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Eliminating log rolling as a spine trauma order

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Abstract

Background: Currently, up to 25% of patients with spinal cord injuries may experience neurologic deterioration during the initial management of their injuries. Therefore, more effective procedures need to be established for the transportation and care of these to reduce the risk of secondary neurologic damage. Here, we present more acceptable methods to minimize motion in the unstable spine during the management of patients with traumatic spine injuries.

Methods: This review summarizes more than a decade of research aimed at evaluating different methods of caring for patients with spine trauma.

Results: The most commonly utilized technique to transport spinal cord injured patients, the log rolling maneuver, produced more motion than placing a patient on a spine board, removing a spine board, performing continuous lateral therapy, and positioning a patient prone for surgery. Alternative maneuvers that produced less motion included the straddle lift and slide, 6 + lift and slide, scoop stretcher, mechanical kinetic therapy, mechanical transfers, and the use of the operating table to rotate the patient to the prone position for surgical stabilization.

Conclusions: The log roll maneuver should be removed from the trauma response guidelines for patients with suspected spine injuries, as it creates significantly more motion in the unstable spine than the readily available alternatives. The only exception is the patient who is found prone, in which case the patient should then be log rolled directly on to the spine board utilizing a push technique.

Key Words: Cervical spine, emergency, pre-hospital management, spinal cord injury

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INTRODUCTION

This review synthesizes previous investigations and presents methods for a continuum of care, which minimizes motion of an unstable spine. Research

indicates that up to 25% of patients with traumatic spine injuries may experience neurologic deterioration after coming under the care of trained medical personnel.^[18] A patient with a traumatic spine injury will require numerous transfers from the scene of the trauma until

receiving definitive surgical stabilization [Figure 1]. For a patient with an unstable spine, each transfer could cause or exacerbate a neurologic injury. Therefore, in order to reduce the risk of secondary neurologic injury, more effective procedures need to be established for the transport and care of the patient so that the risk of secondary neurologic damage is minimized.

For over a decade, our research team has investigated each phase of initial management (i.e. pre-hospital care and early in-hospital care) of a spinal cord injury with the goal of identifying the best practices for minimizing movement of an unstable spine.

MATERIALS AND METHODS

Experimental model

In 2001, we developed an experimental model for evaluating the effects of different spine boarding techniques on the motion of an unstable cervical spine. We chose to use a cadaver model rather than an *in vivo* model. Although cadaver tissue lacks muscle tone present *in vivo*, cadavers offer two unique advantages. First, a cadaveric model allowed us to create a simulated traumatic injury. Simulating a traumatic injury is not possible with an *in vivo* model because it is unethical to create an injury in healthy volunteers or experiment with different techniques in patients with an actual injury. Second, the cadaveric model allowed us to measure accurate segmental motion because we were able to attach sensors directly onto the vertebrae adjacent to the level of injury.

Tracking spinal motion for the stable vs. unstable spine

In the intact spine, all transfer techniques appear

acceptable with respect to the amount of segmental motion they produce. The most widely used method for tracking motion in healthy volunteers is capturing global motion of the head relative to the torso. Unfortunately, this does not provide data about the movement of the individual motion segments or the effect of the movement on a destabilized segment. In fact, the motion occurring in the intact spine is negligible to the point that we have stopped testing the uninjured condition because we noted little to no abnormal motion.

For the patient with a traumatic spine injury, we believe that early in the patient's care, the spine has to be presumed to be unstable until proven otherwise. Based upon the aforementioned, using a cadaver model with a simulated injury is the only method to reliably test the motion of an unstable spine.

Motion measurements

In our studies, segmental motion at the level of injury is measured using a 3D electromagnetic tracking system (Liberty, Polhemus Inc., Colchester, VT, USA). Motion sensors are attached directly to the vertebral segment where the instability is created. An anatomic coordinate system is defined for each motion sensor. The motion sensors produce direction cosines which describe the sensor position and orientation with respect to the global transmitter.

