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The 6-Plus–Person Lift Transfer Technique Compared With Other Methods of Spine Boarding

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Context: To achieve full spinal immobilization during on-the-field management of an actual or potential spinal injury, rescuers transfer and secure patients to a long spine board. Several techniques can be used to facilitate this patient transfer.

Objective: To compare spinal segment motion of cadavers during the execution of the 6-plus–person (6+) lift, lift-and-slide (LS), and logroll (LR) spine-board transfer techniques.

Design: Crossover study.

Setting: Laboratory.

Patients or Other Participants: Eight medical professionals (1 woman, 7 men) with 5 to 32 years of experience were enlisted to help carry out the transfer techniques. In addition, test conditions were performed on 5 fresh cadavers (3 males, 2 females) with a mean age of 86.2 $\pm$ 11.4 years.

Main Outcomes Measure(s): Three-dimensional angular and linear motions initially were recorded during execution of transfer techniques, initially using cadavers with intact spines and then after C5-C6 spinal segment destabilization. The mean maximal linear displacement and angular motion obtained and calculated from the 3 trials for each test condition were included in the statistical analysis.

Results: Flexion-extension angular motion, as well as anteroposterior and distraction-compression linear motion, did not vary between the LR and either the 6+ lift or LS. Compared with the execution of the 6+ lift and LS, the execution of the LR generated significantly more axial rotation ($P = .008$ and .001, respectively), more lateral flexion ($P = .005$ and .003, respectively), and more medial-lateral translation ($P = .003$ and .004, respectively).

Conclusions: A small amount of spinal motion is inevitable when executing spine-board transfer techniques; however, the execution of the 6+ lift or LS appears to minimize the extent of motion generated across a globally unstable spinal segment.

Key Words: prehospital care, spine injuries, spinal immobilization, logroll transfer technique, lift-and-slide transfer technique

Key Points

- The 6-plus–person lift and lift-and-slide transfer techniques appeared to minimize the motion generated across an unstable spinal segment.
- Significantly more lateral flexion and axial rotation was generated with the logroll maneuver than with the lift-and-slide and 6-plus–person lift techniques.

The neurologic status of cervical spine-injured patients is not always a reliable indicator of the structural stability of the spinal column.[1] Therefore, primary responders are expected to follow the standard-of-care recommendations to minimize the risk of creating iatrogenic neurologic injuries during the prehospital stages of management. Mainly, this entails immobilizing the entire spine and maintaining immobilization until the patient has been transported to a medical facility where a thorough evaluation can take place and appropriate treatment can be initiated.

To achieve full spinal immobilization during on-the-field management of an injury, rescuers typically transfer and secure patients to a long spine board.[2–4] The task of moving patients onto a spine board can prove challenging because the head and trunk must be moved together as a unit. Frequently, the logroll (LR) maneuver is executed to aid rescuers in positioning the patient onto the spine board.[5] This transfer technique involves rolling the injured patient to the side-lying position to allow for a spine board to be wedged in place beneath the individual. The alternative is to use a procedure that involves lifting the patient off the ground to permit spine-board placement.

In 2001, the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete[6] published a report expressly advocating the use of a technique for lifting supine athletes referred to as the "6-plus–person lift" (6+ lift). The basis for recommending this technique for transferring supine athletes was that heavy persons could be handled more efficiently because the work of lifting the patient would be apportioned among the greater number of personnel required to execute this procedure. In addition, using this technique in combination with a scoop stretcher avoids rolling the injured athlete over bulky protective equipment, which could interfere with the transfer process and bring about unwanted spinal column movements.[6]

Researchers have attempted to establish the relative safety of the LR and the LS by determining the amount of spinal movement created during their execution,[4,7–12] but to our knowledge, the spinal movement generated during the 6+ lift has never been measured. Therefore, the purpose of our investigation was to examine the effectiveness of the 6+ lift for limiting spinal motion compared with the LR maneuver and LS technique.

METHODS

Using a crossover study design, we analyzed 6 dependent variables: axial rotation, flexion-extension, lateral flexion, anteroposterior displacement, distraction, and medial-lateral translation at the C5-C6 spinal segment. These measures were influenced by 2 independent variables: technique and experimental lesion.

