

## CASE REPORT

# The Initial Lateral Cervical Spine Film for the Athlete with a Suspected Neck Injury: Helmet and Shoulder Pads On or Off?

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### INTRODUCTION

Plain radiographs remain the only reliable way to exclude cervical spine derangement during the initial Emergency Department (ED) evaluation of the athlete with a suspected neck injury. There have been no studies to evaluate whether the cervical spine can be adequately visualized when a helmet and shoulder pads remain on while the lateral cervical spine scout film is done in the ED trauma suite. The objective of our investigation was to determine whether a helmet and shoulder pads interfere with the assessment of the cervical spine on this initial ED radiographic evaluation.

### CASE REPORT

After consent, an uninjured adult male volunteer (age 29, medium frame) was fully immobilized on a spine board under the following conditions: 1) no equipment on, 2) football helmet (Riddell with cage facemask/NOCE approved) and shoulder pads (Riddell Air-Pac/AP55 linebacker) on, and 3) hockey helmet (CCM Jr. Type 1/M90/HECC approved) and shoulder pads (Cooper Techniflex/SP 900) on.

A single lateral cervical spine scout film was done for each of the three immobilization scenarios using a Philips PMX 2000 portable X-ray unit. A constant plate focal distance of 40 inches and a 70 kilovolt peak (KvP) was used for each film. Exposure time was adjusted by the radiology technician for each equipment scenario to maximize cervical spine visualization. Initial postexposure film quality was judged as acceptable by the radiology technician and an attending radiologist not involved in the study.

Radiographic analysis was done by 11 attending emergency physicians and 9 attending radiologists. Interpretative impressions were recorded postanalysis on a questionnaire. Visualization adequacy at each cervical spine

level was interpreted with a yes or no response. If a negative response was given, the reviewer was asked to record what the obstruction was.

Outcomes measured included: 1) visualization of all seven cervical vertebrae, 2) visualization of the upper cervical spine (C1 and C2), and 3) visualization of the lower cervical spine (C3–C7/T1). Data were analyzed using a one-sample exact test for proportions. Exact confidence intervals (CI) for the relative proportions were calculated at the 95% level. A power analysis done a priori determined that 20 reviewers were needed to yield CIs precise enough to answer the questions. Table 1 summarizes the results.

Film 1 was the lateral scout film done with no equipment on (Figure 1). Ninety percent (18/20) of the reviewers were able to visualize all seven vertebrae. The upper cervical spine was adequately visualized by 100% (20/20) of the reviewers. The lower cervical spine was likewise adequately visualized by 100% (20/20) of the reviewers, however, all were unable to visualize the C7/T1 interspace. Ninety percent (18/20) of the reviewers would have repeated the lateral scout film with either a Swimmer's view or mechanical depression of the shoulders by pulling on the arms during the film (CI: 0.683–0.988).

Film 2 was the lateral scout film done with a football helmet and shoulder pads on (Figure 2). None (0/20) of the reviewers could adequately visualize all seven cervical vertebrae. Likewise, none (0/20) could adequately visualize the upper cervical spine. All cited obstructing metal hardware in the shoulder pads as the reason. The lower cervical spine was adequately visualized at C3 and C4 by 20% (4/20) of the reviewers, and at C5 and C6 by 50% (10/20) of the reviewers. At each level, obstructing metal hardware was again cited as the cause of inadequate visualization. None (0/20) of the reviewers could visualize C7 or the C7/T1 interspace. Ninety-five percent (19/20) of the reviewers would have repeated the lateral scout film (CI: 0.751–0.999) with 17 recommending prior removal of the helmet and shoulder pads, and 2 recommending removal of the shoulder pads only.

Film 3 was the lateral scout film done with a hockey helmet and shoulder pads on (Figure 3). Twenty percent

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**TABLE 1.** Proportion of reviewers able to visualize cervical spine (C-spine)

	No equipment		Football		Hockey	
	Film 1	95% CI	Film 2	95% CI	Film 3	95% CI
All 7 Vertebrae	90%	(0.683–0.988)	0%	(0.000–0.168)	20%	(0.057–0.437)
Upper C-spine	100%	(0.832–1.000)	0%	(0.000–0.168)	100%	(0.832–1.000)
Lower C-spine						
C3 and C4	100%	(0.832–1.000)	20%	(0.057–0.437)	100%	(0.832–1.000)
C5 and C6	100%	(0.832–1.000)	50%	(0.272–0.728)	95%	(0.751–0.999)
C7 and C7/T1	0%	(0.000–0.168)	0%	(0.000–0.168)	0%	(0.000–0.168)

