Journal of Spine
ISSN: 2165-7939

Farabegoli, J Spine 2014, 3:5
DOI: 10.4172/2165-7939.1000183

Research Article Open Access

Dragging Instead of Lifting: A New Spine Stretcher Concept

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Abstract

Introduction: The goal of immobilization is to transform the entire body of the patient into a single mass so it can withstand the stress of the rescue without further damage. The traumatized patients must be immobilized on spine stretchers to ensure complete immobilization of their spine. The world's best selling stretcher of this type is the Ferno Scoop Exl65. The Northwall Innovation's Skidboard is a stretcher that does not require the collar and can be dragged on the ground.

Material and Methods: We compared the stress to the spine during the loading and transport steps with both the Skidboard and the Exl65 stretchers. We collected data from electronic devices placed on the patient's suit and helmet. Each sensor inside the suit and helmet showed values on the three Cartesian axes during all manoeuvers. We repeatedly simulated the rescue of a fallen rider and performed rescue operations both by lifting and transporting the patient on the Exl65 stretcher and by loading the patient on the Skidboard and dragging it on the ground, in a variety of scenarios.

Results: In general, the Skidboard creates less energy than the Exl65. The Skidboard ensures correct immobilization of the cervical spine during the entire rescue process, unlike the Exl65 that does not immobilize the cervical spine when the patient is wearing a helmet. The rest of the spine, even if tied on the Exl65, is more subject to pitching and especially rolling on the Exl65 as opposed to the Skidboard. The stresses dragging Skidboard are physically more noisy and we were expecting the body to absorb the vibrations and turn it into injury, but it is not so. Probably because the fastening system of the Skidboard makes the body an integral block with the stretcher, and the energy developed by skidding is dissipated in other forms, without injury to the spine. The Exl65 seems to vibrate slightly during the transport, however the operators perform instinctive ergonomic and compensatory acts that generate energy on the patient, although tied to the stretcher. The Skidboard does not only discharge less energy on patient than the Exl65, but also greatly reduces the severity of the fall of the patient from the stretcher because only a portion of the body is elevated a few centimeters above the ground.

Conclusion: Data show that the stress to the patient using Skidboard is not greater than with another stretcher during the transport on flat ground. The system of dragging a stretcher seems to be a valid system to rescue traumatized and non-traumatized patients. In fact, it does not deliver greater energy than lifting and transporting on other stretchers. The author declares no conflicts of interests.

Keywords: Spine board; Stretcher; Skidboard; Scoop stretcher; Exl65; Trauma; Trauma rescue device

Introduction

Immobilization of the spine after trauma injuries is advocated as the standard of care [1]. The goal of immobilization is to transform the entire body of the patient into a single mass so it can withstand the stress of the rescue without further damage [2]. This assumption requires that the traumatized patients be immobilized on spine stretchers to ensure complete immobilization of their spine [3]. This type of stretcher looks like a table, so it is called spine board (Figure 1).

Figure 1: Spine Board or Spine Stretcher.

For several years, another type of stretcher has also been available, that combines the principle of spine immobilization with a spoon-like loading of the patient [4] .

This stretcher is concave like a spoon and opened longitudinally to allow loading of the patient. When closed, it provides spine immobilization like a traditional spine board [5]. The world's best selling stretcher of this type is the Ferno Scoop Exl65 (Figure 2).

Spine boards and spine scoops are similar in two ways:

1. They both need to be equipped with a rigid cervical collar to ensure immobilization of the entire patient's spine.

2. They must be lifted from the ground to be transported.

These types of stretchers are not without risks for the patients [6]. For instance, the rigid cervical collar may potentially block the patient's airways resulting in serious complications [7]. Lifting and carrying the

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Received June 19, 2014; **Accepted** September 16, 2014; **Published** September 18, 2014

Citation: Farabegoli E (2014) Dragging Instead of Lifting: A New Spine Stretcher Concept. J Spine 3: 183. doi:10.4172/2165-7939.1000183

Figure 2: Scoop Stretcher.

Figure 3: Skidboard.

stretcher can be dangerous for the rescuers because of the risk of falls [8]. The patient may also fall off if not properly secured to the stretcher [9].

Northwall Innovation has created a stretcher that does not require the collar and can be dragged on the ground, thus overcoming the risk of potential falls: the Skidboard (Figure 3a and 3b).

The physical principle underlying the Skidboard is the second class lever, which is always profitable because it has the load between the fulcrum and the effort force. For example, to load 100 kg of weight, two operators load respectively 37.5 kg each (Figure 4).