Joint angles and translations are calculated by determining the position and orientation of the proximal sensor with respect to the distal sensors. Range of motion is calculated by subtracting the maximum angulation or translation from the minimum value. This technique allows accurate measurement of angular displacements [flexion–extension (FE), axial rotation (AR), lateral bending (LB)], as well as linear displacements [medial–lateral (ML) translation, anterior–posterior (AP) translation, and superior–inferior (SI) translation].

RESULTS

The results of each phase of the management of spine injuries are divided into the following sections: collar usage, spine boarding, removal of the spine board, bed transfers, continuous lateral therapy, and prone positioning for surgery [Tables 1 and 2].

Ineffectiveness of collars in cervical spine injuries

During the initial stages of pre-hospital care, the current accepted practice is to apply a rigid cervical collar to the patient with a suspected cervical spine injury. However, a recent study noted that cervical collars are insufficient for immobilizing an unstable spine during passive range of motion tests.^[15] Numerous other studies also revealed that cervical collars fail to provide a significant reduction in motion during any transfer procedure.^[5,13,22,24] Furthermore, in distractive injuries, cervical collars have

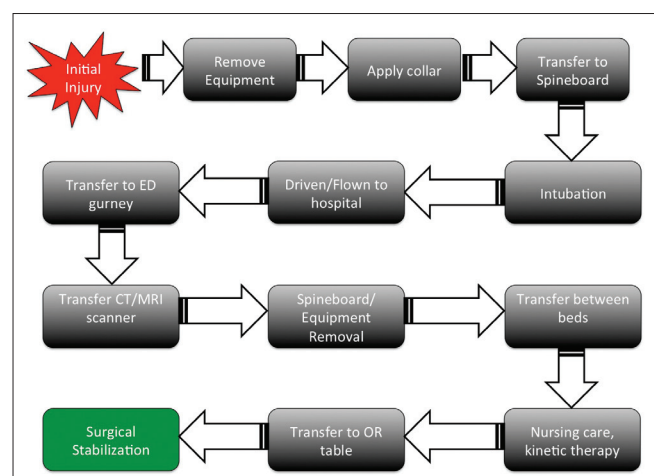


Figure 1: A schematic of the typical sequence of care for a patient who suffers a traumatic spine injury. Although each step of this sequence may not apply to every patient, there are numerous transfers and maneuvers involved in the management of the patient with spine trauma. Each step of this sequence presents a risk of secondary neurologic injury

Table 1: Pros and cons of each patient transfer technique

Technique for moving patient	Indications	Pros	Cons
Straddle lift and slide	Transfer supine patient to spine board	Better motion control compared to log roll	Slight potential for injury to rescuers
6 + lift and slide	Transfer supine patient to spine board	Better motion control compared to log roll	Requires eight rescuers
Scoop stretcher	Transfer supine patient to spine board	Requires only four rescuers, better motion control compared to log roll	Can be difficult to close the mechanism if used on uneven or soft surface
Log roll	Transfer supine patient to spine board	Requires only four rescuers, allows inspection of back in the case of penetrating trauma	Poor motion control
Kinetic Treatment Table	Continuous lateral therapy	Better motion control compared to log roll, less burden on staff, ongoing automatic movements	Requires bed designed for rotation
Log roll	Continuous lateral therapy		Poor motion control
Jackson table	Position patient prone in operating room	Better motion control compared to log roll, less burden of staff	Requires surgical table designed for rotation
Log roll	Position patient prone in operating room	Only option for patient with fixed kyphotic deformity	Poor motion control

Table 2: Recommendations for each phase of management where log roll was traditionally employed

Title of section	Summary statement
Transfer to spine board: Supine	We recommend using a lifting technique (straddle or 6 +). If the rescue is performed on a hard flat surface, the scoop stretcher should be considered
Spine board removal	A 6 + lift and slide technique should be used to remove a spine board in the hospital setting
Continuous lateral therapy	The Kinetic Treatment Table provides a wide arc of motion while stabilizing the cervical and thoracolumbar spine
Bed transfers	Mechanical devices should be considered for transferring a patient with an unstable spine between hospital beds

even been shown to be harmful as they cause increased axial displacement of the spine.^[3]

Continued role of cervical collars to alert medical providers to an injury

Nevertheless, cervical collars can play other important roles, such as alerting medical providers to the presence of a spine injury. For now, their continued usage is justified. However, it is important to be aware that collar usage alone will not be sufficient to provide immobilization of the unstable spine.

