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Helmet and Shoulder Pad Removal From a Player With Suspected Cervical Spine Injury: A Cadaveric Model

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Abstract

Study Design. Video fluoroscopy was used to evaluate the motion in an unstable spine during helmet and shoulder pad removal.

Objective. To observe the amount of motion that occurs during the removal of helmet and shoulder pads in an injured spine.

Summary of Background Data. Removal of shoulder pads and helmet from a football player with suspected cervical spine injury can be particularly hazardous. How much flexion occurs at the unstable level during removal of equipment is unknown.

Methods. Six fresh cadavers were used in the study. In three, an unstable C1-C2 segment was created by transoral osteotomy of the base of C2. In the remaining three, instability was created at C5-C6 by a posterior release. Under fluoroscopic recording, the helmets were removed by first removing the chin strap, face mask, and ear pieces. With the neck stabilized, the helmet was carefully removed. The shoulder pads were carefully removed, with the head stabilized. Angulation, distraction, and space available for the cord were measured at C1-C2. Translation, angulation, distraction, and change in disc height were measured in the specimens with unstable C5-C6.

Results. In cadavers with C1-C2 instability, the mean change in angulation was 5.47°, and space available for the cord was 3.91 mm. Shoulder pads were removed while the head was stabilized. The mean change in angulation at C1-C2 was less during removal of shoulder pads than during helmet removal at 2.9°. Space available for the cord was 2.64 mm. Distraction was also greater during helmet removal (2.98 mm) than during shoulder pad removal (1.76 mm). In the unstable spine, the change in displacement in translation wasgreater during shoulder pad removal (3.87 mm), than during helmet removal (0.41 mm). Disc height change was similar. Distraction of the spinous processes was greater during helmet removal (3.68 mm) than during shoulder pad removal (1.37 mm). Angulation was similar in both maneuvers.

Conclusions. Helmet and shoulder pad removal in the unstable cervical spine is a complex maneuver. In the unstable C1-C2 segment, helmet removal causes more angulation in flexion, more distraction, and more narrowing of the space available for the cord. In the lower cervical spine (C5-C6), helmet removal causes flexion of 9.32°, and during shoulder pad removal the neck extends 8.95°, a total of approximately 18°. Disc height changes from 1.24 mm of distraction to 1.06 mm of compression during helmet removal and shoulder pad removal for a total 2.3-mm change. Translation, which correlates with the change in the space available for the cord, is greater at C5-C6 during shoulder pad removal. Because most of the cadavers had C5 anteriorly displaced on C6 to begin with, the extension force during shoulder pad removal caused a 3.87-mm change in reduction of C5 on C6. Because of the motion observed in the unstable spine, helmet and shoulder pad removal should be performed in a carefully monitored setting. They should be removed together by at least three, preferably four, trained people.

Recent injuries to athletes involved in football, hockey, and competitive horseback riding have focused attention on cervical spine injuries and associated quadriplegia. Most accidents result in injuries to the midcervical spine, particularly at C5-C6, but the most commonly missed injuries are at C1-C2. Torg et al 6 originally brought attention to this problem by the establishment of a National Football Head and Neck Injury Registry in 1971. Through their efforts and those of others, dangerous tackling and blocking techniques have been banned, and the occurrence of quadriplegia has therefore declined significantly during the past 20 years.

Managing a player with a cervical spine injury, specifically the removal of helmet and shoulder pads, remains a poorly understood problem. Swenson et al 5 studied the effects of removing the shoulder pads and helmet on overall cervical alignment in healthy people. They noted that sagittal alignment increased in extension when the helmet was removed and the shoulder pads were left in place. They recommend, therefore, delaying helmet removal until both helmet and shoulder pads can be removed in a controlled setting.

Swenson et al 5 looked at the static position of the neck before and after shoulder pad and helmet removal. The current study was designed to observe directly the effects of removal of the helmet and shoulder pads in a cadaveric model of cervical instability. The object of the study was to determine how much motion occurs in a cadaver with two types of cervical spine injuries when helmet and shoulder pads are removed.

