Spinal Immobilization on a Flat Backboard: Does It Result in Neutral Position of the Cervical Spine?

Study objectives: To determine the amount of occipital padding required to achieve neutral position of the cervical spine when a patient is immobilized on a flat backboard. Neutral position was defined as the normal anatomic position of the head and torso that one assumes when standing looking straight ahead.

Design: Descriptive with hypothesis testing of selected descriptive elements.

Setting: University campus and hospital.

Subjects: One hundred healthy young adults with no history of back disease.

Interventions: Volunteers were measured in standing and supine positions.

Measurements: Occipital offset; height; weight; and head, neck, and chest circumferences were measured for each subject.

Main results: The amount of occipital offset required to achieve neutral position varied from 0 to 3.75 in. (mean, 1.5 in.). Mean occipital offset for men (1.67 in.) was significantly greater than that for women (1.31 in.) Easily obtained body measurements did not accurately predict occipital offset.

Conclusion: Immobilization on a flat backboard would place 98% of our study subjects in relative cervical extension. Occipital padding would place a greater percentage of patients in neutral position and increase patient comfort during transport. [Schriger DL, Larmon B, LeGassick T, Blinman T: Spinal immobilization on a flat backboard: Does it result in neutral position of the cervical spine? Ann Emerg Med August 1991;20:878-881.]

INTRODUCTION

Spinal immobilization of accident victims has become an essential aspect of prehospital trauma care. Although most of the literature advocates the goal of spinal precautions to be immobilization of the neck in neutral position, there is considerable variation regarding the best means of achieving this goal. Several trauma texts advocate placing the occiput directly against a stiff backboard, whereas others suggest that padding should be placed between the occiput and the backboard. The prehospital trauma life support text by Butman et al states that “in most cases, 1 to 1½ inches of padding under the head will be necessary to maintain a neutral position” and also points out that “patients commonly arrive in the emergency department hyperextended. Padding behind the head would in most cases eliminate the problem.” These statements are based solely on the authors’ experience (personal communication, Alex M Butman, December 1990).

McSwain has suggested that proper spinal immobilization is achieved when the patient is within 11° of the normal neutral position and that the prehospital care provider should choose the amount of padding that, under visual inspection, appears to achieve neutral position. Neutral position is defined as “the normal anatomical position of the head and torso that one assumes when standing looking straight ahead,” or, in radiologic terms, 12° of extension. It should be noted that the radiographic definition of neutral position is necessarily based on the radiographic study of patients...
who were visually observed to be in neutral position. Thus, although radiographs may be better than clinical observation in detecting and quantifying small amounts of movement of the cervical spine, the declaration that a subject is in neutral position is best made through visual assessment. We chose the observation-based definition for this study because it is directly applicable to the prehospital environment.

It has been our experience that immobilization without padding results in extension of the neck beyond neutral position and, perhaps more importantly, causes the already-injured patient needless occipital pain. We therefore sought to measure the amount of occipital padding that should be placed on the backboard if neutral cervical alignment is to be achieved. In keeping with the clinical definition of neutral position, we defined occipital offset as the amount of space that exists between a wall and the occiput when the subject is standing comfortably with heels, buttocks, and shoulder blades against the wall and is looking at a distant object held at eye level.

We specifically wanted to test three hypotheses. The first was that the amount of padding needed to achieve neutral position was greater than zero. The second was that men would require more occipital padding than women, and the third was that no easily obtained body measurement would accurately predict the amount of occipital offset required to achieve our neutral position.

### MATERIALS AND METHODS

Volunteers were recruited from a population of hospital employees and university students. Subjects with a history of back problems or back surgery were excluded. A trained observer measured neck and chest circumferences with a standard cloth tape measure. The neck measurement was performed at the level of the cricoid cartilage; the chest measurement was performed at the nipple level. Weight and height were similarly obtained.

Occipital offset was measured as follows. The subject was asked to stand comfortably with heels, buttocks, and shoulder blades touching a wall while looking at a distant object held at eye level. The observer then slid 1/2-in. shims into the space between the occiput and the wall until the space was filled. Next, the subject was placed on a standard wooden backboard with the selected number of shims behind the occiput, and neutral alignment was confirmed by visual inspection and by questioning the subject regarding his comfort versus that resulting from the addition or removal of one or two shims. The observer used the subject's impression of the most comfortable position combined with his own visual impression of neutral alignment to arrive at a shim number. If the true distance appeared to fall between two shim sizes, the smaller number was selected.

For the first 30 subjects, three trained observers independently measured occipital offset. Subjects were instructed not to tell the observers the number of shims placed on previous measurements. The remaining 70 subjects were measured by a single observer.

The reliability of the occipital offset measurements was tested in two ways. First, these data were treated as categorical (eg, number of shims) and a multioobserver-weighted $\kappa$ was calculated. Second, the intraclass correlation coefficient was calculated with occipital offset treated as a continuous variable.

