An Ongoing Series

Walking the Plank

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CONCEPTS AND OBJECTIVES

The series objective is to review various clinical conditions/presentations, including the latest evidence on management, and to dispel common myths. In the process, core knowledge and management principles are enhanced. A clinical case will be presented. Cases will be drawn from real life but phrased in a context that is applicable to the Special Operations Forces (SOF) or tactical emergency medical support (TEMS) environment. Details will be presented in such a way that the reader can follow along and identify how they would manage the case clinically depending on their experience and environment situation. Commentary will be provided by currently serving military medical technicians. The medics and author will draw on their SOF experience to communicate relevant clinical concepts pertinent to different operational environments including SOF and TEMS. Commentary and input from active special operations medical technicians will be part of the feature.

KEYWORDS: *cervical spinal injury; Canadian C-spine rule, NEXUS criteria; cervical collar*

The Case

You are deployed as part of a 20-person forward element delegated with assessing suitability of a remote area in which to establish a forward operating base and receive a larger follow-on force. Access to the area is via a rural airstrip, and travel to a major city center by road is limited due to distance and the difficult nature of overland routes. The country and environment are permissive, but local resources and medical facilities consist of small outreach clinics with limited capability. The team plans to use sport utility vehicles (SUVs), already in place, to reconnoiter the local area and gather information about the surroundings. Thinking forward, you have brought medical supplies and equipment for each vehicle in case of accident or injury, because groups will not always be co-located.

Your planning and forethought come to fruition when, late on your second day, you receive word that one of the teams was in a vehicle rollover. You are informed that a two-vehicle packet was traveling over difficult terrain when the lead SUV got stuck. All passengers got out to assist except the driver; they managed to get the vehicle moving again but, as the driver accelerated to keep momentum, the wheels caught a rut and the vehicle tipped over. The team provided first aid and managed to extract the driver onto a backboard. They tell you that the patient is alert and conscious, he has a small laceration on his forehead, and is complaining of pain to his right thumb where the steering wheel struck him when the vehicle caught the rut. The team is en route to meet you at a designated location but, because of the terrain, it will take some time to get there.

What Are Your Next Steps?

You arrive at the meeting location just before the SUV carrying the patient comes into view. It has been approximately 75 minutes since the accident. A 32-year-old, male logistics officer is offloaded and brought into a small housing structure. The patient has a bandage applied to his forehead, a cervical collar around his neck, and is strapped securely to a full-length backboard you had previously placed inside the SUV. He remembers the accident fully and denies losing consciousness. When asked about the laceration, he believes it was from a piece of the windshield when it broke during the rollover. His major complaint still remains his right hand; however, further inquiry now reveals that he is experiencing neck pain as well.

The damaged SUV has a smashed windshield and the passenger side is dented, but the vehicle is otherwise functional and made the trip back without any issue. As for your patient, he remains alert with a Glasgow Coma Scale score of 15; he is otherwise healthy and

has no significant prior medical illness. His heart rate is 90, respiratory rate 12, oxygen saturation is 99%, and temperature is 37°C (98.6°F). He has no abnormal neurological findings, his vital signs are stable, and he appears to be uninjured aside from the aforementioned laceration and right-hand complaint, although he continues to complain of worsening neck pain.

Having just completed your own assessment of the area and its local medical facilities, you know that diagnostic imaging is hours away. You reach out to higher medical authority to ask for advice and assistance in organizing the lengthy process of evacuation.

History Lesson

Spinal immobilization of trauma patients with a cervical collar and a rigid backboard has long been associated with the standard of care for over 50 years. The first paper to correlate injury as a result from movement of an unstable spine in an unprotected patient was in a retrospective study by Geisler et al. in 1966.[1] Despite the study only discussing two patients who suffered delayed neurological deficits, the authors went on to conclude that the patients "would surely have been protected from the paraplegic condition had the spinal instability been recognized and precautions taken."[1] The publication by Geisler et al. prompted the medical community to conclude that patients who suffered blunt-force trauma were at risk of neurological complications from inadvertent manipulation of occult spinal injury and should be immobilized on a rigid device to reduce this risk.