Transfer to spine board: Supine

There are four standard methods described for transferring an injured individual onto a stretcher or spine board from the supine position:^[26] log roll [Figure 2], straddle lift and slide [Figure 3], 6 + lift and slide [Figure 4], and the

scoop stretcher [Figure 5]. In all cases, the rescuer at the patient’s head coordinates the team.

Log roll

A minimum of four rescuers is required for the log roll procedure. One rescuer maintains manual inline stabilization of the head, while another one is responsible for positioning the spine board. At least two people are positioned on the same side of the patient to perform the roll. During the roll, the patient is rotated axially to an angle of approximately 30°–90°, at which point the spine board is placed at an angle beneath the patient. After the spine board is in place, the patient and the board are rolled back to the ground. Finally, the team must center the patient on the spine board in the supine position.

Straddle lift and slide

Five rescuers are required for the straddle lift and slide maneuver. One rescuer maintains manual inline stabilization of the head, while another one is responsible for positioning the spine board. The three other rescuers straddle the body at the level of the chest, pelvis, and lower extremities to perform the lift. Once the patient is lifted 10–20 cm off the ground, the board is slid beneath the patient, from the feet toward the head. The patient is then carefully lowered onto the board.

6 + Lift and slide

Eight rescuers are required during the 6 + lift and slide maneuver. One rescuer maintains manual inline stabilization of the head, while another one is responsible for positioning the spine board. Six additional rescuers are placed in pairs across from one another at the chest, pelvis, and lower extremities to perform the lift. Once the patient is lifted 10–20 cm off the ground, the board



Figure 2: Transferring a supine patient to a spine board using the log roll technique



Figure 3: Transferring a supine patient to a spine board using the straddle lift and slide technique



Figure 4: Transferring a supine patient to a spine board using the 6 + lift and slide technique

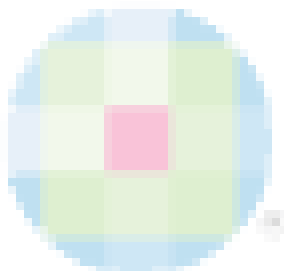


Figure 5: Photograph of the scoop stretcher. The head is placed at the wide end and the feet are placed at the narrow end. There is a mechanical latch at either end to close the two longitudinal halves of the board

is slid beneath the patient from the feet toward the head. The patient is then carefully lowered onto the board.

Scoop stretcher

Four rescuers are required for the scoop stretcher transfer. One rescuer maintains manual inline stabilization of the head. Three rescuers position and secure the scoop stretcher: two are located at shoulder level on either side of the patient and the third one is located at the feet. The two longitudinal halves of the scoop stretcher are separated and then positioned on either side of the patient. Each half of the scoop stretcher is carefully wedged beneath the patient until both ends are securely locked into place.^[4]

Transfer to spine board: Supine summary

In our initial study, neither the log roll nor the straddle lift and slide technique emerged as a clearly superior transfer method.^[10] However, this study evaluated only FE

motion. We examined the intact spine along with partial and global instabilities. The increasing severity of cervical spine injury corresponded with an increase in the amount of motion produced during the execution of spine board transfer techniques. In addition to FE motion, other angulations and displacements could potentially pose a risk to the spinal cord, and in subsequent investigations we included these measurements as well.