(4/20) were able to adequately visualize all seven cervical vertebrae with all the reviewers citing the inability to visualize the C7/T1 interspace. All (20/20) of the reviewers adequately visualized the upper cervical spine. The lower cervical spine was adequately visualized at the C3 and C4 level by 100% (20/20) of the reviewers, and at the C5 and C6 levels by 95% (19/20), with one reviewer citing metal as the cause of obstruction. All (20/20) of the reviewers would have repeated the lateral scout film (CI: 0.832–1.000), with 15 recommending either a Swimmer's view or mechanical depression of the shoulders and 5 recommending prior removal of the helmet and shoulder pads.

### DISCUSSION

There has been considerable debate regarding the location and timing of helmet and shoulder pad removal in an athlete with a suspected neck injury. Several radiographic studies have documented the excessive lordosis

**FIG. 1.** No helmet and shoulder pads.

that results from isolated helmet removal and the excessive flexion that results from isolated shoulder pad removal.<sup>1–5</sup> These same studies verify that no significant difference in cervical spine sagittal alignment exists when either no equipment or both helmet and shoulder pads are worn. Fluoroscopic studies done during helmet and shoulder pad removal have documented that significant translation and angulation of both the upper and lower cervical spine occur during helmet and shoulder pad removal<sup>3,6</sup> even with a standard three-person removal technique.<sup>7,8</sup> Therefore the current consensus supports prehospital Emergency Medical Service transport of the athlete with a suspected neck injury with the helmet and shoulder pads remaining on and subsequent removal of both pieces of equipment simultaneously in a controlled hospital setting.<sup>9</sup>

The dilemma facing those providing the initial assessment and treatment of the athlete arriving in the ED with a suspected neck injury is whether to remove the helmet and shoulder pads before or after the initial lateral cervical spine scout film. All sports helmets and many shoulder pads have metal and plastic components that theoretically could interfere with adequate visualization of the cervical spine on the lateral cervical spine scout film. If these components did not allow adequate visualization, then the helmet and shoulder pads would have to either be removed or mechanically altered prior to the scout film to enable film interpretation. If no interference was evident, however, then they could remain in place during the initial clinical and radiographic assessment in the ED. At the present time, the practice differs between institutions and clinicians. Recommendations have been made; however, none have been validated based on radiographic outcome studies.

Our results indicate that adequate cervical spine visualization is not possible when a football helmet and shoulder pads remain in place during the lateral cervical spine scout film. Obstructing metal hardware contained in the shoulder pads completely obscured the upper cervical spine. The lower cervical spine was judged to be adequately visualized by 20–50% of the reviewers; however, this is still unacceptable. Several reviewers cited difficulty in indentifying the correct cervical level because visualization of the upper cervical spine was so obstructed.

The hockey helmet and shoulder pads, however, allowed adequate visualization of all but C7 and the C7/T1 interspace. Of note, the no-equipment scenario also ob-

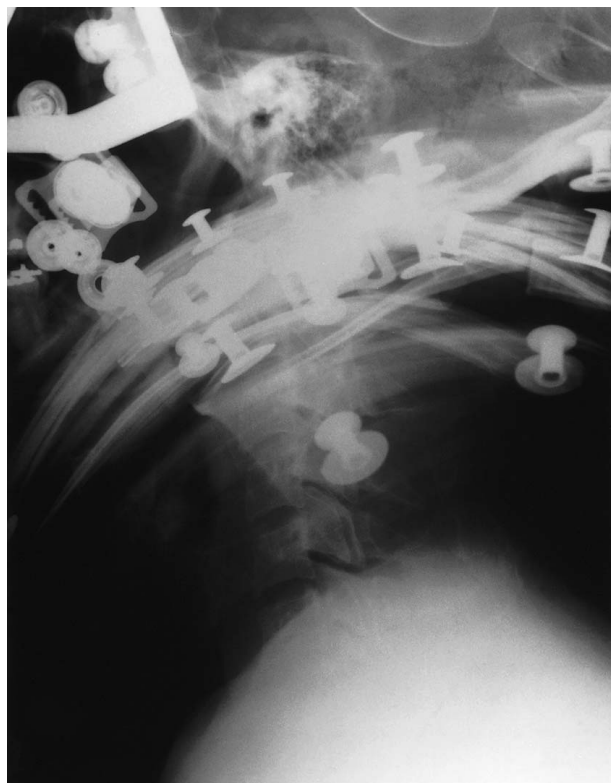


FIG. 2. Football helmet and shoulder pads.

