MAXIMIZING COMFORT AND MINIMIZING ISCHEMIA: 
A COMPARISON OF FOUR METHODS OF SPINAL IMMOBILIZATION
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ABSTRACT

Objective. To determine which of four methods of spinal immobilization causes the least ischemic pain. Methods. A prospective, nonblinded comparative trial was conducted at a statewide emergency medical services training facility using a convenience sample of emergency medical technician students. After lying motionless for 10 minutes, students evaluated each device using a 10-centimeter visual analog scale. Subjective comfort was used as a measure of ischemia. Results. Comfort scores were significantly different for all methods (F = 101, p < 0.001). A backboard padded with a gurney mattress and eggcrate foam (the equivalent of a spinal rehabilitation bed) caused the least ischemic pain (9.6 cm, 95% CI, 8.9 to 9.8 cm). A backboard padded with a gurney mattress was the second most comfortable device (7.0 cm, 95% CI, 6.4 to 7.4 cm). A backboard padded with a folded blanket was the third most comfortable (3.3 cm, 95% CI, 2.6 to 4.9 cm). The backboard alone caused the most pain (0.8 cm, 95% CI, 0.7 to 2.1 cm). Conclusion. Increasing the amount of padding on a backboard decreased the amount of ischemic pain caused by immobilization. Key words: injury; spine; immobilization; ischemia; comfort.

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Prehospital full body immobilization has become the accepted standard of care for transporting patients who may have spinal injuries. The usual method is to secure the patient to a wooden or plastic backboard and immobilize the spine with blanket rolls, sandbags, or a variety of premade commercial devices.1–3 Although refinements have been made to this system and other devices (such as bead-filled vacuum mattresses) are available, the practice of using a hard, flat, and rigid surface as a splint for the spine has changed very little within the last 30 years.4,5 Backboards are ideal for extricating patients because they are thin and smooth but their lack of resiliency rapidly causes discomfort and ischemia in tissues that come in contact with them. Paralyzed patients are at risk for tissue necrosis and decubiti, but rigid backboards can cause pain from ischemia in the tissues of the head, neck, and back, even in normal volunteers.6–11 Many patients may be getting unnecessary radiological procedures because physicians base the decision to obtain cervical spine radiographs, in part, on the presence of pain.12,13 If the rigid splint can be made more comfortable, patients will experience less pain from immobilization, and hence may receive fewer unnecessary radiographs. A soft surface is actually more appropriate for immobilization; the standard of care for paralyzed patients is a well-padded hospital bed.14 In this study, we compared four methods used to immobilize and transport patients. We hypothesized that an unpadded backboard would be significantly less comfortable than a padded backboard and that padding similar to that used for spinal rehabilitation would be most comfortable.

METHODS

Four methods of spinal immobilization were compared. Our methods have been published elsewhere.15 Subjective comfort was used as an endpoint because discomfort from pressure is caused by tissue ischemia.16,17 The four devices compared were:

1. a traditional backboard (a standard extrication device),
2. a backboard padded with a folded blanket,
3. a backboard padded with a 3-cm gurney mattress, and
4. a backboard and mattress padded with a 6-cm eggcrate foam pad (similar to a standard spinal fracture bed).

The University of New Mexico Health Sciences Center Human Research Review Committee approved the study, and all subjects gave written informed consent.

We recruited subjects from a convenience sample of 22 students from four emergency medical technician (EMT)–basic classes. None of the subjects had any prior training in spinal immobilization techniques. Subjects were excluded if they had any pre-existing injuries that would make lying supine for 10 minutes potentially hazardous. The students lay supine on each surface without being secured with straps. Devices were assigned in random order for each sub-
ject using a table of random digits. After lying motionless for 10 minutes, the students rated comfort on a 10 cm visual analog scale.\textsuperscript{16–21} All four methods were evaluated using the same scale to allow each participant to compare his or her four responses.\textsuperscript{22} A score of 0 represented “the comfort of a concrete slab” and 10 was equivalent to the subject’s “bed at home.” Although 10 minutes is much shorter than many cases of prehospital transport, we found that it is difficult for volunteers to tolerate immobilization on a hard surface for longer periods. Each participant evaluated all four devices and was given a 15-minute rest interval between trials.