Statistically significant differences between transfer techniques

In further studies, statistically significant differences between transfer techniques emerged. The log roll produced significantly greater LB and AR motion in the unstable cervical spine compared with the straddle lift slide technique [Figure 6].^[9] Compared with the straddle lift and slide and the 6 + lift and slide techniques, the log roll generated significantly more AR, more LB,

and more ML translation.^[8] In an additional study, the log roll maneuver not only created more motion than straddle lift and slide and 6 + lift and slide [Figure 7], but also created more segmental displacement than the scoop stretcher transfer [Figure 8].^[9] The scoop stretcher performed very well on hard flat surfaces, but has a tendency to bind up when used on a soft or uneven surface [Figure 9]. For this reason, we do not recommend that it be used on uneven terrain or when a patient will be transferred onto a bed.

We found a similar pattern when we evaluated the effect of spine boarding on thoracolumbar injuries. Again, the execution of the log roll maneuver produced more motion than any other technique.

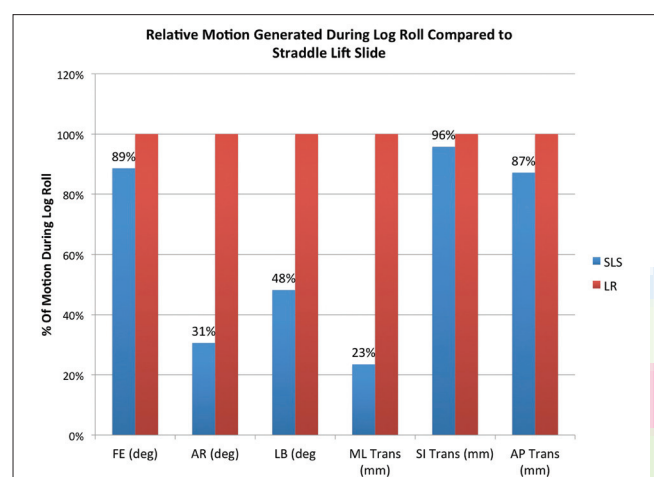


Figure 6: Percentage of motion produced during the straddle lift slide spine boarding procedure normalized to the log roll motion. FE: Flexion-extension; AR: Axial rotation; LB: Lateral bending; ML: Medial-lateral translation; AP: Anterior-posterior translation; and SI: Superior-inferior translation

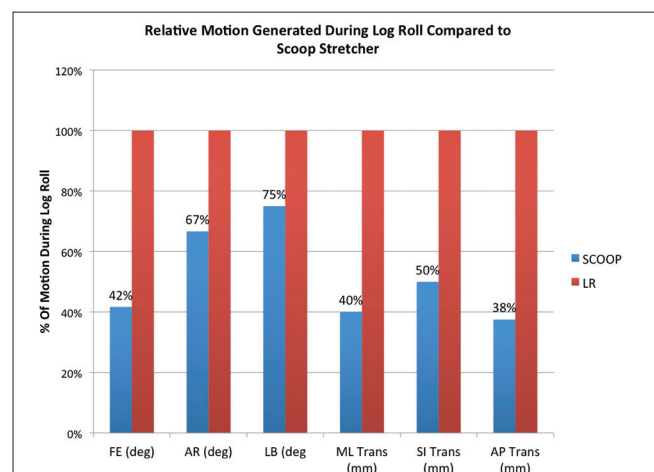


Figure 8: Percentage of motion produced during the scoop stretcher spine boarding procedure normalized to the log roll motion. FE: Flexion-extension; AR: Axial rotation; LB: Lateral bending; ML: Medial-lateral translation; AP: Anterior-posterior translation; and SI: Superior-inferior translation

Transfer to a spine board: Prone

While the above methods have been proposed for spine boarding when a patient with a spinal cord injury is found in the supine position, less is known about how to best manage the spine injured prone patient.^[6] For the supine patient, straddle lift and slide, 6 + lift and slide, and scoop stretcher techniques have emerged as the best choices to minimize spinal motion. However, for the prone patient, it is not possible to perform a lift and slide maneuver. Therefore, the only feasible option is to rely on the log roll maneuver. In their position statement, the National Athletic Trainers Association (NATA) describes two different techniques for log rolling a prone athlete: the prone log roll push and the prone log roll pull method.^[26]