In subsequent years, protocols and medical directives were developed that instructed providers to approach the patient and manually immobilize the spine in the found position until a cervical collar was placed. Spinal precautions are maintained through extrication onto a backboard, and the patient is immobilized with a cervical collar on the backboard until cleared by a physician.[2] This dogmatic adherence to the use of a cervical collar and backboard is nearly universal for all trauma patients in Canada and the United States. With no obvious downside and a significant fear of causing further harm to these already traumatized patients, it was viewed as a low-cost intervention that prevented spinal cord injury in all patients. Clinical judgment, the presence or absence of symptoms, and the mechanism of injury were not part of the front-line decision-making.

What Is the Harm?

Protecting a patient from further harm stands at the center of competent medical care. It is important, therefore, to periodically review our practices and assess whether our standard practice could be harming patients. The protection of a patient with a potential spinal injury is one such example. Patient restraint on a backboard leads to conditions that promote formation of pressure sores; these sores can become incredibly painful and very complicated to heal. Contact points can have significant pressures above the point at which tissue necrosis occurs and pressure ulcers can develop.[3] Berg et al. showed that otherwise healthy adults had tissue hypoxia and pressure sore development after only 30 minutes on a backboard.[4] Furthermore, pain can be induced in areas that are not even in contact with the backboard. Due to the patient's position on a flat surface and the axial skeleton's innate curvature, supine restraint can cause pain in the lower back and cervical spine.[5] Lower back and cervical pain has been reported to persist in previously pain-free, healthy volunteers 24 hours after being subjected to only 1 hour on a backboard.[6] This pain in areas that were not painful at the time of the accident leads to difficultly in patient assessment and probably unnecessary imaging.

When a patient is placed on a backboard, not only are they exposed to contact with a hard surface but also often are strapped into place at multiple points across the chest, abdomen, and waist. This strapping is aimed to secure the patient in place but has its own associated risks and consequences. Studies conducted with healthy, nonsmoking men show that straps tightened across the torso have a restrictive effect and can lower forced vital capacity, forced expiratory volume over 1 second, and forced mid-expiratory flow.[7] Patients with injuries to the chest or with lung dysfunction may experience worsening conditions as a result of typical backboard strapping.

Simply stated, the goal of spinal precautions is to prevent spinal cord injury in patients with spinal fractures and to prevent worsening of spinal cord injuries, with or without evidence of such an injury. In 1998, Hauswald et al.[8] compared neurological outcomes between two patient populations: one based in New Mexico, where all studied patients received full spinal immobilization with a collar and backboard; and the other in Malaysia, where none of the patients received formal spinal precautions. Correcting for age, mechanism, and level of spinal cord injury, the study found that neurological disability was higher in the New Mexico group.[8] More recently, Haut et al. compared outcomes of penetrating trauma patients who underwent spinal immobilization with those who did not.[9] The odds ratio for death for the immobilized patients was 2.06; in other words, the risk of death in the studied immobilized patients was 2.06 times higher than that of the nonimmobilized patients. This risk ratio of immobilization, including backboard use, to nonimmobilization was upheld across all types of penetrating trauma. Any potential immobilization benefit was reduced even more when considering

that only 0.01% of the studied patients had spinal injuries that would have benefited from operative fixation.[9]

It is clear that the routine and universal use of complete immobilization on a backboard may not be without potential harm. It is beyond the scope of this article to question whether this practice should be re-evaluated. The tactical clinician needs to practice within their scope and adhere to the principles and practices outlined by their unit and their superior medical authority. Instead, let us focus on whether there is evidence to support the identification of a group of patients who do not need routine immobilization or imaging.

Selective Immobilization

When examining spinal immobilization, it is clear that the patient population is split into two groups: one that has no significant injury and receives no benefit, and the other, small group that truly has unstable spinal injuries that have the potential for catastrophic complications. Identifying these two groups is at the forefront of clinical decision-making.

