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Effect of training in advanced trauma life support on the kinematics of the spine

A simulation study

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Abstract

More than 7.5 million people in the world are affected by spinal cord injury (SCI). In this study, we aimed to analyze the effect of training in advanced trauma life support (ATLS) on the kinematics of the spine when performing different mobilization and immobilization techniques on patients with suspected SCI. A quasi-experimental study, clinical simulation, was carried out to determine the effect of training in ATLS on 32 students enrolled in the Master's program of Emergency and Special Care Nursing. The evaluation was performed through 2 maneuvers: placing of the scoop stretcher (SS) and spinal board (SB), with an actor who simulated a clinical situation of suspected spinal injury. The misalignment of the spine was measured with the use of a Vicon 3D motion capture system, before (pre-test) and after (post-test) the training. In the overall misalignment of both maneuvers, statistically significant differences were found between the pre-test misalignment of 62.1°±25.9°, and the post-test misalignment of 32.3°±10.0°, with a difference between means of 29.7° [(95% confidence interval, 95% CI 22.8–36.6°), (*P* = .001)]. The results obtained for the placing of the SS showed that there was a pre-test misalignment of 65.1°±28.7°, and a post-test misalignment of 33.2°±10.1°, with a difference of means of 33.9° [(95% CI, 23.1–44.6°), (*P* = .001)]. During the placing of the SB, a pre-test misalignment of 59.0°±28.7° and a post-test misalignment of 33.4°±10.0° were obtained, as well as a difference of means of 25.6° [(95% CI 16.6–34.6°), (*P* = .001)]. The main conclusion of this study is that training in ATLS decreases the misalignment provoked during the utilization of the SS and SB, regardless of the device used.

Abbreviations: AM = accumulated misalignment, ATLS = advanced trauma life support, CIARD = high performance sport center, EMS = emergency medical services, intensive and coronary medicine units, SB = spinal board, SCI = spinal cord injury, SEMICYUC = Spanish Society of Critical, SS = scoop stretcher, TAM = total accumulated misalignment, UCAM = Catholic University of Murcia.

Keywords: immobilization, spinal board and scoop stretcher, spine, training

1. Introduction

Spinal cord injury (SCI) is a pathology that can produce sensorial, motor, or autonomous function alterations, and affect the physical, psychological, and social well-being of the patient.[1] The global prevalence of this pathology is about 236 and 1.009 cases per million inhabitants,[2] so that at present, this could mean that more than 7.5 million people in the world are affected by this condition.

The prehospitalization spinal immobilization guidelines have been developed in order to protect the spine in cases where SCI is suspected, until a clear diagnose is given.[3] Their objective is to prevent any additional movement of the spine, in order to reduce the risk of secondary complications, and to facilitate release and transport.[4] Immobilization is conducted through the use of devices and techniques that are appropriate for the transferring of patients.

In spite of these recommendations, there are studies that indicate that immobilization techniques are not performed correctly in a large number of cases. Adib-Hajbaghery et al[5] showed that the quality of immobilization was insufficient in 95% of the cases, with it being significantly related to the lack of training of the emergency personnel who performed it. In this study, the authors showed that there was an association between the quality care and the training of the emergency service workers. Emergency medical services (EMS) staff with higher qualifications had immobilized the spine and limbs better than the staff with lower qualifications.

Editor: Baltasar Sanchez Gonzalez.

Funding/support: This work was financed by the "Official Nursing College of the Region of Murcia".

This funding corresponds to a research grant for Junior researchers with the title "Effect of training in Advanced Trauma Vital Support" on the kinematics of the spine. Therefore, there is no conflict of interest associated with this funding.

This work and these data have not been previously published anywhere.

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Medicine (2017) 96:48(e7587)

Received: 4 May 2017 / Received in final form: 15 June 2017 / Accepted: 30 June 2017

http://dx.doi.org/10.1097/MD.0000000000007587

Therefore, the implementation of an evidenced-based training and assessment algorithm is necessary. Until a few years ago, finding a system that was sensitive enough for measuring the movement of the spine was difficult. The only possible methods were imaging tests used to scan the patient, but their use was not feasible for the monitoring of learning during training in mobilization techniques.[6] However, thanks to the high degree of technological advancement, the kinematics of the spine can be monitored through the use of 3D motion analysis systems.[7]

For this reason, this study has been planned with the objective of experimentally determining the effect of training in advanced trauma life support (ATLS) on decreasing the misalignment of the spine when performing diverse techniques of mobilization and immobilization of the patient with suspected SCI.