Participants

We enlisted the aid of 8 medical professionals (1 woman, 7 men) for our investigation. This group of certified first-aid providers consisted of 3 physicians, 2 certified athletic trainers, and 3 other hospital staff members. The number of years of experience for each of the participants ranged from 5 through 32 years. Only 5 of the participants were needed to execute the LR maneuver and LS technique, whereas all 8 were required to perform the 6+ lift technique.

Experimental Lesion

We used 5 fresh cadavers (3 males, 2 females; age = 86.2 ± 11.4 years, height = 175.9 ± 10.2 cm, mass = 84.7 ± 28.0 kg) to test transfer techniques. All 3 transfer techniques were initially carried out on cadavers with intact spines and then repeated after the creation of a complete segmental lesion that resulted in global instability at the C5-C6 spinal level. To standardize the injury condition, a spine surgeon created the experimental lesion on all cadavers. The lesion was created by excising the supraspinous and interspinous ligaments, the ligamentum flavum, the spinal cord, the facet capsules, and the anterior and posterior longitudinal ligaments along with the intervertebral disc. To access the lower cervical vertebrae of the cadavers and measure the magnitude of the movements created at the segmental level of interest, the surgeon had to displace or remove a number of structures overlying the anterior aspect of the cervical spine. These structures included the larynx, the esophagus, and the trachea.

According to White and Panjabi,[13] the cervical spine is considered unstable if the angular displacement of a vertebral body compared with an adjacent vertebrae is more than 11° or if the horizontal displacement exceeds 3.5 mm. To verify that sectioning of soft tissue restraints resulted in global instability, we examined the angular displacement of C5 relative to C6 as the head and neck were moved passively through the full ranges of motion possible in each of the 6 directions (flexion, extension, right and left rotation, and right and left lateral flexion). The average degree of instability (±SD) achieved with our test cadavers was 46.8° (±4.8°) in the sagittal plane, 43.1° (±23.0°) in the transverse plane, and 34.2° (±18.0°) in the frontal plane.

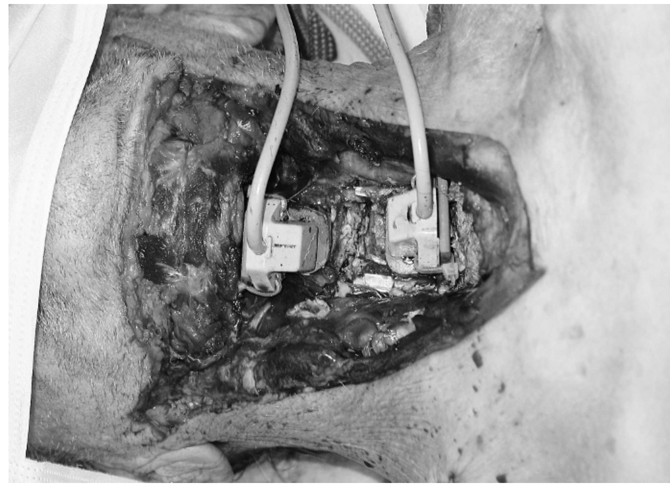

Figure 1. Sensor placement.

Equipment

We used a motion-tracking device (LIBERTY; Polhemus Inc, Colchester, VT) to quantify the motion generated between C5 and C6 during the execution of transfer techniques. This 6-degrees-of-freedom motion-tracking device uses electromagnetic fields generated by a transmitter to determine the 3-dimensional (3D) position and orientation of its sensors. The maximal capture volume for the motion-tracking system is a hemisphere with a radius of approximately 79 cm from the transmitter. For this investigation, the transmitter was implanted inside the cadaver's chest cavity during testing. Pilot testing revealed that placing the transmitter in this location maximized the accuracy of the system because the transmitter was never more than 40 cm from any of the sensors at any given time.

The output of the sensors was unfiltered, 3D position and orientation data presented as a matrix of direction cosines for the sensors relative to the transmitter. The rotation matrices of the sensors were transformed so that the direction cosine matrix (DCM) was calculated for the distal sensor relative to the proximal sensor using the following equation:

$$\mathrm{DCM} = [A] - 1 \times [B],$$

where [A] is the rotation matrix for the sensor placed on the proximal vertebral body and [B] is the rotation matrix for the sensor placed on the distal vertebral body. Angles were calculated using the tilt-twist method described by Crawford et al.[14] A custom LabVIEW (National Instruments Corporation, Austin, TX) program was written to collect and process the data from the motion-tracking system.

