



Original Contribution

## Are scoop stretchers suitable for use on spine-injured patients?

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### Abstract

**Introduction:** In the prehospital setting, spine-injured patients must be transferred to a spine board to immobilize the spine. This can be accomplished using both manual techniques and mechanical devices.

**Objectives:** The study aimed to evaluate the effectiveness of the scoop stretcher to limit cervical spine motion as compared to 2 commonly used manual transfer techniques.

**Methods:** Three-dimensional angular motion generated across the C5-C6 spinal segment during execution of 2 manual transfer techniques and the application of a scoop stretcher was recorded first on cadavers with intact spines and then repeated after C5-C6 destabilization. A 3-dimensional electromagnetic tracking device was used to measure the maximum angular and linear motion produced during all test sessions.

**Results:** Although not statistically significant, the execution of the log roll maneuver created more motion in all directions than either the lift-and-slide technique or with scoop stretcher application. The scoop stretcher and lift-and-slide techniques were able to restrict motion to a comparable degree.

**Conclusion:** The effectiveness of the scoop stretcher to limit spinal motion in the destabilized spine is comparable or better than manual techniques currently being used by primary responders.

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To determine the best practice for out-of-hospital transfers of spine-injured patients, researchers have assessed the relative safety of a number of manual transfer techniques [1-5]. The safety of these transfer methods has been determined by evaluating the effectiveness with which these techniques can limit cervical spine motion when they are performed. Most studies have revealed the log roll

maneuver to be inferior to other transfer techniques such as the lift and slide; [1,3-5] yet the log roll maneuver continues to be preferentially used by primary responders. Although there are a number of possible explanations that the log roll maneuver continues to be used exclusively by responders in the prehospital setting, the most plausible reason is that personnel requirements can be minimized when using the log roll as compared to any of the available lifting methods. Whereas the log roll can be performed with as little as 2 or 3 people, most lifting techniques require a

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minimum of 4 individuals to be able to safely carry out the patient transfer [6,7]. Fortunately, mechanical devices are now available that may finally persuade primary responders to seriously explore the idea of using a transfer method other than the log roll [8,9]. In fact, one such device is the scoop stretcher, and a preliminary report has already revealed that much like most other manual techniques, the scoop stretcher performs better than the log roll maneuver [8].

The scoop stretcher is an adjustable device that separates into 2 hinged interlocking pieces along its longitudinal axis. Because each of the halves is wedge-shaped, they can, in theory, be inserted beneath the patient without the need for rolling or lifting the individual. In the past, these devices were constructed using materials or design features that were not suitable for providing acceptable levels of spinal immobilization, and thus, were not used to transfer or transport spine-injured patients. However, newer models have been redesigned to be able to safely accomplish such tasks (Fig. 1). As indicated, a preliminary study conducted on healthy individuals revealed that rescuers could minimize the amount of spinal motion produced while in the prehospital setting by using one of the available reengineered scoop stretchers [8]. Krell et al [8] reported that head and neck motion generated in healthy individuals was  $6^\circ$  to  $8^\circ$  less in each of the 3 planes of movement when using the scoop stretcher as compared to the traditional log roll [12]. Although the results of this preliminary study showed some promise, to fully evaluate the safety of the scoop stretcher, additional testing was warranted to be able to assess how the scoop stretcher would fare when used with the patient with a structurally unstable spinal segment. Therefore, in this investigation, we created experimental lesions in cadaver specimens to assess the amount of motion generated across a destabilized vertebral segment when using a scoop stretcher and compared this motion to that which is produced during the execution of 2 commonly used manual transfer techniques.



**Fig. 1** Scoop stretcher.

## 1. Methods

### 1.1. Experimental lesion

All test trials were at first carried out on cadavers with intact spines and then repeated after the creation of a complete segmental lesion, which resulted in global instability at the C5-C6 spinal level. Five lightly embalmed cadavers with no previous history of cervical spine pathology were included in this study. The cadavers had a mean age of  $83.0 \pm 8.0$  years and an average weight of  $61.2 \pm 14.1$  kg. To standardize the aforementioned injury condition, a single spine surgeon created the experimental lesions in all cadaver spines. The test 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 ligament along with the intervertebral disk. In addition, to be able to position movement sensors onto the vertebrae of interest, it was necessary to displace and/or remove the structures overlying the anterior aspect of the cervical spine that included the larynx, esophagus, and trachea.