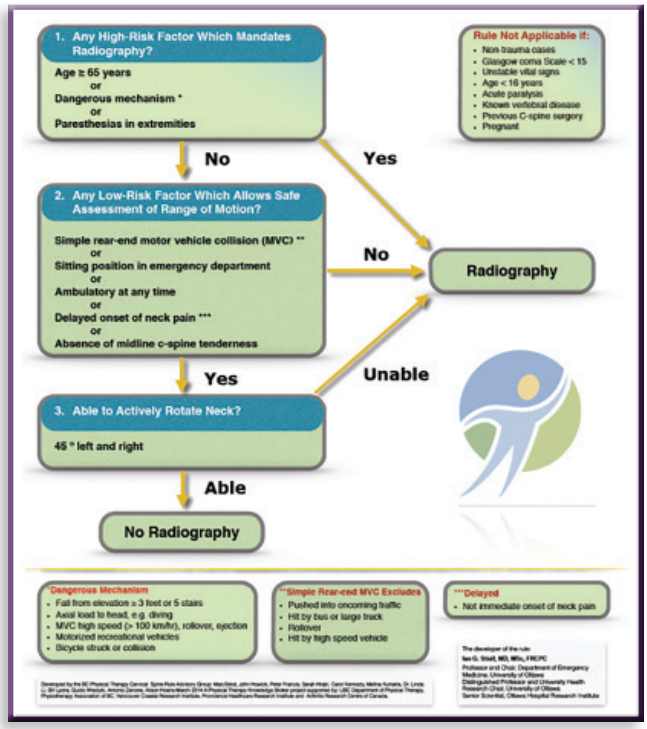
In 2001, Stiell et al. published a prospective cohort study dubbed "the Canadian C-spine rule" (Figure 1).[10] The goal was to derive a clinical decision rule that would be highly sensitive to acute cervical spine injury in otherwise alert and stable patients. Among their sample of 8,924 patients with blunt trauma, 151 had significant spinal injuries. Identifying these patients with 100% sensitivity was achieved with the following three questions[10]:

1. Is there any high-risk factor present that mandates radiography (e.g., age ≥65 years, dangerous mechanism, or paresthesias in extremities)?
2. Is there any low-risk factor present that allows safe assessment of range of motion (e.g., simple rear-end motor vehicle collision, sitting position in the emergency department, ambulatory at any time since injury, delayed onset of neck pain, or absence of midline C-spine tenderness)?
3. Is the patient able to actively rotate the neck 45° to the left and right?

In 1992 Hoffman et al.[11] published the National Emergency X-Radiography Utilization Group (NEXUS) criteria to identify patients with blunt trauma who are at very low risk for cervical spine injury. They determined that patients who met the following five specific criteria did not need radiography to rule out cervical spine injury:

- NEXUS Cervical Spine Rule
  - o No midline cervical tenderness
  - o No focal neurological deficits
  - o Normal alertness
  - o No intoxication
  - o No painful distracting injury

Figure 1 *Canadian C-spine rule.*



The study found that the rule was 99.6% sensitive for a clinically important injury and its specificity was 12.9%.[11]

These rules create a framework allowing for selective immobilization based on simple clinical assessment. Vaillancourt et al. showed that paramedics (a suitable analog for military medical personnel) could reliably apply the Canadian C-spine rules to avoid unnecessary immobilization without missing any clinically significant cervical spine injuries.[12] Providing this decision point at an earlier stage in care not only has the advantage of avoiding unnecessary diagnostic investigations but also reduces or eliminates time spent on a backboards and the associated risks.

Transport or extended evacuation present a substantially different issue. A standard rigid stretcher is essentially a flat surface that, when combined with a cervical collar, serves the same function as a backboard. This is not dissimilar to a bed, and both can provide spinal protection and be equipped with straps to further reduce motion if necessary. The padding and the nonslick surface provided by a mattress or similar surface conform to a patient's back, minimize movement, and are largely without the risks of backboards.[13]

The threat of spinal injury is most apparent when considering motor vehicle accidents. Standard spinal

precautions for these patients includes the immediate cessation of all movement, with a medical provider providing manual stabilization of the head and neck until the patient is passively transferred onto a backboard. Even if the patient is awake and fully alert, this process is common practice for rigidly "protocolized" medicine directed at prehospital providers. These types of elaborate and regimented maneuvers have never been shown to improve outcomes in patients and would result in said patients ending up on backboards for potentially extended periods of time. In fact, the overall utility of a backboard toward the goal of immobilization is questionable. Mazolewski and Manix showed that a patient strapped to a backboard still could move in a variety of directions.[14]

The movement the medical provider is trying to eliminate often depends on the cooperation of the patient. It is counterintuitive, then, to not use this capability for self-movement and control to the advantage and enhancement of spinal precautions. Engsberg et al.[15] used high-speed infrared motion analysis cameras and sensors to detect motion of the cervical spine during different extrication techniques. They found self-extrication with a cervical collar resulted in the least movement of the spine.[15] Patients with a positive spinal assessment should have a cervical collar applied; then, if able, they can ambulate to a stable flat surface on their own power or with assistance, but do not need to be placed on a backboard.