Materials and Methods

Six fresh cadavers were used. In three (Group I), unstable C1-C2 segments were created by transoral osteotomy at the waist of the odontoid process, which caused a Type II odontoid fracture. In the remaining three (Group II), instability was created at C5-C6 by sectioning through a posterior approach the interspinous ligaments, facet capsules, posterior longitudinal ligaments, and posterior one third of the disc. Instability was then documented fluoroscopically during flexion and extension. The subject-to-source distance was held constant while the recordings were performed. Four people removed the shoulder pads and helmet according to the technique prescribed by the National Athletic Trainer's Association, while the unstable segment was continuously monitored and recorded under fluoroscopy. The helmets were removed by first removing the face mask, unfastening the chin strap, and removing the ear pieces. With the neck stabilized, the helmet was removed. As fluoroscopic recording continued, the shoulder pads were removed while the head was stabilized. The maximum displacements were recorded during these maneuvers and subtracted from the images obtained before helmet and shoulder pad removal. The fluoroscopic images were then transferred to a floppy disk by a commercial frame-grabbing package (Targa Card; Video Capture Card), and measurements were made using an imaging software package (Sigma Scan; Jandel Scientific, Corte Madera, CA). As in previous studies by the current investigators,1-3 an inserted endotracheal tube was used to standardize measurements to eliminate the effect of magnification. Measurements were then made according to figures 1 and 2, examining the angulation, distraction, and space available for the cord in Group I. The angulation was measured between the base of C2 and a line through the midportion of the ring of C1. Distraction was measured between the posterior ring of C1 and the spinal lamina line superiorly at C2. Space available for the cord was measured from the ring of C1 perpendicular to the posterior body of C2.

In Group II, translation was measured as the distance between the back of the body at C5 and C6, disk height was measured between the endplates of C5 and C6, distraction was measured from the superior portion of the spinal laminar line of C5 and C6, and angulation was measured between the vertebral endplates of C5 and C6.

Results

The instability created by the osteotomy of C2 is recorded in Table 1. Helmet removal caused a change in angulation of 5.47°, distraction of 2.98 mm, and a change in the space available for the cord of 3.91 mm. Shoulder pad removal resulted in a change in angulation of 2.9°, distraction of 1.76 mm, and a change in the space available for the cord of 2.64 mm. Because these were positive values, the changes in angulation were also in flexion, and measurements all represented less space available for the cord.

The unstable C5-C6 model was recorded similar to a method described previously.3 Helmet removal created a 0.41-mm change in translation, a 1.24-mm change in disk height, a 9.32° change in flexion, and a 2.68-mm distraction. With shoulder pad removal, translation was 3.87 mm, the change in disk height was 1.06 mm, distraction was 2.37 mm, and the change in angulation was 8.57° in extension (Table 2). The change in translation correlated with a decreased space available for the cord but was reported in this manner to maintain consistency with the previously used method.

Discussion

Helmet and shoulder pad removal in the athlete with a suspected spinal cord injury or cervical fracture must be performed in a controlled setting. In earlier studies, investigators have suggested that helmet and shoulder pad removal should be accomplished at the same time to diminish the chance of abnormal alignment that may occur with helmet removal alone.5 This method is similar to that used in young children who are immobilized on a standard back board and results in relative cervical flexion because of the large size of the head.[4] Swenson et al [5] have shown that helmet removal without shoulder pad removal results in relative extension of the cervical spine and may be dangerous.

