Radiographic Analysis of the Cervical Spine.

Detecting Sagittal Movement Inflating and Deflating an Interposed Air Mattress on a Spine Board.

A Pilot Study

Robert W. Heck, MD, William S. Hoster, PM

Introduction: Spine boards (back boards) have been used for transporting and stabilizing accident victims for many years. This method of transport is universally accepted and generally considered safe. However, there have been numerous reports of secondary injury incurred using these boards for prolonged periods of time. It has been shown that the average length of time a patient spends on a spine board is 80 minutes and sometimes as great as 240 minutes.[1] At this length of time, not only is the spine board very uncomfortable for the patient, but it can also cause tissue breakdown at the pressure points. Furthermore, incidents of lower back strain and headache are an associated complication.

An air mattress designed by MedicTech, Inc. called the Back Raft™, offers a simple solution to the aforementioned problems associated with spine boards (see picture 1). The Back Raft™ creates a comfortable interface between the patient and the spine board. It cushions the patient from the board. It cradles the patient, thus increasing his or her sense of security. And it fills the void between natural spine curvature and a back board with a pillow of air.

The purpose of this study was to determine if a clinically significant amount of cervical spine motion is associated with inflation and deflation of the Back Raft.

The study objective was (Phase I) quantify the amount of cervical spine movement observed during inflation and deflation of an air mattress on a standard spine board. (Phase II) Compare phase I data to the normal observed cervical movement of a patient placed from a sitting position to a supine position upon a spine board.

It remains unknown how much cervical spine motion is permissible without causing neurologic harm during transport and during the initial work up of a victim of blunt trauma. Patients who experience blunt trauma may or may not be in an aligned supine position when EMS personnel arrive on scene. For example, a patient involved in a motor vehicle accident will typically be found in a sitting position and most fall patients may be found in a prone or decubitus position. To package the patient for transport, EMS personnel must place a cervical collar on the patient, maintain manual head immobilization, and attempt to position the patient onto a rigid spine board with as little movement of the spine as possible. Any exaggerated spinal movement during transport and packaging must obviously be avoided. Although, the degree of spinal movement which occurs with all of these precautions utilized by EMS personnel (i.e., cervical collar, manual head stabilization and a rigid spine board) is not defined.

Materials & Methods: This was a prospective, controlled study performed in the radiology department of a community hospital. The subject was a healthy thirty six year-old male volunteer without any prior or acute history of cervical spine injury or disease. The location was Alta View Hospital in the Radiology Department, Salt Lake County, Utah. The materials used in this study included: a standard long spine board, a *Stiff Neck*® cervical collar measured according to standards published by Laerdal Corp., and the Back Raft™ by MedicTech, Inc. (see note 1)

The volunteer was placed erect in a chair with similar dimensions to that of an automobile seat. To simulate pre-hospital transport conditions, two trained paramedics maintained manual head immobilization

and placed a *Stiff Neck*® cervical collar of proper size onto the volunteer. A cross-table c-spine x-ray of the volunteer in this erect position was performed.

The volunteer was then positioned onto a rigid spine board with an interposed, deflated air mattress by trained paramedics using established protocol of patient movement technique. This procedure is defined by the Department of Transportation Emergency Medical Technician procedures manual[2]. A second cross-table c-spine x-ray of the volunteer was then performed with the patient in the supine position on the spine board.

The interposed air mattress was inflated and a third cross-table c-spine x-ray was performed of the volunteer on the spine board. The interposed air mattress was inflated to the volunteer's level of comfort – filling the voids between the volunteer and the spine board, with a simultaneous, slight elevation noted of the head, scapula, and sacrum off the board.

The three cross-table c-spine x-rays were then compared using a modified Cobb Technique[3] measuring the sagittal angular alignment between the occiput and second cervical vertebra, the second and the seventh cervical vertebrae, and the occiput and seventh cervical vertebra (see picture 2).