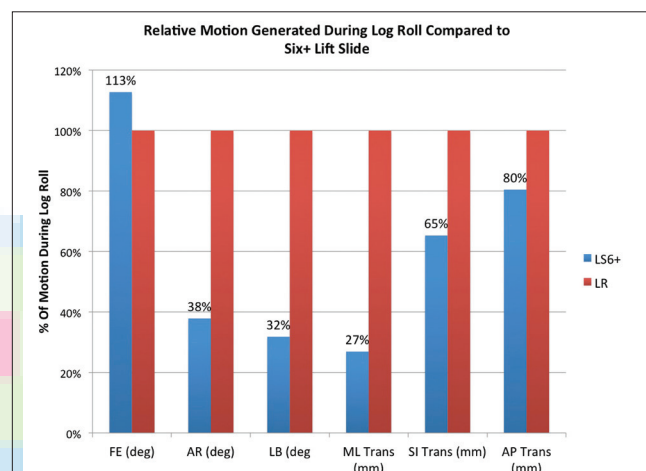


Figure 7: Percentage of motion produced during the 6 + lift slide spine boarding procedure normalized to the log roll motion. FE: Flexion-extension; AR: Axial rotation; LB: Lateral bending; ML: Medial-lateral translation; AP: Anterior-posterior translation; and SI: Superior-inferior translation



Figure 9: When the scoop stretcher is used on a soft or uneven surface, the latching mechanism might bind, making it difficult to open or close

Prone log roll push

The prone log roll push requires five rescuers. One rescuer takes the lead and is positioned at the patient's head to provide manual inline stabilization to the cervical spine. Three rescuers perform the roll, and are positioned at the shoulders/chest, hips, and legs on the side that the patient's head is facing. The final rescuer is in charge of the spine board. The three rescuers performing the roll push the patient toward the fifth rescuer, who is holding the spine board at a 45° angle beneath the patient. The patient is then slowly lowered onto the spine board [Figure 10].

Prone log roll pull

Five rescuers were also required for the prone log roll pull maneuver. One rescuer takes the lead, and is positioned at the patient's head to provide manual inline stabilization to the cervical spine. Three rescuers perform the roll, and are positioned along the patient's body opposite to the direction that the patient's head is facing: one rescuer is positioned at the shoulders/chest, one at the hips, and one in control of the patient's legs. The fifth rescuer is in charge of the spine board. The rescuers performing the roll slowly pull the patient toward them as the spine board is positioned between their arms and the patient's body. The patient is then slowly lowered onto the spine board [Figure 11].

We have recently investigated the two prone log rolling techniques described above for both thoracolumbar^[6] and cervical injuries.^[7] There are small, but significant

differences between the two methods, with the prone log roll push technique resulting in less motion. Nevertheless, both prone methods produced approximately twice as much motion as the supine version of the log roll maneuver.

Spine board removal

Upon arrival at the emergency department, a patient should be removed from the spine board as soon as possible. However, removal of the spine board is often overlooked during the initial management of trauma patients. Even in healthy volunteers, tissue perfusion in the sacral area is adversely affected in as little as 30 minutes on a rigid spine board.^[16]

Preferred use of lift-slide technique for removing patient from spine board

Motion during removal of the spine board is decreased compared to the motion produced during the initial placement of the patient onto the spine board. Nevertheless, spine board removal must be performed with the appropriate technique to minimize the risk of further neurologic compromise to the spinal cord of the injured patient. We have investigated two methods for the removal of a spine board: the 6 + lift and slide, and the log roll.^[14] The log roll technique produced significantly more motion in four out of six motion parameters. We therefore concluded that when a patient with a spine injury is removed from a spine board, the lift and slide technique should be employed.