Each marked 10-cm visual analog scale was measured on two separate occasions to the closest 0.1 cm by the same observer (CS), and the mean of these two estimates was recorded.\textsuperscript{23} Differences among comfort score means were analyzed using repeated-measures analysis of variance (ANOVA), with subjective comfort as the dependent variable, and with spinal immobilization method and subject as the independent variables. Departure from normality of the outcome variable, comfort, was rectified by using the rank transformation. The Tukey procedure was used to correct for multiple post-hoc comparisons and to estimate simultaneous 95\% confidence intervals.\textsuperscript{24} Statistical calculations were made using Statgraphics plus for Windows (version 3.1, Manugistics, Inc., Rockville, MD). Two-tailed tests and a type 1 error rate of 0.5 were employed throughout.

**RESULTS**

The subjective levels of comfort were significantly different for the spinal mobilization devices (F = 101, p < 0.001). Each treatment was statistically significantly different from each of the others at the 0.05 level (Fig. 1). The differences were all within the range shown to be clinically different.\textsuperscript{25,26} The bare backboard was the least comfortable device; while the backboard with the gurney mattress and eggcrate foam was the most comfortable. The mean scores were: backboard 0.8 cm (95\% CI, 0.7 to 2.1 cm), backboard with folded blanket 3.3 cm (95\% CI, 2.6 to 4.9 cm), backboard with gurney mattress 7.0 cm (95\% CI, 6.4 to 7.4 cm), and gurney mattress plus foam 9.6 cm (95\% CI, 8.9 to 9.8 cm).

**DISCUSSION**

Pressure that exceeds capillary filling pressure will eventually cause tissue ischemia. Nociceptors are activated within minutes by inflammatory mediators liberated by ischemic tissue.\textsuperscript{16,17} Discomfort measures ischemia in much the same fashion that subjective brightness measures luminosity.

Patients who are able to feel pain and respond to it will reposition themselves to minimize the ischemia.
the use of a foam pad significantly decreases discomfort caused by ischemia in the short term. Providers should be aware that even the use of a spinal fracture bed is only a temporary solution. Adequate padding will increase the amount of time the patient can safely remain supine from minutes to hours, but eventually the subject must be repositioned.  

Prehospital spinal immobilization has never been shown to affect outcome, and the estimates in the literature regarding the incidence of neurologic injury due to inadequate immobilization are clearly exaggerated. Nonetheless, immobilization is prudent and appropriate for many patients. Much current research focuses on ways to minimize harm caused by immobilization by decreasing the number of patients who receive it. Unfortunately, the group at highest risk for ischemic damage are those patients who have neurologic damage and hence are most likely to benefit from it. Prolonged transport on a hard surface will invariably cause tissue damage, which is the most common cause of morbidity in these patients.  

LIMITATIONS AND FUTURE STUDIES  

Our methodology is hampered by the inability of volunteers to tolerate a hard surface for the length of time that patients are subjected to it. Although common experience confirms that softer surfaces are comfortable for longer periods, the exact length of time that causes irreversible ischemia on various surfaces is not known.  

CONCLUSION  

A backboard, even if padded with a blanket, is considerably less comfortable than the equivalent of a spinal fracture bed. Most patients will reposition themselves to relieve ischemic areas, which could theoretically worsen any spinal injuries. Patients who are unable to move or feel pain due to trauma are at risk for soft-tissue injury. Patients who cannot be clinically cleared and must undergo prolonged periods of immobilization during transport and workup should be moved to soft surfaces such as a mattress pad or contoured splints (vacuum mattresses).  

References  