadavers had any prior cervical conditions, interventions, or anomalies that could potentially interfere with intervertebral motion. The anterior and posterior restraints to intervertebral motion between the first and second cervical vertebrae were surgically destroyed through a midline posterior incision. The muscles were first carefully dissected longitudinally away from the posterior elements and their fascial and ligamentous attachments, but were otherwise left intact. A dissociative injury was simulated by severing the nuchal ligament, the left and right facet joint capsules, the tectorial membrane, the inferior aspect of the cruciate ligament, and the anterior longitudinal ligament. In addition, the odontoid was severed at its base from the body of C2. The damage created to the ligaments, facet joints, and odontoid was intended to replicate injury patterns observed in our trauma patients and in previously reported dissociative injuries.10–12 The presence of a severely unstable injury, and initial reduction of any surgically created mal-alignment, was verified by fluoroscopic imaging. In all cadavers, a conventional extrication collar (Ambu Perfit Ace, Ballerup, Denmark) was applied using routine emergency medical service protocol. Collars were

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