Lifting only a portion of the body a few decimetres off the ground produces a low amount of kinetic energy (as shown by the formula $Ec=mxv^2/2$) which is not dangerous to the patient. A special system that blocks the cervical spine by means of a head rest and front straps, allows avoiding the use of a cervical collar. The Skidboard represents a new concept in spine board, so we set out to verify its real effectiveness.

Material and Methods

The Northwall Innovation Skidboard is a composite made stretcher, very strong. It's a long spinal board which excludes the accidental dragging of the feet of the patient. The Ferno Exl65 is the world's best selling scoop/spine stretcher. We compared the stress to the spine during the loading and transport steps with both the Skidboard and the Exl65 stretchers. We collected data from electronic devices placed on the patient's suit and helmet (Figure 5):

- Chin
- Nape
- Hump
- Chest
- Lumbar region

Each sensor inside the suit and helmet showed linear and gyro values on the three Cartesian axes during all maneuvers. The sensors were: accelerometers GPS inside and synchronized with each other. The stresses were detected on the three Cartesian spatial dimensions calculated in degrees per second. Suit and helmet with sensors were provided by qualified engineers who also handled the data processing. We repeatedly simulated the rescue of a fallen rider and performed rescue operations both by lifting and transporting the patient on the Exl65 stretcher and by loading the patient on the Skidboard and dragging it on the ground, in a variety of scenarios. The stretchers were

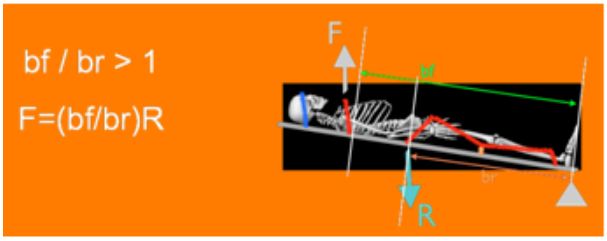

Figure 4: The second-class lever is always profitable.

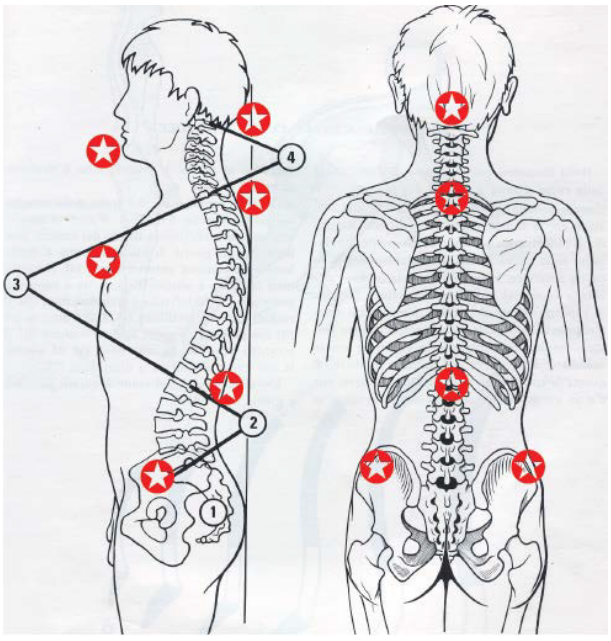

Figure 5: sensors inserted in anatomical highlighted sites.

transported on a real life, 25 meter long path, including asphalt, curb, artificial turf, natural grass and gravel. About forty repetitions were carried out using Skidboard, twenty using Exl65. Some maneuvers were discarded for unavoidable problems and practical difficulties, for example: roles mistakes inside team, mistakes recording time, etc. Final data repetitions were: n. 34 Skidboard and n. 14 Exl65.

The procedures to fix the patient on both stretchers were the same from the instruction manual of the producers. We used the Exl65's quick belts straps because fastest and the Skidboard's originals belts (Figure 6).

Because of obvious ethical reasons, it was not possible to check how much administer energy may be dangerous for the spine of the patient on the stretcher. Also, the actors who undergone tests were obviously healthy and using new personal protective equipment. The energy theoretically produced in rescuing should be zero, as much as possible, respecting the caution medical principle and because the physics laws remind that kinetic energy is potentially an injury [10].

Results

Acceleration in percentage values less than 2 m/s^2 and speed values less than 50°/s were discarded because biomechanically not significant for the analysis. Deviation values smaller than 5% were considered not significant.