Motion that was generated at the C5-C6 segment during the execution of the 3 test procedures was acquired by positioning a tethered sensor on the anterior surface of each vertebral body (Figure 1). Given the size of the bodies of the cervical vertebrae, physical space upon which the sensors could have been placed was limited. In all cases, we attempted to centrally position the sensors along the vertebral bodies of interest. After the sensors were positioned, they were aligned with the anatomical coordinate system by aligning the cadaver with the transmitter (before it was implanted in the chest) and "zeroing" out the rotation matrix of each sensor, thereby effectively correcting for any misalignment of the sensors with respect to the vertebral body.

To secure the sensors from the motion-tracking device onto the chosen landmarks, we fitted sensors onto small, custom-designed, polyethylene mountings. The mountings were secured to the vertebral bodies using titanium surgical screws. The motion-tracking device has the ability to detect distortions in the magnetic field signal that can adversely affect the accuracy of the data. Pilot testing demonstrated that titanium screws did not affect the magnetic field of the motion-tracking system. If any signal distortion was detected, the cadaver was moved away from the distortion source (usually a nearby metal object), and the trial was repeated.

All possible angular motions (axial rotation, flexion-extension, and lateral flexion) and linear shifts (anteroposterior displacement, medial-lateral translation, and axial translation) were recorded in real time during the execution of each test trial. With an update rate of 240 Hz per sensor and accuracy of 0.076 cm root mean square for position and 0.15° root mean square for orientation, this device is well suited for collecting real-time data.

Treatments

Five participants were needed to execute the versions of the LR maneuver and LS technique used in our investigation.[5] Each technique required 4 rescuers to roll or lift the cadaver and 1 individual to position the spine board. For the 6+ lift technique, 8 participants were required. To maximize the response to the treatments (ie, angular and linear displacement at the C5-C6 vertebral segment), an extrication collar was not used during the execution of transfer techniques. In the case of a true emergency, a spine-injured individual found in the supine position and not wearing protective equipment is unlikely to be transferred to a spine board without an extrication collar in place.

The Logroll Maneuver. The 4-person LR required 1 individual to give directions and provide manual in-line stabilization of the head and neck and 3 others to assist in rolling the body. One of the assisting rescuers was located at the level of the shoulders; 1, at the hip and pelvis; and 1, alongside the knees. In a coordinated manner, all 4 participants rolled the cadaver to the side-lying position. Next, a fifth individual was required to wedge the spine board beneath the cadaver at an angle of approximately 45° to the horizontal. The cadaver was then rolled back to the supine position, at which point the rescuers often needed to make some minor adjustments to center the cadaver on the spine board.

The Lift-and-Slide Technique. With the 4-person LS, 1 individual maintained manual, in-line stabilization of the head and neck, while the 3 other rescuers straddled the cadaver in preparation for lifting the upper torso, hips, pelvis, and lower extremities. A fifth assistant again was responsible for placement of the spine board. When all participants were ready, the individual stabilizing the head and neck directed the others to raise the cadaver off the ground to enable the remaining rescuer to slide the spine board under the cadaver from the foot end. To complete the procedure, the cadaver was settled gently into place on the spine board.

The 6-Plus–Person Lift. As described by the Inter-Association Task Force,[6] the 6+ lift technique required 1 person to immobilize the head and neck and 6 individuals (1 positioned on each side of the chest, pelvis, and legs) to assist with the lift. Once again, the person providing manual in-line stabilization guided the procedure, directing the others to lift the cadaver from 4 to 6 in (10.16 to 15.24 cm) off the ground in a coordinated fashion. This provided clearance for the eighth rescuer to slide the spine board into place from the foot end of the cadaver. To complete the procedure, the cadaver was lowered carefully onto the spine board.

Procedures

Before data collection, participants were required to complete a brief familiarization session to become acquainted with the experimental protocol and each of the transfer techniques. We assigned each volunteer a specific task to complete with each transfer technique, and each practiced the test techniques from 2 to 3 times. The individual with the most experience in providing emergency care was selected to provide manual stabilization of the head and neck for all test trials. The others were assigned randomly to the other lifting or rolling positions. Testing began upon completion of this familiarization session.