Results: With the subject sitting, the measured angle between the occiput and C-2 was 100.5º, the measured angle between C-2 and C-7 was 85º, and the measured angle between the occiput and C-7 was 75.5º. When supine with air mattress deflated, the measured angle between the occiput and C-2 was 104º, the measured angle between C-2 and C-7 was 90º, and the measured angle between the occiput and C-7 was 75.5º. When supine with the interposed air mattress inflated, the measured angle between the occiput and C-2 was 104.5º, the measured angle between C-2 and C-7 was 88º, and the measured angle between the occiput and C-7 was 75º (see table 1).

With the limitations of this study, the data shows that the angular displacement generated by moving a patient from an erect position onto a spine board with a cervical collar in place is greater at two out of three levels tested (occiput to C-2 and C-2 to C-7), than the angular displacement generated by inflation and deflation of an interposed air mattress.

Discussion: No previous studies have defined or quantified a safe amount of cervical movement allowed to a patient without causing neurologic harm during transport and initial work-up. In addition, Hauswald, et al[4], comments that the clinical importance of immobilization during transport and initial work-up remains unknown. Or study reveals that the amount of movement of the cervical spine measured between an inflated interposed air mattress and a deflated interposed air mattress on a spine board is significantly less than or equal to the movement typical of transferring a patient onto a spine board from and accident scene.

The results of this study must be interpreted in light of several limitations and potential sources of error. First, because this experiment could not be blinded, bias could not be ruled out. Inflation of the interposed air mattress to the patient's level of comfort was subjective on behalf of the volunteer and the paramedic inflating the air mattress. The lack of blind review of the radiologic studies and the difficulty in clearly reproducing the defined bony landmarks is also a source of bias. It was necessary to modify the Cobb technique to establish more reproducible landmarks. We feel that the modified landmarks, however, can more accurately be reproduced in a larger study.

Furthermore, our findings are the result of studying only one subject with no history, present or past, of spinal injury. A similar study on injured subjects with potential neurologic sequella would not be ethically possible. The use of cadavers with artificially created injuries to their necks would permit investigation of the destabilized cervical spine, but loss of normal tissue characteristic in cadaveric specimens secondary to preservation techniques and rigor mortis may make comparison to the clinical scenario invalid.

Additional variables that may have an effect on cervical spine position after a neck injury include 1) the presence or absence of protective paraspinal muscle spasm, 2) cervical instability secondary to loss of bony or ligamentous integrity or both, and 3) poorly fitting equipment. Each of these factors may accentuate or minimize the magnitude of movement of the cervical spine.

Finally, we conducted this study to evaluate whether unacceptable cervical movement occurred with the inflation of an interposed air mattress on a spine board. This study revealed that the common EMS practice of placing a patient onto a spine board produces more movement of the cervical spine than inflating and deflating an interposed air mattress on a spine board.

In practice, patients who are strapped to the rigid, unyielding surface of a spine board for any length of time will voluntarily squirm to relieve pressure points. This voluntary movement will undoubtably change the alignment of the cervical spine. Hopefully, by increasing patient comfort, this type of voluntary movement can be eliminated. Further studies of the same nature are warranted utilizing a larger subject population with varying body weight, height, and gender.

References:

1. Cordell, William H, et al: Pain and Tissue-Interface Pressures During Spine-Board Immobilization. *Annals of Emergency Medicine.* July 1995: 25:1:31-36.
2. Caroline, Nancy L: Emergency Care in the Streets. Massachusetts: Little, Brown and Company, 5th edition.
3. Swenson, Todd M, et al: Cervical Spine Alignment in the Immobilized Football Player: Radiographic Analysis Before and After Helmet Removal. *The American Journal of Sports Medicine.* 1997: Vol.25/No.2
4. Hauswald, Mark, et al: Out-of-Hospital Spinal Immobilization: Its Effect on Neurologic Injury. *Academic Emergency Medicine.* Mar 1998: Vol 5/No 3.