Vegso and Torg et al [7] have outlined the proper transport of a patient from the field into a controlled environment in which the equipment can then be removed. The face mask can be removed while the player is on the field, but the helmet should remain in place. Once the athlete is in a medical facility, the chin strap is removed as are the cheek pads. The head is supported by the occiput as the ear pieces are widened and the helmet is removed, with the head maintained in line with the spine. With the head stabilized, the shoulder pads are then removed. Safely accomplishing this technique requires four people. In general, football players are large, and four people are required to turn the patient supine if the injured player is prone on a stretcher or spine board. Generally, the one person is in charge of the head, one the shoulder region, one the hips, and one the legs. Once the player is on a spine board and supine, the mask can be removed by cutting the plastic loops with a knife. The actual helmet and shoulder pad removal should not be attempted on the playing field but should be performed with a minimum of three people once in a controlled environment. One person should be in charge of the helmet, taking out the ear pieces and cheek pieces, and widening the helmet at the ears. A second person should control the neck while the third counteracts the forces on the torso. The helmet can then be safely removed with the neck stabilized by the second person. Shoulder pads can then be removed with the head and neck stabilized by two other people and a collar safely applied.

In the current study, the effects of helmet and shoulder pad removal on the injured cervical spine were examined in a cadaveric model. With C1-C2 instability, the occipitocervical complex flexed an average of 5.47° during helmet removal, causing a narrowing of the space available for the cord of 0.41 mm. Shoulder pad removal created 2.9° of flexion and a 2.64-mm change in the space available for the cord. At C5-C6, however, helmet removal caused 9.32° of flexion while the helmet was removed, which narrowed the space available for the cord in translation by 0.41 mm. Shoulder pad removal caused 8.57° of extension. Even using the prescribed technique, almost 18° of flexion-extension occurred in the injured C5-C6 during helmet and shoulder pad removal. Translation also occurred, which correlated to a decreased space available for the cord of 3.87 mm. During the removal of the helmet in cadavers with the C5-C6 injury, the disc was distracted an average of 1.24 mm and compressed 1.06 mm, so that there was a total change in disc height of 2.3 mm. Because most of the cadavers had C5 anteriorly displaced on C6 to begin with, the extension force of shoulder pad removal caused a 3.87-mm change, with reduction of C5 on C6.

White and Panjabi [8] considered radiographic criteria for instability of the lower cervical spine to be more than 3.5-mm translation or greater than 20° rotation on flexion-extension films, and more than 11° on static films. Although all cadavers showed this amount of translation before the studies after posterior release of C5-C6, some showed this amount of motion during the maneuvers. However, by White's and Panjabi's definition, all of the cadavers were rendered unstable. At C1-C2, White and Panjabi considered more than 4 mm of space available for the cord to be markedly unstable. All cadavers showed this instability after transoral osteotomy of C2. During the removal of the helmet, translation approached 4 mm (3.87 mm). It is difficult to relate the criteria to the cadavers, because spines in all cadavers were rendered unstable; the significance of the magnitude of motion occurring in an already unstable spine is unknown.

It is unknown how much narrowing of the space available for the cord or how much translation is safe before neurologic injury is precipitated or worsened. It is assumed that the least amount of motion possible is best, but there is no critical level at which injury is known to occur. Even with the head stabilized in ideal conditions similar to those in this study, the C5-C6 segment went through 18° of flexion and extension, disc height changed 2.3 mm, including distraction and compression, and approximately 2.5 mm translation occurred. At C1-C2, there appears to be less flexion and extension during equipment removal, but the change in the space available for the cord was almost 4 mm.

Although the results show the motion that occurs during removal of the helmet and shoulder pads in the unstable spine, safe criteria were not determined. Determining such criteria was not the intent of the study. Although no new recommendations for helmet and shoulder pad removal can be concluded from this study, the information gained shows that a significant amount of motion occurs, even in the best clinical setting. Muscle spasms in the conscious injured player may alter the findings in this study, the results of which are similar to those in the unconscious person.

In conclusion, significant, potentially dangerous motion occurs in the presence of an unstable cervical spine injury during shoulder pad and helmet removal, even in the idealized conditions of the current study. The purpose was not to explore alternative equipment removal techniques, although the findings show that the presently accepted method may not be ideal. It is essential, however, that people involved in the care of football players be aware of the limitations of this technique.

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