Before each test trial, all cadavers were positioned supine with the head placed in line with the torso. By placing the cadavers in this starting position, we were able to consistently assess the amount of segmental motion generated as a direct result of completing the individual transfer techniques. The maximal angular and linear excursion of the vertebral segment that occurred within each plane of motion was calculated from this movement data. In all cases, motion data were collected from moments before the transfer technique was initiated and continued until the cadaver was lying supine and centered on the spine board. As might be expected, the amount of time required to complete each of the trials or each of the techniques was variable.

The order of testing for transfer technique was randomized using a computer-generated random numbers list (Stat Trek Inc, Atlanta, GA). Each of the transfer techniques was repeated 3 times in succession with a short rest period between each of the 3 trials to allow for repositioning of the cadaver. Testing took place with the spines intact (9 trials) and then after C5-C6 destabilization (9 trials). To avoid participant fatigue, only 1 cadaver was tested on any given day.

Statistical Analysis

A 2×3 (experimental lesion by technique) analysis of variance with repeated measures was used to analyze each of the variables of interest. The mean maximal linear displacement and angular motion obtained and calculated from the 3 trials for each condition were included in the analysis. Post hoc pairwise comparisons with Bonferroni adjustments were calculated when necessary. All statistical analyses were performed using SPSS statistical software (version 14.0; SPSS Inc, Chicago, IL) with the level of significance for all statistical tests set a priori at $\alpha \leq .05$.

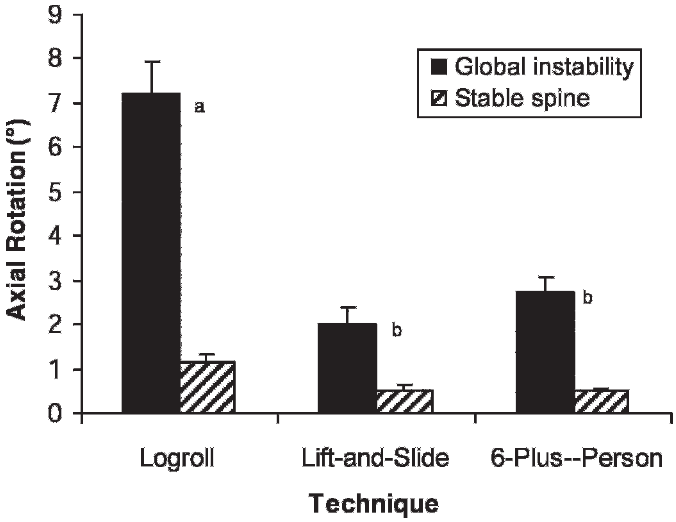

Figure 2. Angular motion occurring in transverse plane. [a]Denotes significantly different ($P < .05$) from stable condition. [b]Indicates significantly different from logroll ($P < .05$). Error bars denote standard error of the mean.

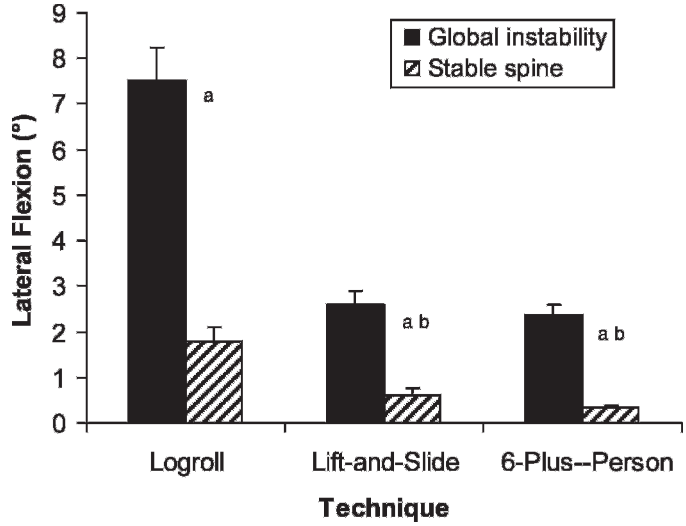

Figure 4. Angular motion occurring in frontal plane. [a]Denotes significantly different ($P < .05$) from stable condition. [b]Indicates significantly different from logroll ($P < .05$). Error bars denote standard error of the mean.

RESULTS

The mean maximal linear and angular motion generated at the C5-C6 segment with each of the 3 transfer techniques are presented in Figures 2 through 7.