To verify that sectioning of the various soft tissue restraints (ie, ligaments, joint capsule, intervertebral disk) resulted in a global instability, we assessed the angular displacement of the C5 vertebra relative to the C6 vertebra as the head and neck were moved passively through the full ranges of motion in each of 6 directions (flexion, extension, right and left rotation, and right and left lateral flexion). The motions were then compared to the reported minimum displacement necessary for the spinal segment to be considered unstable. According to White and Panjabi [10], the cervical spine is considered unstable if the angular displacement of a vertebral body compared with an adjacent vertebrae is more than  $11^\circ$  or if the horizontal displacement exceeds 3.5 mm. The average degree of instability ( $\pm$ SD) achieved with our test cadavers was  $31.1^\circ (\pm 7.5^\circ)$  in the sagittal plane,  $19.5^\circ (\pm 6.7^\circ)$  in the transverse plane, and  $15.4^\circ (\pm 5.6^\circ)$  in the frontal plane. Therefore, our range of motion assessment confirmed that instability was achieved with all cadavers.

### 1.2. Equipment

A Liberty motion analysis device (Polhemus Inc, Colchester, Vt) was used to quantify the motion generated between the C5 and C6 vertebral segment during the execution of transfer techniques and during the application of the scoop stretcher. This 6 degrees-of-freedom motion-tracking device uses electromagnetic fields to determine the 3-dimensional position and orientation of its sensors.

Motion generated between the C5 and C6 vertebrae was recorded using tethered sensors affixed to the bodies of the vertebrae. To secure the sensors from the Liberty device onto the chosen landmarks, we attached the sensors directly to the

vertebrae using small nylon cable ties and 2.5-cm wood screws. For this investigation, all possible angular and linear motions were recorded by the Liberty device.

### 1.3. Treatments

Five individuals were needed to execute the specific versions of the log roll and lift-and-slide techniques that were selected for investigation in this study [6]. Specifically, 4 rescuers were required to roll or lift the cadaver, and a fifth individual was needed to position the spine board. Because the application of the scoop stretcher does not require any lifting or rolling of the cadaver, only 4 rescuers were needed to carry out this task.

#### 1.3.1. The log roll maneuver

With the 5-person log roll, one person provided manual in-line stabilization of the head and provided directions to 3 others who assisted in rolling the body. One of the assisting rescuers was located at the level of the shoulders/chest, another at the hip and pelvis, and the third assistant was alongside the knees. These 4 participants rolled the cadaver in a coordinated manner to the side-lying position. Once the cadaver was in the side-lying position, a fifth individual carefully wedged the spine board beneath the cadaver. The cadaver was then rolled back to the supine position, at which point it was often necessary to make some minor adjustments to center the cadaver on the spine board.

#### 1.3.2. The lift-and-slide technique

With a 5-person lift-and-slide, 3 rescuers were responsible for lifting the upper torso, hips/pelvis, and lower extremities all the while a fourth rescuer maintained manual in-line stabilization of the head. A fifth individual was again responsible for placement of the spine board. When all participants were ready, the person stabilizing the head directed the others to raise the cadaver 20 to 30 cm up off the ground to allow the spine board to be introduced beneath the cadaver from the foot end. With the spine board in place, the cadaver was then gently lowered onto the spine board.

#### 1.3.3. The scoop stretcher

While 1 rescuer stabilized the head and neck, the 2 longitudinal halves of the scoop stretcher (Scoop EXL Stretcher, Ferno-Washington Inc, Wilmington, Ohio) were separated and positioned on either side of the cadaver. Following the orders of the person in charge, 3 rescuers carefully wedged the scoop stretcher halves beneath the cadaver until the hinges at either end were latched and in the locked position. Two of the rescuers were located at shoulder level on either side of the cadaver and the third was located at the foot end of the cadaver and was solely responsible for locking that end of the scoop stretcher.