Figure 10: (a-c) Prone log roll push maneuver for transferring a prone patient to a spine board. Figure reused with permission^[7]



Figure 11: (a-c) Prone log roll pull maneuver for transferring a prone patient to a spine board. Figure reused with permission^[7]

Lack of training in alternative maneuvers

Perhaps the log roll endures because of lack of training in alternative maneuvers. The NATA has published a position statement with recommendations on how to best manage a catastrophic spine injury in the athlete.^[26] In the guidelines, the NATA acknowledges that the log roll maneuver produces more motion in the head and neck, and that the lift and slide technique should be used in appropriate situations (i.e. enough trained personnel are available). It is imperative that athletic trainers and emergency responders be trained to properly perform lift-slide techniques. One argument against the 6 + lift and slide technique is that it requires more people than may be available in an emergency situation. In situations where no more than four rescuers are available, the log roll is the only option.

Assessment of penetrating injuries

In cases of penetrating injury, it might be argued that log rolling is necessary to examine the patient's back for potential wounds. However, in most cases where a penetrating trauma exists, unless the patient has experienced multi-trauma, it is unlikely that the patient will have an unstable spine. In situations where the patient has multi-trauma, computed tomography (CT) scans are generally obtained as soon as possible and can help to determine if the spine is stable.

Continuous lateral therapy

Patients with a spinal injury are at a high risk for multisystem complications due to secondary injuries and prolonged immobilization. Immobilization can pose significant risks to the pulmonary, hematological, renal, and integumentary systems. Changing a patient's body position on a regular basis [continuous lateral therapy (CLT)] is one way to reduce the risk of comorbidities associated with immobilization. The most commonly used method to perform CLT is manual log rolling. During this procedure, nurses roll the patient laterally onto one side and place pillows or wedges under the contralateral side to maintain the position. Mechanical devices are also available to provide continuous body position changes to the patient.^[21] We performed a study to determine if using a mechanical device to provide CLT compared to log rolling resulted in less motion to the unstable cervical spine.

The unstable cervical spine

In both embalmed^[23] and fresh^[5] cadavers, we compared motion produced in the unstable spine during CLT using the RotoRest Delta Kinetic Treatment Table (KTT, Kinetic Concepts, Inc.) [Figure 12] to the manual log roll technique. In cadavers with an unstable cervical spine, body position changes using the KTT produced less motion compared to the log roll. In patients with a cervical spine injury (or suspected injury), we recommended that a KTT be used to achieve body

position changes and that the log roll maneuver should be avoided since it can potentially produce significant motion in the spine [Figure 13].

Utility of a mechanical bed for the spine-injured patient

In the case of CLT, in addition to reducing motion to the unstable spine, there are other advantages to using a mechanical bed. By reducing the manual effort required by the nursing staff, the risk of injuries to the staff could be reduced. Also, the timing and degree of rotation can be precisely specified to ensure that the desired effect is achieved.

Prone positioning for surgery

Patients with unstable cervical spine injuries will ultimately require surgery to achieve definitive internal stabilization of the spine. We know of two techniques that can be used to position a patient prone for posterior spine surgery in the operating room: log rolling and the Jackson Spinal Table (OSI, Union City, CA, USA) [Figure 14]. During the log roll procedure, one person maintains manual inline stabilization of the head, while three additional team members perform the 180° rotation from supine on the stretcher to prone on the adjacent Jackson table. The alternative method uses the Jackson table's built-in rotation mechanism to perform the 180° rotation.

Superiority of Jackson table for cervical spine immobilization

Significantly more cervical motion was produced utilizing the manual log roll method compared to the Jackson table method [Figure 15].^[13] Log rolling produced approximately 3 times more angulation and displacement in all three anatomic planes of motion. This observation was consistent for an unstable C1–C2 injury^[11] as well as for an unstable C5–C6 injury.^[2,13] Because of this large and statistically significant difference in motion, we recommend that the Jackson table be the preferred method of transferring a patient in the prone position in the operating room.