Axial Rotation

Analysis of axial rotation data revealed a significant lesion-by-technique interaction effect ($F_{2,8} = 24.56$, $P < .001$) (Figure 2). Post hoc tests revealed a significant difference between the LR (7.21 ± 0.73°) and both the 6+ lift (2.73 ± 0.33°) ($P = .008$) and LS (2.01 ± 0.37°) ($P = .001$) when these were executed in the presence of a destabilized C5-C6 segment. In addition, the amount of motion generated with the LR before the creation of the instability (1.16 ± 0.18°) differed significantly from the amount of motion generated after the creation of the instability (7.21 ± 0.73°) ($P = .002$).

Flexion-Extension

No significant difference was noted for flexion-extension among techniques or for any 1 technique compared before and after the spinal instability was created. As might be expected, we found a main effect for lesion ($F_{1,4} = 26.24$, $P = .007$), with the greatest amount of motion generated after destabilization of the C5-C6 segment (Figure 3).

Lateral Flexion

A lesion-by-technique interaction was detected for lateral flexion ($F_{2,8} = 30.98$, $P < .001$) (Figure 4). Post hoc tests using a Bonferroni adjustment revealed a significant difference between the LR (7.50 ± 0.73°) and both the 6+ lift (2.35 ± 0.26°) ($P = .005$) and LS (2.58 ± 0.31°) ($P = .003$) techniques when performed on an unstable

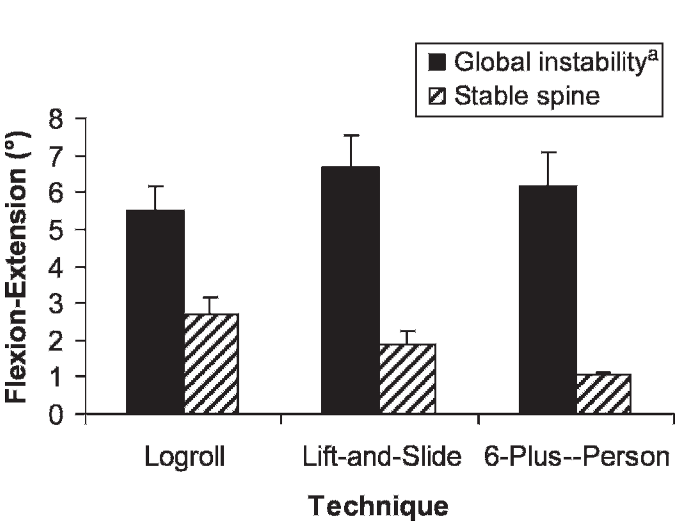

Figure 3. Angular motion occurring in sagittal plane. [a]Indicates significantly different from stable spine for all techniques ($P < .05$). Error bars denote standard error of the mean.

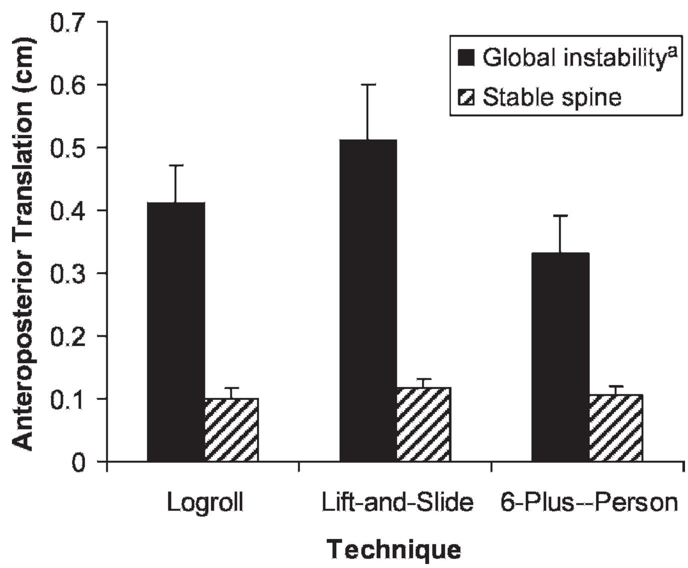

Figure 5. Anteroposterior translation. [a]Indicates significantly different from stable spine for all techniques ($P < .05$). Error bars denote standard error of the mean.