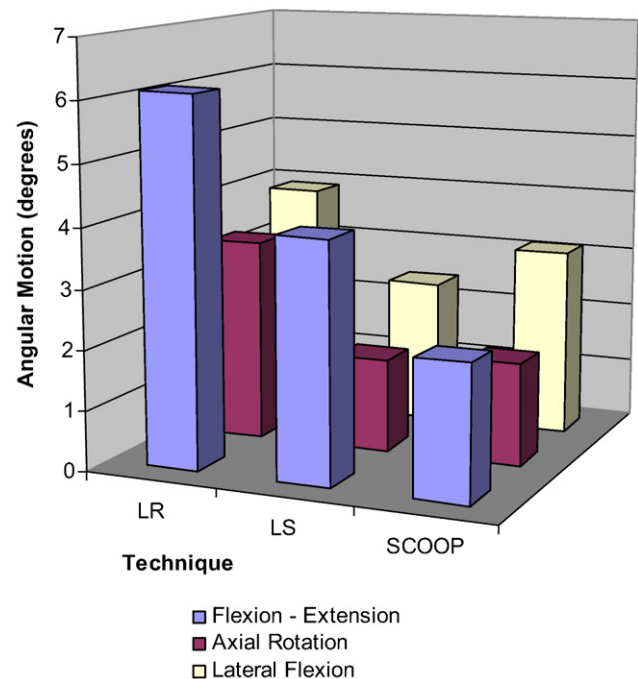
### 1.4. Procedures

The rescue team recruited to perform cadaver transfers consisted of 3 physicians and 2 certified athletic trainers. All members of this team were required to practice the 3 test transfer techniques before data collection to become acquainted with the experimental protocol and to learn how to coordinate the execution of each technique. For this study, the individual with the greatest amount of experience in providing emergency care was selected to provide manual stabilization of the head and neck and to direct all others in completing test trials. All remaining members of the rescue team were randomly assigned to carry out other related duties such as a lifting and rolling the cadavers, positioning the spine board, or applying the scoop stretcher. As part of this familiarization phase, a minimum of 2 to 3 practice trials were completed with each of the transfer techniques. Testing began upon completion of this practice session.

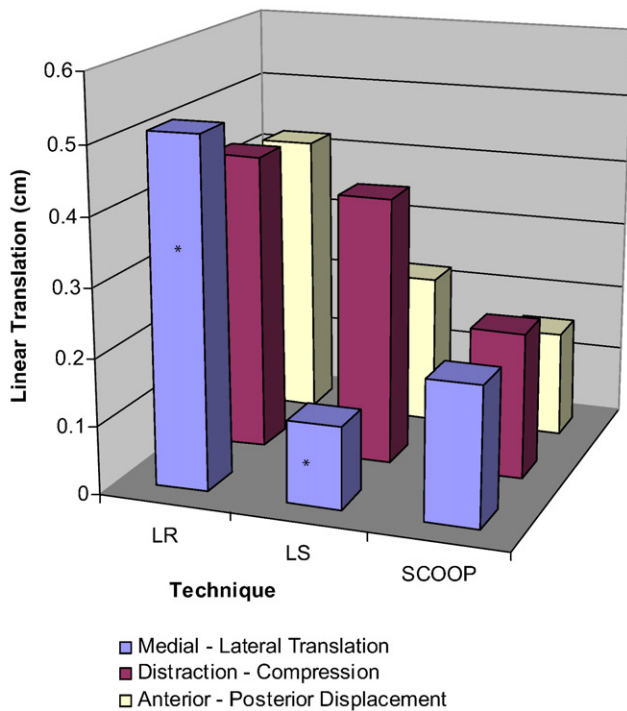
The order of testing for transfer technique was randomized using a computer-generated random numbers list. All transfer techniques were repeated 3 times and began with the cadaver in a standard starting position, which consisted of the cadaver laying supine on the ground and the head and neck aligned with the torso. To minimize the level of fatigue experienced by the rescue team, only one cadaver was tested per day.