The head anchoring on Skidboard restricts the rotation around three cartesian axes effectively. Exl65 is more excavated and allows better housing of the hump, thereby limiting the spine rotation. The Skidboard is different because it has a flat plate which creates a line of contact between support surface and hump, thus allowing the hump to rotate around the X axis. However, the strain by the Skidboard is

Figure 6: Patient fixed on Skidboard.

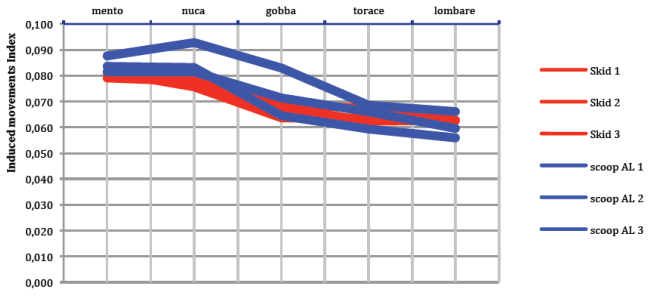

Figure 7: Index based on biomechanical movements.

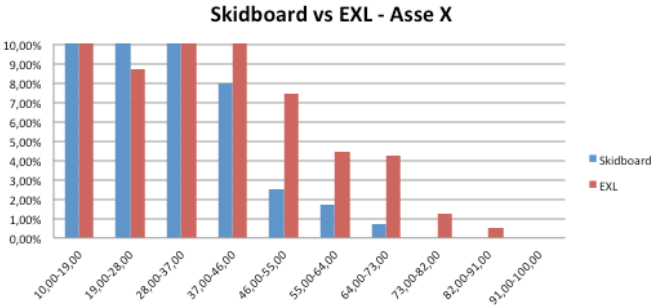

Figure 8: Rolling differences between Skidboard and Exl65 chin level.

less than the Exl65. The chin and neck, data on the X axis (rolling) was between 2% and 5% in favor of the Skidboard. The chin and nape data on the Y axis (pitching) was between 4% and 7% in favor of the Skidboard. On the various types of ground walked by the rescuers with the Exl65, we noticed a pronounced pitching stress of the patient's body especially upon changing ground. The subtraction of signals between lumbar and neck on the X axis, the spectra amplitude is higher in the Exl65 than the Skidboard. The same values on lumbar and chin. The rotation stress between lumbar, thoracic and cervical vertebrae is greater on the Exl65 than on the Skidboard. The most significant findings regarding the comparison between the Skidboard and the Exl65 are shown in the graph below. The sensors detected the rotational stress (rolling), as shown in the graph on the X axis. The longitudinal stresses (pitching) are shown in the graph on the Y axis (measurement units: degrees per second). Within reasonable approximation, kinesiologically, the sensors in the neck and chin can both be considered like cervical vertebrae. The lumbar sensors correspond to lumbar vertebrae. The average of the coefficients of the Skidboard and the Exl65's movements is between 0.25 and 0.84 (significant if >0.02) In general, the Skidboard creates less energy than the Exl65. Considering chin and nape as corresponding to the entire cervical spine, biomechanically, data show that anchoring the head on the Skidboard effectively restricts the rotation around the three cartesian axes, as opposed to what happens with the Exl65 (Figure 7).

Examining the dorsal spine by sensors on the hump and sternum, we noticed that the Exl65 is more excavated and allows a better housing of the hump, by limiting the spine rotation. The Skidboard is different because it has a flat plate which creates a line of contact between the support surface and the hump, thus allowing the hump to rotate around the X axis. However, as seen below, the strain by the Skidboard is less than that of the Exl65. The chin data are on the X axis and represent the rotation stress (rolling). We recorded different percentage values starting from 37°/sec values. In particular, there was a difference between 2% and 4% in favor of the Skidboard, as displayed in Figure 8.

On the chin, the Y axis represents the longitudinal stresses (pitching). We recorded a different percentage from values above 28°/s. In particular, the difference was between 4% and 7% in favor of the Skidboard, though uneven, as shown in Figure 9 and 10.

On the nape, the Y axis represents the longitudinal stresses (pitching), we recorded the percentage of data difference starting from 28°/s values. In particular, we recorded differences between 2% and 5% in favor of Skidboard, as shown in Figure 11.