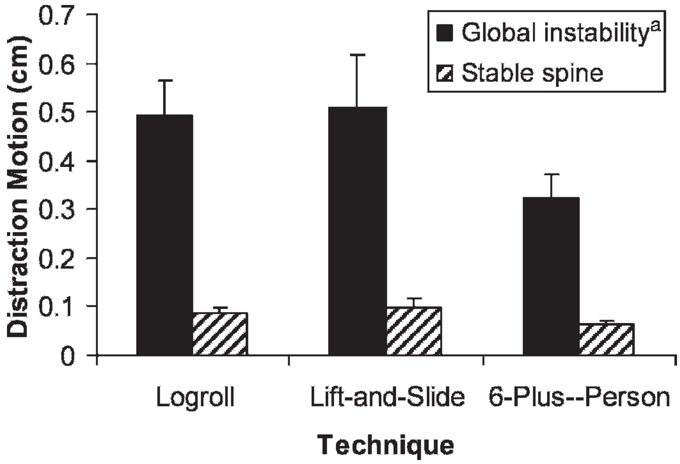

Figure 6. Distraction. [a]Indicates significantly different from stable spine for all techniques ($P < .05$). Error bars denote standard error of the mean.

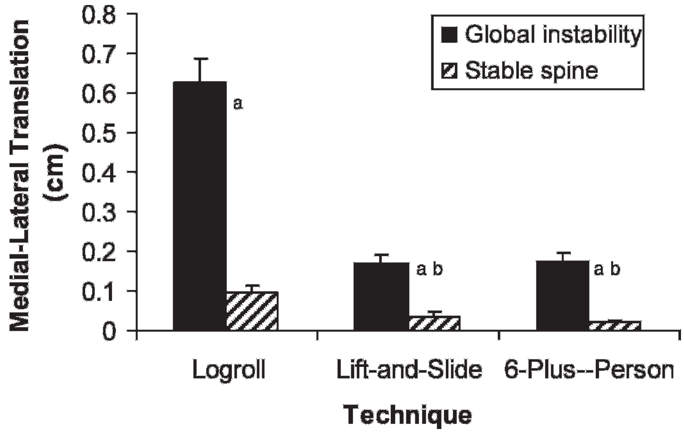

Figure 7. Medial-lateral translation. [a]Denotes significantly different ($P < .05$) from stable condition. [b]Indicates significantly different from logroll ($P < .05$). Error bars denote standard error of the mean.

cervical spine. In both cases, the motion generated at the unstable segment with the execution of the LR maneuver was significantly more than the motion produced with either lifting technique. Post hoc tests also revealed significant differences between stable and unstable conditions with all techniques: stable LR (1.80 ± 0.30°) versus unstable LR (7.50 ± 0.73°) ($P = .002$), stable 6+ lift (0.33 ± 0.04°) versus unstable 6+ lift (2.35 ± 0.26°) ($P = .0040$), and stable LS (0.62 ± 0.14°) versus unstable LS (2.58 ± 0.31°) ($P = .002$).

Anteroposterior Translation

A main effect for lesion was observed ($F_{1,4} = 15.85$, $P = .016$), with a notable increase in anteroposterior motion occurring after the development of global instability (Figure 5).

Distraction Motion (Axial Translation)

The statistical analysis of distraction data indicated that significantly greater motion (main effect) was detected subsequent to the creation of the lesion at C5-C6 ($F_{1,4} = 10.82$, $P = .03$) (Figure 6).

Medial-Lateral Translation

A lesion-by-technique interaction was observed with medial-lateral translation data ($F_{2,8} = 33.53$, $P < .001$) (Figure 7). Once again, post hoc tests revealed a significant difference between the LR (0.63 ± 0.06 cm) and both the 6+ lift (0.17 ± 0.02 cm) ($P = .003$) and LS (0.17 ± 0.02 cm) ($P = .004$) techniques after the C5-C6 instability had been created. In addition, post hoc tests identified significant differences between stable and unstable conditions across all techniques: stable LR (0.10 ± 0.01 cm) versus unstable LR (0.63 ± 0.06 cm) ($P = .004$), stable 6+ lift (0.02 ± 0.003 cm) versus unstable 6+ lift (0.17 ± 0.02 cm) ($P = .003$), and stable LS (0.04 ± 0.01 cm) versus unstable LS (0.17 ± 0.02 cm) ($P = .002$).