The utility of the Jackson table for safe spinal positioning

Training for positioning the spine-injured patient is not only an issue in the pre-hospital setting, but also is critical in the operating room. We have shown that using a Jackson table to position a patient prone in the operating room produces significantly less motion than the log roll with a C1–C2 injury,^[11] a C5–C6 injury,^[2,13] and with a thoracolumbar injury.^[12] However, the maneuver requires a precise sequence of steps and should be practiced with the surgical team. It is important to note that the time to practice using the Jackson table is not when a patient with an unstable spine arrives in the operating room. Instead, the maneuver should be a part of the regular routine, so that when it becomes necessary,



Figure 12: Kinetic Treatment Table, a mechanical device for performing continuous lateral therapy



Figure 14: Jackson spinal table for rotating a patient into the prone position for surgery in the operating room. Abbreviations: FE, flexion-extension; AR, axial rotation; LB, lateral bending; ML, medial-lateral translation; AP, anterior-posterior translation; and SI, superior-inferior translation

the movements are well rehearsed and natural (not unlike the way a pit crew operates during an NASCAR race).

Complete sequence

In two recent studies, for both a cervical^[19] and thoracolumbar injury,^[20] we evaluated the cumulative effects of repeated log roll maneuvers during sequential stages of trauma management. Each of these studies tested the motion that occurred during spine board placement, spine board removal, bed transfers, lateral therapy, and prone positioning in the operating room.

Motion for spine-injured patients transferred between hospital beds

During a typical hospital stay, a patient with an unstable spine will require numerous transfers between beds within the hospital (i.e. to different diagnostic locations and imaging facilities), making this an important phase

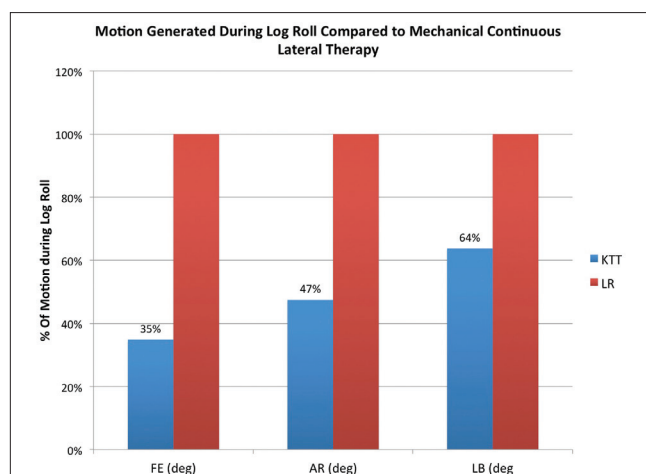


Figure 13: Percentage of motion produced during continuous lateral therapy using mechanical Kinetic Treatment Table normalized to the log roll motion. Abbreviations: FE, flexion-extension; AR, axial rotation; LB, lateral bending

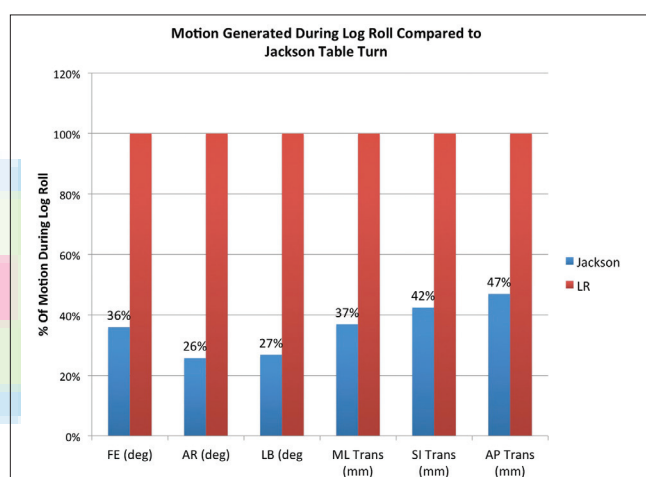


Figure 15: Percentage of motion produced while prone positioning in the OR using the Jackson table procedure normalized to the log roll motion