The Case

You confirm no changes from your initial assessment and move your patient to where a simple cot is available. Wanting to remove the backboard and perform a more thorough examination of your patient, you organize other members of your group to assist in transferring the patient onto the cot. During the log roll maneuver, you are able to fully palpate the patient's spine. You note a small area of erythema over C-7; it is not tender to palpation. The patient states, "No, it doesn't hurt if you press. It just feels good to be off that board."

You have the backboard removed and roll the patient back flat onto the cot. You address the superficial laceration to the forehead and confirm that he still has pain in his right-hand thumb. Physical examination of this area reveals edema and ecchymosis surrounding the right thumb and his grip strength is reduced, specifically during "pinch" testing (thumb to forefinger). A more focused neurological examination reveals an alert and oriented patient with a Glasgow Coma Scale score of 15. He is not experiencing any memory loss or nausea. There is no facial asymmetry and the patient denies any numbness or tingling in his extremities. Strength testing, aside from grip, is equal throughout and full sensory testing does not reveal any deficits. Given the patient's lack of significant signs or symptoms of spinal injury, you remove the collar and have the patient actively rotate his neck 45° to the left and right. He accomplishes this task without complaint. You instruct the patient to remain lying down in a position of comfort while you take a moment to communicate your findings to your higher medical authority.

Speaking with your senior medical contact, you explain the situation, including that the vehicle "tipped" over at relatively low speed (versus a high-speed rollover) and was driven back, and that the patient was free of any neurological findings on examination. Your examination revealed a minor forehead laceration, a right thumb injury, no pain during C-spine palpation, and the patient was able to rotate his neck without complaint. Given this information, your medical officer agrees with you that the likelihood for a significant spinal injury is remote. Urgent evacuation is difficult to achieve and is unwarranted at this time. You are advised that it is prudent to observe your patient, and that he should avoid any high-risk or high-impact activities and can depart with the rest of the group in a couple days as planned.

Over the next 48 hours you observe your patient as he resumes his normal activity around camp. He complains of some mild muscular pain and continues to wear a splint for his thumb injury, but is otherwise doing well. Once back at home, you hear that the patient underwent surgery. You have a moment of apprehension, worried if you missed something. You are relieved to hear that it was for the repair of the ulnar collateral ligament of his right thumb and he is expected to make a full recovery.

Case Summary

Trauma patients with an unstable cervical spinal injury represent a very small percentage of blunt trauma patients. The fear of missing one of these injuries and the resultant neurological impairment has led to a very dogmatic and rigid approach to universal immobilization on a backboard. This practice may actually be harming some of our patients. There is sufficient evidence that allows for the separation of patients into groups based on who is at extremely low risk for cervical spine injury. Using the Canadian C-spine rule or the NEXUS criteria can help identify those who receive no benefit and would only be exposed to risk. All trauma patients should receive an assessment of their spine based on one of these evidence-supported clinical decision tools. If they fail to meet the criteria of the rules or if a neurological deficit is present, a cervical collar should be applied. If the patient is awake and able, self-extrication is reasonable. If extrication must be assisted, then the backboard is a helpful

tool, but the patient should be transferred off the backboard as soon as feasible. The patient with suspected spinal injury must be recognized, and careful steps taken and judgment made during their handling and transport to maximize benefits from interventions performed, but also minimize risks from those same actions.

Disclaimers

The views and medical opinion herein represent those of the authors. They do not reflect the operation practice or views of the Canadian Forces or other organizations. The cases are provided to be educational and thought provoking; at no time does the author suggest that the tactical clinicians exceed the scope of their practice or act against the direction of their medical protocols or recommendations of their medical leadership.

Disclosures

The authors have nothing to disclose.

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