2. Method

2.1. Design

A clinical simulation, quasi-experimental study was conducted in order to determine the effect of ATLS training at the Catholic University of Murcia (UCAM), which lasted for 8 months. This work was performed following the Declaration of Helsinki norms, and was approved by the University's Ethics Committee, and all the participants were asked to sign an informed consent form.

The evaluation was done through comparing the misalignment before training (pre-test) and misalignment after the training concluded (post-test), as the patient was placed onto the scoop stretcher (SS) and the spinal board (SB).

2.2. Sample selection

The study population was comprised by the students enrolled in the Master's program of Emergency and Special Care Nursing at the UCAM (class of 2015–2016). From the 35 Master's students, only 32 were included in the end, which corresponded to 91.42% from the total. All the students had a nursing degree. The 8.57% of the students did not complete the study. The average age of the students was 29 ± 6 years, with 31.25% being male and 68.75% female. Each of the students led a simulation, placing themselves at the head of the patient, with help from another 2 students who were randomly selected from the rest of the group.

2.3. Advanced Trauma Life Support (ATLS) Training

The training analyzed is found within the course *"Advanced Trauma Life Support"* (ATLS) that belongs to the Spanish Society of Critical, Intensive, and Coronary Medicine Units (SEMICYUC). The training lasted 72 hours that were distributed among 4 weeks (50% theory and 50% practical training).

2.4. Kinematic analysis

The study was performed at the High-Performance Sport Center (CIARD) at the UCAM with the use of a Vicon 3D motion capture system (T-Series, Vicon Corp, Denver, Colorado, EE.UU) composed of 8 cameras that simultaneously record a healthy volunteer, to whom 39 markers where attached. The system was calibrated following the manufacturer's instructions. In similar studies, the results of the correction coefficient intraclass with this system was 0.971 ($P < .001$)[7] and 0.33% coefficient of variation.[8]

The aim of the simulation was to place a patient, with a suspected SCI, in the supine position, onto a SS and onto a SB (Fig. 1). The digital reconstruction of the process allowed for the measuring of the average misalignment found between the vertical axis and the head axes (A1), shoulders (A2), and pelvis (A3). In each of the processes, 2 phases were analyzed: for the SB, Phase 1 (lateral rotation when resting the board) and Phase 2 (placing the patient in the center of the device); and for SS, Phase 1 (lateral rotation for placing the first half of the SS) and Phase 2 (lateral rotation for placing the second half of the SS). The accumulated misalignment (AM) was calculated (AM = A1 + A2 + A3) for each of the phases, and the main variable was the Total Accumulated Misalignment [TAM = AM (Phase 1) + AM (Phase 2)]. Each student tested both devices.

2.5. Statistical analysis

The data were collected with the Microsoft Excel spreadsheet program, and analyzed with the SPSS Statistics (IBM Corporation, Chicago, Illinois, EE.UU) v.21 program. The results are presented as means and standard deviations. The normality tests were performed with the Shapiro–Wilk test. For comparing the pre- and post-training results of the study, the Student *t* test for paired data was utilized. The differences were deemed significant if $P \leq .05$.

3. Results

The TAM mean during the performing of both maneuvers showed that there were statistically significant results between the pre-test misalignment of $62.1° \pm 25.9°$, and the post-test misalignment of $32.3° \pm 10.0°$, with a difference between means of 29.7° [(95% confidence interval, 95% CI 22.8–36.6), ($P = .001$)]. Table 1 summarizes the results obtained from the comparison of the misalignment between the pre-test and the post-test for each of the devices studied in each of the axes and phases.

The results from Phase 1 showed that the pre-test misalignment was $48.4° \pm 23.2°$, and the post-test misalignment was $19.6° \pm 8.3°$, with a difference between the means of 28.8° [(95% CI 22.4–35.2), ($P = .001$)]. As for Phase 2, no statistically significant differences were found, with a pre-test misalignment of $13.6° \pm 9.1°$, and a post-test misalignment of $12.7° \pm 6.5°$, with a difference between means of 0.9° [(95% CI 1.4–3.1), ($P = .443$)].