of care to be evaluated. The studies by Prasarn and colleagues^[19,20] analyzed the motion that occurs when a patient is transferred between hospital beds. One common practice for performing bed transfers is to log roll the patient onto a transfer board (sliding board or roller board) and then shift the patient from one bed to the adjacent bed. Recently, several new devices have been introduced to assist nursing staff with bed-to-bed transfers. Some of these devices utilize an inflated mattress, which glides on a cushion of air to transfer patients between beds. For every transfer in the continuum of care, the log roll maneuvers produced more motion than the alternatives. Overall cumulative motion to the unstable spine can be reduced by approximately 50% if the log roll is avoided and alternative measures are employed.

CONCLUSIONS

Data against log rolling and difficulty determining baseline neurologic status

Despite at least 25 years of overwhelming data from our research team and others^[4,17,25] against log rolling, the practice persists. There may be several reasons for this. One is that the risk is difficult to assess. To identify secondary neurologic injury, it is necessary to first document the neurologic status of the patient as a baseline to detect changes over time. In many cases, the precise neurologic status of the patient will not be known until extensive evaluation has been performed in the trauma center. Any deterioration that occurs before the baseline status will be difficult, if not impossible, to detect and is not likely to be associated with a particular mechanism.

Ineffectiveness of log roll maneuver

The ineffectiveness of the log roll maneuver can be explained by examining the human anatomy. The head, shoulders, torso, and hips vary in dimensions, and when the body is rolled onto the side, it is very difficult to maintain spinal alignment. In addition, the job of the person manually stabilizing the head and neck is complicated by the fact that the head must be rotated and translated in two planes in coordination with the motion of the torso. If the motion does not follow the correct path or the timing is off, relative motion between the head and torso will occur. Contrast this with the movements required during the lift-slide transfer in which the head holder is required to move in only one dimension.

False assurance of log roll technique

One reason for continued use of the log roll is that experience can sometimes provide false assurance. For instance, a surgeon who was asked why he insisted on using the log roll maneuver responded: "I have never had a problem with it." This is a faulty premise and can be demonstrated statistically. Four percent of patients admitted for blunt trauma injuries have a spine fracture or neurologic deficit.^[24] Therefore, 96% of patients who are managed with spinal precautions because of a suspected spine fracture will ultimately be cleared. In patients with a stable spine, there is minimal risk of secondary neurologic injury during management regardless of the techniques utilized. In light of this, medical personnel may falsely assume that since they have not observed any problems, the log roll technique is adequate.

Prepare for the few cases of spinal instability

We should not base our guidelines on the many incidences when a patient with a stable spine is transported; instead, our focus should be on being prepared for the few cases when a patient truly has an instability that places them at risk of secondary neurologic injury. This same rationale

is behind the Advanced Trauma Life Support (ATLS) guidelines of the American College of Surgeons which recommend that "all trauma patients should be presumed to have an unstable cervical spine injury ... until all aspects of the cervical spine have been adequately studied and an injury excluded."^[1]

Too much motion and secondary neurologic injury

At this point, we have been unable to determine how much motion of the unstable spine is required to cause secondary neurologic injury. Our goal is to minimize motion as much as possible. In every situation that we have evaluated, the log roll maneuver has produced more motion than any of the readily available alternatives. Guidelines for patients with spine trauma should be based on the safest techniques available [Table 2], which is why we recommend that the log roll be eliminated from spine trauma orders.

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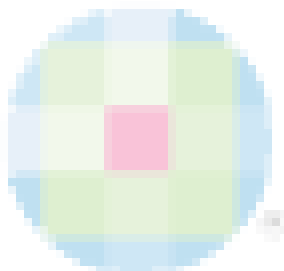
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