scured the C7/T1 interspace. This is a common occurrence with the lateral cervical spine scout film, and adequate visualization at this level often requires a Swimmer's view or mechanical shoulder depression by pulling on the patient's arms during the scout film.<sup>10</sup>

Based on these findings the following recommendations are proposed:

1. Hockey helmets and shoulder pads allow adequate initial visualization and can remain on during the lateral cervical spine scout film. Visualization of C7 and the C7/T1 interspace will likely require mechanical depression of the shoulders by an assistant or a Swimmer's view.
2. Football helmets and shoulder pads do not allow adequate visualization on the initial lateral cervical spine scout film. Several options are available to the clinician in the ED:
  - a. Removal together prior to the lateral scout film using the standard three-person removal technique described in the literature ( see refs. 7 and 8)
  - b. Mechanical alteration of the shoulder pads prior to the lateral scout film. This would entail removal of the anterior shell of the shoulder pads while leaving the posterior shell intact. Theoretically the absence of the anterior shell should allow improved visualization while the intact posterior shell provides stability.
  - c. Use of computed tomography scan as the initial imaging option prior to helmet and shoulder pad removal in the athlete with a high suspicion of



FIG. 3. Hockey helmet and shoulder pads.

cervical spine injury (severe neck pain/neurologic deficit). This is technically feasible, however, timely access in a busy ED is often an issue.

The primary limitation of this preliminary study is that a single uninjured volunteer with one type of body frame was studied. The effects of postinjury muscle spasm and different types of body frame are unknown, therefore the results can not be generalized. A larger sample would validate the conclusions; however, it is our opinion that any effects of muscle spasm and changes in body frame would primarily impact visualization at C7 and the C7/T1 interspace, which have already been elucidated and addressed in our model. Repeating the study on injured patients in the clinical setting is not feasible.

Future studies should address the proposed mechanical alteration of the anterior shell of the shoulder pads prior to the lateral scout film and any impact this would have on cervical spine visualization and stability. Also, different helmet and shoulder pad combinations need to be studied (e.g., lacrosse) with a compilation done of their various radiopaque characteristics. This would serve as a resource for potential equipment redesign with alternative radiolucent materials.

## REFERENCES

1. Gastel JA, Palumbo MA, Hulstyn MJ. Emergency removal of football equipment: a cadaveric cervical spine injury model. *Ann Emerg Med* 1998;32:411-417.

2. Palumbo MA, Hulstyn MJ, Fadale PD, et al. The effect of protective football equipment on alignment of the injured cervical spine: radiographic analysis in a cadaveric model. *Am J Sports Med* 1996; 24:446-453.
3. Prinsen RKE, Syrotuik DG, Reid DC. Position of the cervical vertebrae during helmet removal and cervical collar application in football and hockey. *Clin J Sport Med* 1995;5:155-161.
4. Swenson TM, Laueran WC, Blanc RO, et al. Cervical spine alignment in the immobilized football player: radiographic analysis before and after helmet removal. *Am J Sports Med* 1997;25: 226-230.
5. Metz CM, Kuhn JE, Greenfield ML. Cervical spine alignment in immobilized hockey players: Radiographic analysis with and without helmets and shoulder pads. *Clin J Sport Med* 1998;8:92-95.
6. Donaldson WF, Laueran WC, Heil B, et al. Helmet and shoulder pad removal from a player with suspected cervical spine injury: a cadaveric model. *Spine* 1998;23:1729-1733.
7. Feld F. Management of the critically injured football player. *J Athl Train* 1993;28:206-212.
8. Patel MN, Rund DA. Emergency removal of football helmets. *Phys Sportsmed* 1994;22:57-58.
9. Waninger KN. On-field management of potential cervical spine injury in helmeted football players: leave the helmet on! *Clin J Sport Med* 1998;8:124-129.
10. Shaffer MA, Doris PE. Limitation of the cross-table lateral view in detecting cervical spine injuries: a retrospective study. *Ann Emerg Med* 1981;10:508-513.