The TAM results obtained for the placing of the SS showed that there was a pre-test misalignment of $65.1° \pm 28.7°$, and a post-test misalignment of $33.2° \pm 10.1°$, with a difference of means of 33.9° [(95% CI 23.1–44.6), ($P = .001$)]. During the placing of the SB, a pre-test misalignment of $59.0° \pm 28.7°$ and a post-test misalignment of $33.4° \pm 10.0°$ were obtained, as well as a difference of means of 25.6° [(95% CI 16.6–34.6), ($P = .001$)].

4. Discussion

Historically, it has been stated that up to 25% of patients with SCI in a traffic accident could be due to the management of the patient by the health professionals.[9] Moreover, the results of a study on the immobilization of 400 patients concluded that in more than 90% of cases the quality of the immobilization was undesirable and, therefore, prehospital health professionals should be better trained.[10]

The most important results of the present study show that the pre-test degree of movement was relatively high (62.1°), taking

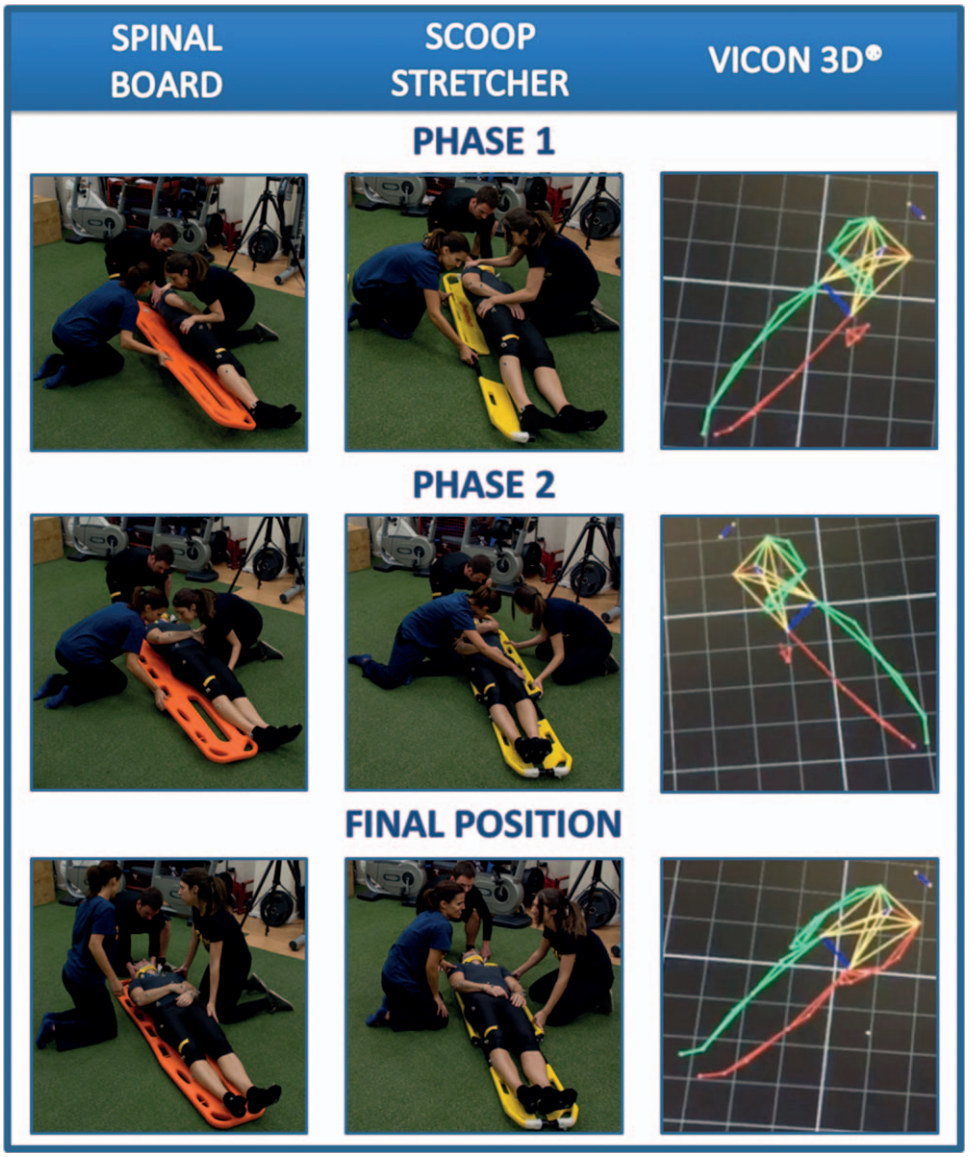

Figure 1. Images of spinal board, scoop stretcher, and Vicon 3D analysis screen.

into account that the patient simulated having a SCI. These results were similar to results described by other authors, who pointed to the importance of instruction and training, as some professional workers preferred to use mobilization techniques that produced more misalignment.[11] This could be due to their lack of knowledge and expertise in the use of the devices and other techniques that were more recommended for the immobilization of the spine.

Table 1

Results of the misalignment, before and after ATLS training for each of the segments with both devices.

Axis	Device	Pre-test	Post-test	Significance	Axis	Device	Pre-test	Post-test	Significance
Phase 1							**Phase 2**		
Head	SS	21.2	7.6	.001*	Head	SS	4.5	3.5	.189
	SB	13.9	6.7	.001*		SB	5.4	5.4	.949
Shoulders	SS	20.0	6.9	.001*	Shoulders	SS	4.3	3.8	.534
	SB	16.0	6.5	.001*		SB	4.6	3.8	.303
Hip	SS	10.8	5.9	.006*	Hip	SS	4.2	3.5	.228
	SB	14.8	5.4	.001*		SB	4.2	5.5	.233
Total 1	SS	52.0	20.5	.001*	Total 2	SS	13.1	10.8	.129
	SB	44.8	18.6	.001*		SB	114.2	114.7	.789
Total SS		65.1	31.2	.001*	Total SB		59.0	33.4	.001*

SB = spinal board, SS = Scoop stretcher, Student *t* test.
* $P < .05$.