### 1.5. Statistical analysis

In this investigation we analyzed 6 dependent variables that consisted of 3 angular motions and 3 linear motions.



**Fig. 2** Angular motion created when using various patient transfer methods. LR indicates log roll; LS, lift-and-slide; SCOOP, scoop stretcher.



**Fig. 3** Linear translation created when using various patient transfer methods. Asterisk indicates statistically significant difference between log roll and lift-and-slide for medial-lateral translation.

These variables of interest were flexion-extension, lateral flexion, axial rotation, medial-lateral translation, anterior-posterior translation, and distraction-compression produced at the C5-C6 spinal segment. A 1-way analysis of variance with repeated measures was calculated using each of these dependent variables to evaluate the differences in motion produced with the various transfer methods tested in this investigation. The maximum range of motion from the 3 trials performed with each cadaver was included in the statistical analyses. Post hoc pairwise comparisons with Bonferroni adjustments were calculated when necessary. All statistical analyses were performed using SPSS statistical software (SPSS, Inc, version 15.0, Chicago, Ill) with the level of significance for all statistical tests set, a priori, at  $\alpha$  of less than .05.

## 2. Results

The mean maximum linear and angular motion (with standard deviations) generated at the C5-C6 segment during the performance of the log roll and lift-and-slide transfer techniques as well as the motion produced during the use of the scoop stretcher are presented in Figs. 2 and 3.

### 2.1. Angular motion

Analysis of axial rotation data revealed a significant main effect for technique ( $F_{2,8} = 4.70$ ,  $P = .045$ ,  $\eta^2 = 0.54$ );

however, post hoc pairwise comparisons revealed no significant differences between any of the treatments after the results had been corrected with a Bonferroni adjustment. Flexion-extension and lateral bending data revealed no significant differences between treatments after statistical testing.

### 2.2. Linear motion

Analysis of anterior-posterior translation data also revealed a significant main effect for technique ( $F_{2,8} = 5.64$ ,  $P = .03$ ,  $\eta^2 = .59$ ) but the Bonferroni corrected pairwise comparisons again revealed no significant differences between any of the treatments. A main effect for technique was observed with medial-lateral translation data as well ( $F_{2,8} = 13.81$ ,  $P = .003$ ,  $\eta^2 = 0.78$ ), with post hoc comparisons revealing that the log roll generated significantly more motion (approximately 3.9 mm more) than the lift-and-slide technique ( $P = .009$ ). No other post hoc comparisons were found to be significant after calculating the Bonferroni adjustment. Finally, statistical testing of axial distraction data revealed that the sphericity assumption was not met so the Huynh-Feldt correction was applied. After this correction, no significant differences between techniques were noted.

## 3. Discussion

The results of the present study seem to concur with numerous other studies that have reported that the log roll maneuver not only tends to create more motion than various lifting techniques but also creates more segmental displacement than the scoop stretcher [1-5,8], particularly in the medial-lateral and anterior-posterior directions. In a previous study, Krell et al [8] provided a preliminary assessment of the scoop stretcher by reporting angular head and neck motion produced in a group of healthy volunteers during the application of this device. Our data not only support these earlier findings by Krell et al but also reinforce the notion that the scoop stretcher might be a viable alternative to the log roll because it not only results in less angular motion but also tends to generate less linear motion. This is significant because linear motion is likely to have a greater proclivity for creating secondary neurologic injury because pathologic linear movements of the vertebrae such as anterior displacement or compression can more readily or significantly diminish the space available for the spinal cord within the spinal canal [11,12]. For example, Ebraheim et al [12] reported that 6 mm of anterior vertebral translation resulted in spinal canal narrowing that occluded the area available for the spinal cord by 59% at the level of C6 and by 51% at C7.