Occipital offset measurements were tested for normality using a $\chi^2$ goodness-of-fit test. The two-tailed Student's $t$ test was used to test whether occipital offset significantly differed from zero and to determine whether mean occipital offset differed between men and women.

A univariate linear regression model was used to determine whether neck circumference, chest circumference, weight, or height or any of the combined indexes of chest circumference/neck circumference, neck circumference/weight, or height/weight was able to accurately predict occipital offset. Data were entered and manipulated with dBase IV and analyzed with GB-STAT statistical software (Dynamic Microsystems, Silver Springs, Maryland).

### RESULTS

Characteristics of the study subjects are shown (Table 1). Fifty women and 50 men were enrolled. Mean age was 24.4 years (SD, 5.5 years; age range, 18 to 45 years). Intraobserver reliability was studied in the first 30 subjects. There was complete agreement among the three observers in 18 subjects and agreement between two observers in 11 subjects. In the one remaining subject, there was no agreement. The maximum difference between minimum and maximum measurements for any subject was 1/2 in. (two cases). Formal testing of intraobserver reliability revealed a multioobserver $\kappa$ of 0.99 and an intraclass correlation coefficient of 0.98. Because agreement was so good, the remaining 70 patients were measured by a single observer.

The distribution of occipital offset measurements is shown (Figure). $\chi^2$ goodness-of-fit analysis provided no evidence that the distribution of occipital offsets was non-normal, therefore, parametric statistics were used for all analyses. Occipital offset ranged from 0 to 3.75 in. with a median and mode of 1.5 in. and a mean of 1.49 in. (95% confidence intervals [CI], 1.37 to 1.60). Mean occipital offset significantly differed from zero ($P < .0001$, $t$ test). Mean occipital offset of 1.67 in. for men was significantly different from the 1.31-in. mean offset for women ($P = .0016$, $t$ test).

Univariate linear regression was used to assess the capacity of sex, age, weight, height, neck circumference, chest circumference, or combinations of these parameters to predict shimm size. Weight ($R^2 = .15$, $P < .001$) was the best predictor. It explained, however, only 15% of the variance in shimm size, and it was evident that none of the variables was sufficiently predictive to be of use in the field. There was no relation be-

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**TABLE 1. Characteristics of the study population**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Age (Mean SD Range)</th>
<th>Weight (lb) (Mean SD Range)</th>
<th>Height (in.) (Mean SD Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>50</td>
<td>24.7 6.1 18–42</td>
<td>124.3 13.1 100–162</td>
<td>65.2 2.5 61–72</td>
</tr>
<tr>
<td>Men</td>
<td>50</td>
<td>24.1 4.9 19–45</td>
<td>173.3 23.9 130–225</td>
<td>71.0 2.4 65–76</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>24.4 5.5 18–45</td>
<td>148.8 31.4 100–225</td>
<td>68.1 3.8 61–76</td>
</tr>
</tbody>
</table>

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suggestion that a wooden backboard has ever resulted in the exacerbation of a spinal injury, the absence of an absolute definition. Thus, if minimizing this difference were the only consideration, 1.5 in. would be the ideal width for healthy young people. Other factors must, however, be considered. The purpose of immobilization is to protect the small percentage of patients who have bony and/or spinal cord damage from further injury. Although evidence suggests that the number of fractures and dislocations of the cervical spine that are unstable in flexion equals the number that are unstable in extension, it appears that the majority of cervical cord injuries occur with fractures that are unstable in flexion. Thus, although there is no evidence that the position of immobilization makes any difference in outcome, it may initially be preferable to choose a padding size that places fewer patients in relative flexion. With 1.5 in. of padding, 23% of our subjects would be placed in some degree of flexion, whereas with a 1-in. pad, only 5% (95% CI, 1.2% to 10.9%) would be in a relatively flexed position.

Potential problems with the external validity of this study arise from the lack of an accepted standard for neutral position and from our use of an observation-based, non-radiographic method for confirming neutral position. Although this study demonstrated that the observation-based method is accurate and reliable, we welcome skeptics to repeat this study with radiographic confirmation of neutral alignment.

We caution that our findings should not be generalized to populations other than those we studied. Although there was no evidence that occipital offset varied with age in our population, the amount of padding necessary to achieve neutral position in children (who may need thorax and neck padding rather than occipital padding), the elderly, and per-
sons with back problems was not evaluated in this study. Further work will be needed to characterize the role of occipital padding in these populations and to demonstrate the safety and feasibility of occipital padding in the population that we studied.

CONCLUSION

The thickness of occipital padding needed to maintain neutral alignment of the cervical spine was measured in 100 healthy young adult volunteers who were placed on a standard wooden backboard. Occipital padding requirements ranged from 0 to 3.75 in., with a mean of 1.5 in. Easily measured body parameters such as height and weight were not helpful in predicting the amount of occipital padding required. Data suggest that padding may be helpful in maintaining patients in a more neutral position during transport. Occipital padding would have the added benefit of decreasing the discomfort of spinal immobilization.

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REFERENCES