DISCUSSION

The implementation of cervical spine immobilization during the emergency management of traumatically injured patients has become standard practice,[15–18] presumably because first responders may not be able to verify with certainty the degree of spinal stability or because the onset of signs and symptoms of spinal cord injury may be delayed.[19,20] In recent years, however, opposition to the routine use of spinal immobilization has emerged because investigators[19] have reported that only a small fraction of patients immobilized onto a spine board by emergency medical services personnel actually have an unstable spine. Furthermore, Vickery[21] reported that prolonging the period of time spent on a rigid spine board can result in discomfort, pain, and possibly the development of pressure sores. Even though these possible complications related to spine-board use are of concern, they still pale in comparison with the potentially catastrophic consequences of not stabilizing and immobilizing a patient with actual spinal instability.

People with missed or mismanaged injuries might be expected to exhibit an escalation in neurologic deficit, but those who were cared for in a cautious manner, using approved and acceptable methods, would not be expected to exhibit this escalation. Yet, some patients, who were presumably cared for in an appropriate manner, have presented to hospital emergency departments with neurologic injuries believed to have been caused or exacerbated by actions taken during the early stages of management.[22,23] The intimation that interventions designed to minimize the risk of neurologic deterioration may be more perilous than previously thought has brought into question the relative safety of many procedures used in the prehospital management of spine-injured patients. As a result, researchers[7–12,24–34] have expressed considerable interest in assessing the effectiveness of these procedures, which include airway management protocols, spinal stabilization strategies, procedures for removing protective sporting equipment, and spine-board transfer techniques.

An examination of those studies[7–12,24–34] evaluating the various interventions performed in the prehospital setting revealed that some spinal motion is inevitable. Although some authors[35,36] believe that the motion generated by practitioners is insufficient in both magnitude and duration to produce adverse neurologic effects, a few reports[37,38] indicate otherwise. The description by Harrop et al[38] of a patient who experienced neurologic deterioration during the fitting of a halo vest suggested that large magnitudes of motion may not be necessary to produce secondary or progressive injury. However, the precise amount of motion necessary to compromise the spinal cord remains unknown.

Determining the threshold for neurologic injury is difficult. Among other factors, individual differences in anatomy, the location of the injury, and the degree of instability could affect the risk of neural tissue compression. Furthermore, with some injuries, the kinematics of the unstable cervical spine may become markedly unpredictable compared with the kinematics of the intact spine.[22] Therefore, instead of quantifying the amount of motion required to exacerbate an existing spinal injury, researchers[39,40] have chosen to identify the types of movement (ie, direction) that tend to pose the greatest risk to neural tissue.

The amount of spinal canal encroachment that may occur while moving the spine has been examined using diverse injury models of instability. Dimensional changes to the spinal canal (and intervertebral foramina) have been recorded after the creation of vertebral burst fractures and after a variety of anterior cervical lesions.[39,40] Ching et al[39] reported that extension; extension combined with lateral bending; and, to a lesser degree, axial rotation tended to result in notable occlusion of the spinal canal. In comparison, using a much different injury model, Nuckley et al[40] determined that spinal canal space was affected only minimally by any type of cervical bending. However, they reported that, compared with measurements on intact spines, compromise of the intervertebral foramen increased greatly with extension, ipsilateral bending (lateral flexion), and ipsilateral bending with extension. They also reported that the greatest potential for neurologic injury occurred when the spine was loaded in extension combined with ipsilateral bending because the area available for the nerve root was reduced approximately 39%. The findings of these 2 investigations[39,40] seem to indicate that extension, lateral flexion, and extension in combination with lateral flexion (and possibly axial rotation) may pose the greatest risk. Moreover, if applied to the results of our investigation, the LR appears to be the technique that tends to produce motions that are most likely to imperil neural tissue. However, the study methods that we employed precluded the evaluation of neural tissue compromise, making it impossible to compare results and draw definite conclusions.

In some of the earliest research on spine-board transfer techniques, investigators[4,10] examined the suitability of the LR for transferring patients with thoracolumbar injuries. These authors suggested that the LR maneuver might not be appropriate to use with patients who have sustained lower thoracic or lumbar spine injuries. An investigation[7] to examine the effectiveness of transfer techniques in limiting motion of the cervical spine was not conducted until 2003. Since then, several other investigations have been published,[7–9] and our results are consistent with these findings. That is, motion in the sagittal plane did not vary between the LR and other techniques, yet the execution of the LR tended to generate significantly more lateral flexion and axial rotation.