Analysing the various types of ground walked by the rescuers with the Exl65, we noticed a pronounced pitching stress of the patient's body (Y axis reported) especially upon changing ground: from curb to asphalt, from synthetic to natural grass and gravel. As the rescuers walk, they have to keep the Exl65 aligned and raised and they need to

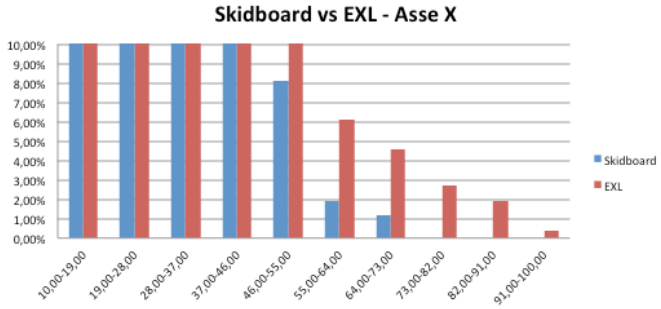

Figure 9: Roll differences between Skidboard and Exl65 on the neck.

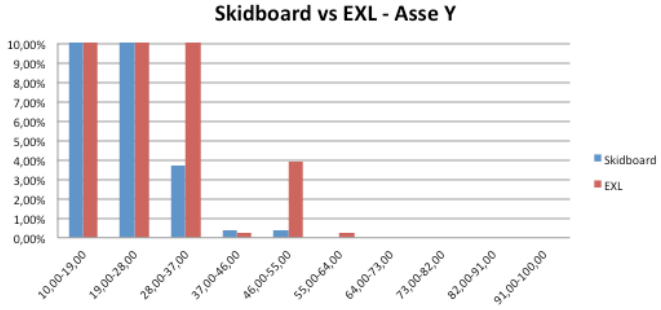

Figure 10: Pitching differences between Skidboard and Exl65 on the chin.

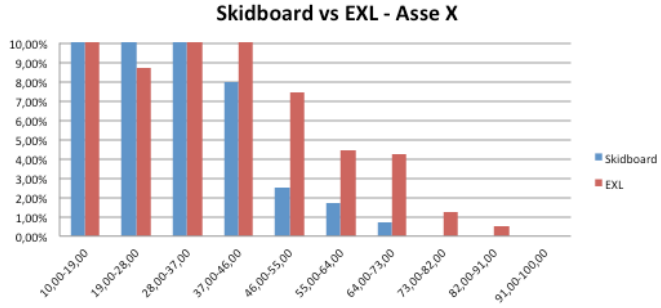

Figure 11: Pitching differences between Skidboard and Exl65 on the nape.

continuously adjust to compensate the stretcher's movement due to the advancing effort, especially on gravel

Discussion

The Skidboard ensures correct immobilization of the cervical spine during the entire rescue process, unlike the Exl65 that does not immobilize the cervical spine when the patient is wearing a helmet. This is not surprising considering that the Exl65 cannot restrict the head when the helmet is on and has no headrest to align the spine. It is interesting to consider that the Exl65 has an open bottom and a concave shape which accommodates the suit's hump and makes the spine more stable against rolling during transport, so it is less unstable even for the neck. The rest of the spine, even if tied on the Exl65, is more subject to pitching and especially rolling on the Exl65 as opposed to the Skidboard. This finding is not surprising because the stresses dragging Skidboard are physically more noisy and we were expecting the body to absorb the vibrations and turn it into injury, but it is not so. Probably because the fastening system of the Skidboard makes the body an integral block with the stretcher, and the energy developed by skidding is dissipated in other forms, without injury to the spine. The Exl65 seems to vibrate slightly during the transport, however the operators perform instinctive ergonomic and compensatory acts that generate energy on the patient, although tied to the stretcher. The Skidboard does not only discharge less energy on patient than the Exl65, but also greatly reduces the severity of the fall of the patient from the stretcher because only a portion of the body is elevated a few centimeters above the ground. The same happens if a rescue operator falls down. In comparison to other stretchers which must be raised to be transported, the Skidboard is more ergonomic.

Conclusion

The comparison nape vs. lumbar spine and between chin and lumbar spine demonstrates that the entire spine is firmly tied to the Skidboard, cervical spine also. Data show that the patient does not undergo stress by the Skidboard dragging over any grounds. The Skidboard lifts the patient by a few centimeters, so it is decidedly safer than other stretcher. Data confirm that the Skidboard administers lower energy to the patient's body than the Exl65. Data show that the stress to the patient using Skidboard is not greater than with another stretcher during the transport on flat ground.

The system of dragging a stretcher seems to be a valid system to rescue traumatized and non-traumatized patients. In fact, it does not deliver greater energy than lifting and transporting on other stretchers.

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