Differences in motion between the log roll and all other methods of patient transfer have previously been attributed, in part, to the complexity of the log roll maneuver [3]. For the head to remain aligned with the body during the

execution of the log roll, the head and neck must come up off the ground and translate along a curvilinear path about a horizontal plane as the body is rolled to the side-lying position. Either perceptual errors or deviations in synchronicity between the various rescuers involved in the procedure can easily result in spinal deviation. One of the advantages of the scoop stretcher over the log roll and other manual techniques is that in the case of the supine patient, it does not require purposeful movements for rescuers to position the patient onto the stretcher. Because the supine patient does not need to be rolled or lifted to position the scoop stretcher, the only event that could potentially create spinal motion is the sequence when the interlocking pieces of the scoop stretcher are wedged beneath the head of the patient. The data seem to indicate that, indeed, some motion is created during this part of the process (and presumably during the disengagement of the interlocking pieces), yet the amount of spinal motion that is generated during this time is still comparable to, or less than, the motion produced with the lift-and-slide. Moreover, by eliminating altogether the need to shift the patient, as is required with the log roll and lift-and-slide, the rescue team can significantly reduce the risk associated with the development of miscues that can potentially result in the creation of secondary neurologic injuries before surgical stabilization.

When compared to a recent study on efficacy of spine board transfer techniques, the spinal motion produced in the present study was only slightly less than that reported in the previous investigation, although our cadaver specimens had been fitted with a cervical extrication collar, whereas in the previous study, they had not. This result might suggest that cervical extrication collars might be of limited benefit to the rescue team in so far as providing absolute stability of the cervical spine. Yet, their role or effectiveness should not be discounted because the magnitude of motion that the cervical spine can tolerate before a neurologic injury is either precipitated or exacerbated is not known, and thus the benefit of wearing a collar may not be realized unless a disproportionate amount of motion is produced such as in the unlikely event of a miscue or error on the part of the rescue team.

All investigations have limitations inherent in the research methodology that affect the generalizability of the results. One limitation of our study was related to the use of cadaver specimens that were significantly older than most patients. It is well known that the mobility of human tissue decreases with advanced age [13], and this may have affected the amount of motion produced throughout the study. We also acknowledge that a study with a larger sample of cadaver specimens could have produced potentially different data trends.

Along with study limitations related to the cadaver specimens used in this investigation, there are other aspects of our methodology that limit the generalizability of the observed results. Given that a 3-dimensional electromagnetic tracking device was used to track motion in real time across the C5-C6 spinal segment, the visualization of spinal canal

encroachment was not possible. Therefore, we were unable to assess the absolute risk posed by each technique or device because it was not possible to determine the extent of neurologic impingement that would have resulted given the motion created during testing sessions. Nevertheless, relative risk can still be established by taking into account the movements generated with each of the transfer methods and determining which of the methods allows rescuers to maintain the best stabilization, or alternatively, which technique creates the greatest spinal motion, keeping in mind that the greater the motion, the greater the risk.

Also, in this investigation, a complete segmental spine injury that resulted in global instability at a single level of the spine was created in all cadavers in an effort to simulate a worst case scenario. Because vertebral motion is dependent in large part to the extent of the instability created by the injury, it is safe to assume that no 2 injury types will react in a similar fashion. Therefore, it is not known how vertebral motion produced with each of the transfer methods would have varied from the current findings if a different injury model had been used.

Lastly, it should be noted that scoop stretcher design varies between manufacturers. The fastening hinges for the model used in this investigation had the interlocking pieces located directly along the midline of the device. Devices from other manufacturers have the latching system positioned away from the midline, either one side or the other. It is not known how these differences in design features would have impacted the amount of head and neck motion produced during application.

In summary, although the use of the scoop stretcher is limited to situations in which the patient is supine, this investigation revealed that in the hands of a practiced rescue team, the scoop stretcher can be applied just as safely as the lift-and-slide and generates less motion than the log roll maneuver. Because this conclusion is based on data collected using one of several different scoop stretcher designs, additional research is warranted to determine if all scoop stretchers offer the same level of protection to the patient when being transferred.

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