Completion of the LR requires more complex coordination than the 6+ lift and LS, and this may explain why a tendency for more axial rotation and lateral flexion appears to occur with the LR. Naturally, the rescuer stabilizing the head plays a significant role in coordinating the patient transfer. With the 6+ lift and LS techniques, this rescuer is required to lift the head and move it in simple linear fashion with the rest of the body. In comparison, during the execution of the LR, the body never leaves the ground as the patient is rolled to the side-lying position. Therefore, to remain aligned with the body, the head must rise from the ground and follow an arc of motion and, thus, must translate along a curvilinear path about a horizontal plane. Perceptual errors on the part of the rescuer completing this curvilinear movement might result in the positional deviation sometimes observed between the head and body.

In addition, Suter et al[4] suggested that, during the performance of the LR maneuver, the slope of the thoracolumbar spine is likely to change because of differences in girth proportions among various areas of the body. Differences in width among the pelvis and the torso, while of no consequence when the patient is supine, might become problematic as a patient is rolled to the side-lying position. In the side-lying position, notable differences between pelvic and torso girths can cause the spinal column as a whole to slope. If not anticipated by the rescuer stabilizing the head, the development of a slope along the spinal column can result in deviations of the cervical spine if the position of the head departs from its alignment with the body.

Recently, a motorized spine board, which slides under the patient, was evaluated and compared with the LR.[11] The investigators reported that equal amounts of head motion were generated with the LR in each of the 3 cardinal planes and observed that mean motion in the frontal and transverse planes was greater with the LR than with the motorized spine board. This finding demonstrates yet again that alternatives to the LR maneuver are available and should be considered by those providing care to spine-injured patients.

The Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete[6] has advocated the use of the 6+ lift in combination with a scoop stretcher, but the effectiveness of the scoop stretcher only recently has been investigated. In a study that measured head motion in healthy individuals,[12] the execution of the LR produced from 6° to 8° more motion in each plane than the motion that resulted from the application of the scoop stretcher. Clearly, testing the effectiveness of the scoop stretcher would have been fitting in our investigation because it would have established how the structurally unstable spine reacts during the use of this device. However, because we did not incorporate the scoop stretcher in our investigation, additional research is needed to further establish the potential benefits of using a scoop stretcher in combination with the 6+ lift.

All investigations have limitations that affect the generalizability of the results because of the methods used in the study. The various methodologic limitations of our investigation include the use of cadaver specimens that were significantly older than typical patients and likely smaller compared with some athletes. With advanced age, the mobility of human tissue is diminished,[29] and this may have affected the amount of motion produced throughout the study. In addition, larger-sized patients may pose different challenges to the rescue team than the challenges that our research team experienced.

Along with the limits of generalizability related to the cadaver specimens, other factors needed to be considered. In our study, one person with 24 years of experience was responsible for maintaining manual stabilization during all trials. Compared with a less experienced person, this individual may have been able to restrict movement to a much greater extent. Also, to induce a spinal column injury that would mimic a worst-case clinical situation, we generated a complete segmental spine injury that resulted in global instability at a single level of the spine and precluded the use of a cervical extrication collar to maximize the response to the treatments. As indicated previously, no 2 injuries react in a similar fashion, and the amount of additional support that a cervical extrication collar would have provided to the rescue team is unknown; therefore, any extrapolation of conclusions should be considered carefully. Also, this investigation was completed in a controlled, laboratory setting, where the repercussions of a "botched" trial were trivial, but primary responders must understand that sloppy or careless on-field management of a spine-injured patient can result in large spinal deviations and a potentially tragic outcome. Finally, during our laboratory assessment of transfer techniques, the rescue team did not have to contend with challenges posed by other variables, such as sporting equipment worn by the patient, lack of rescue personnel, or lack of space.

CONCLUSIONS

Because a small amount of spinal motion is likely to occur with most emergency interventions and the quantity of motion necessary to compromise neural tissue is unknown, primary responders providing the initial care to potentially cervical spine-injured patients may want to become familiar with either the LS or 6+ lift; the execution of these spine-board transfer techniques appears to minimize the motion generated across an unstable spinal segment. Additional research is necessary to assess whether using a scoop stretcher in combination with either of the 2 lifting techniques could further improve the effectiveness of the transfer process.

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