When comparing the results from the application of both devices (SS and SB), we observed that there was a decrease of 29.7° ($P = .001$) in the misalignment of the spine after the training session. The misalignment obtained after training was almost half than that at the beginning. Our results were very similar to those obtained by Morrissey et al,[12] which showed that after training of paramedics in pre-hospitalization care, the use of non-recommended mobilization techniques was reduced by 58%.

Once each of the maneuvers was divided into 2 phases, we only found statistically significant differences in Phase 1 ($P = .001$), with an improvement in the misalignment of 31.6° when using the SS and 26.1° when SB was utilized. Our results were congruent with those of Gordillo et al,[7] who concluded that Phase 1 was the most critical when both devices where placed. Therefore, the professional health workers should be more careful when performing this action. The difference between both phases could be that in Phase 2, the movement generated is much less, as part of the device is already placed, already leading to a certain degree of immobilization.

Once the ATLS training was completed, a misalignment of $33.2° \pm 10.1°$ was produced with the use of the SS, while for the SB, the misalignment produced was $33.4° \pm 10.0°$. In a study with a group of experts, it was determined that the SS produced less misalignment than the SB,[7] but in our study, with nonexpert nurses, we could not obtain the same results. The results on the manner of immobilizing and transferring a patient, who is in the supine position, indicated that the SB contributed a degree of misalignment of 30° to 90° of movement.[13] The Training significantly improved our study population, but they did not reach the level of the group of experts.

The main limitation of our study is that it was conducted with a healthy volunteer. The ideal situation would be to have data from real victims suffering SCI and an unstable spinal column, but this creates too many research problems and ethical-legal controversies. This is the reason why the results of a Cochrane review indicated that almost all of the suspected SCI trials were in simulated scenarios,[11] with real-scale maniquies, healthy volunteers, or cadavers.

The results of our study allowed us to conclude that health professionals who have received ATLS training have performed a misalignment of the spine that is significantly less than those who have not had this type of training. Therefore, we believe that an initial and continuous training of the prehospitalization emergency service health professionals is a must.

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