The Internet Journal of Allied Health Sciences and Practice

<http://ijahsp.nova.edu>

A Peer Reviewed Publication of the College of Allied Health & Nursing at Nova Southeastern University

Dedicated to allied health professional practice and education

<http://ijahsp.nova.edu> Vol. 6 No. 1 ISSN 1540-580X

Loop-Strap Type Does Not Affect Facemask Removal Using an Anvil Pruner

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CITATION: Seegmiller, J., Stechschulte-Musielewicz, D. Loop-strap type does not affect facemask removal using an anvil pruner. *The Internet Journal of Allied Health Sciences and Practice*. Jan 2008, Volume 6 Number 1.

ABSTRACT

Purpose: To compare time and movement characteristics of four different brands of football facemask loop straps during a cutting task. **Methods:** Ten certified athletic trainers, age 24.8 ± 3.4 , years of experience 2.4 ± 2.5 , cut four different brands of football helmet loop straps (Shockblocker™, ASI (Athletic Specialty), Schutt™ AG (Armourguard) Elite, and Riddell™) with an anvil pruner. Task completion time was measured with a time code generator. Helmet movement was measured in the lateral flexion plane using 2-dimensional motion analysis. **Results:** Measureable but non-significant differences were observed between loop strap types ($P < 0.05$) for dependent variables (time, range movement, and mean movement). **Conclusions:** Emergency personnel can effectively cut through various brands of football helmet loop straps using an anvil pruner and do not need brand-specific tools for facemask removal. Similar movement characteristics were observed while cutting all four brands of loop straps. Movement occurring during facemask removal may increase cervical displacement and increase injury severity. Measureable differences in cutting time warrant further investigation.

INTRODUCTION

Immediate care for a suspected cervical spine injury in a football player can be difficult with the helmet and facemask placing a physical barrier between the athlete and emergency personnel. If an athlete's airway becomes compromised by an injury, access to the airway is vital.¹ Studies have shown that the cervical spine is taken out of normal alignment when the football helmet is removed and the shoulder pads are left in place.¹⁻⁴ It is estimated that as little as 1 to 2 mm of helmet displacement decreases the amount of space for the spinal cord and may damage the cord itself.⁵ If the possibility of a cervical spine injury (CSI) exists, the facemask should be the only protective equipment that is removed.² In 1997, the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete (IATFACSIA) was created to develop pre-hospital guidelines for athletes with suspected spine injuries.^{6,7} They recommend cutting all four loop straps, removal over retraction.²

Football helmet manufacturers use various types of loop straps. Therefore, the tool selected to perform this vital task should be capable cutting through all loop strap types. Popular tools used for facemask removal are the polyvinyl chloride (PVC) pipe cutters, anvil pruner, Phillips screwdriver (manual/electric), emergency/Durashears, rotary cutting devices, Trainer's Angel (TA), and the Facemask Extractor (FME).^{1,8} Previous studies have examined which of these tools is best for facemask removal in regards to time, motion, and efficiency, but results remain conflicting.^{1,9}

Recent research has suggested that facemask removal time is not dependent upon the tool used, but the type of loop strap fastened to the helmet.¹⁰ Soft, polypropylene loop straps were once common; however most manufacturers are currently using harder, surlyn loop straps.^{7,9} Common loop strap brands include Riddell™, Schutt™ Polypropylene, Schutt™ Surlyn, Shockbloker™, and Bike™. Previous research indicated that the Schutt Surlyn™ loop strap was the easiest to cut through followed by Riddell™ and Shockbloker™ when using the Trainers Angel™ and anvil pruner.^{7,10} Similar studies indicated that the Schutt™ loop strap was easier to cut through with the anvil pruner and the Bike loop strap with the Trainers Angel™.^{4,7,11}

However, there is limited research on the amount of movement created while cutting through various loop strap types. The purpose of this investigation was to determine if there is a difference between the amount of time and movement associated with cutting through four brands of loop straps using one tool, the anvil pruner (Figure 1). The anvil pruner was used in this study since previous research found it to be an effective removal tool.^{1,8,10,12}

Figure 1: Anvil Pruner (Facemask removal tool).

METHODS

Subjects

Ten Certified Athletic Trainer's (ATC's) (2 men, 8 women) from Ohio University voluntarily agreed to be participants in this study (age= 24.8 ± 3.4 , years certified= 2.4 ± 2.5). All subjects had entry level experience with cutting loop straps to remove the facemask. This study was approved by the university's institutional review board.

Instrumentation

The loop straps used in this study were the Shockblocker™, ASI (Athletic Specialty), Schutt™ AG (Armourguard) Elite, and Riddell™ (Zides, Marietta, OH). For all trials, the facemask loop straps were cut using an anvil pruner (Figure 2).

Figure 2: Loop straps used in study (L to R: Shockblocker™, ASI, Schutt™ Armourguard Elite, Riddell™).

A 2-Dimensional Peak Motus motion analysis system collected video data using a 60Hz camera (Panasonic CW-350). A live model was fitted with a Schutt™ DNA football helmet (Zides, Marietta, OH) and was positioned supine on a black blanket in the middle of the data collection area. A research assistant stabilized head and neck. To ensure equalized stabilization pressure on the helmet during clip removal for each subject, two sphygmomanometers were used to determine the pressure that the research assistant was exerting on the helmet. The time to cut through the loop straps was taken with a time code generator. A flat dime-sized reflective marker was placed under the anvil pruner to determine the exact time the tool was picked up and put back down.

Four 2.54 cm (1-in) and two 1.54 cm (0.5 in) retroreflective markers were used. Two 2.54 cm markers were placed in the center of the helmet, 4.5 cm and 8.8 cm respectively, from the top of the facemask bar. Another 2.54 cm marker was placed 22 cm from the top of the blanket and another 27.5 cm on the ground to the right of the research assistant's shoulder. The 1.54 cm markers were placed on the model's manubrium and sternum (Figure 3).

Figure 3: Experimental set-up

Protocol

A reliability study was completed before data collection to ensure the pressure the research assistant exerted on the helmet was the same for every trial. Two sphygmomanometers were pumped up to 20mmHg and placed on either side of the helmet. The research assistant was instructed to apply enough force on each side until the needles reached 40mmHg. The research assistant practiced this skill while looking at the readings then closed their eyes trying to keep the needles constant at 40mmHg. When the research assistant could maintain constant equalized pressure for the duration of a facemask removal, then data for the reliability study was collected. The reliability analysis (with eyes closed) resulted in an average of (15 ± 4.2) out of 20 trials.

Each subject was instructed on the proper use of the anvil pruner. Subjects were instructed not to touch the facemask during removal so as not to interfere with movement data collection. They were also informed that a cut was considered complete only when the side of the facemask bar could be retracted from the cut in the loop strap (Figure 4). Subjects practiced cutting through the loop straps with the anvil pruner until they felt comfortable with the skill.

Figure 4: Riddell loop strap after cut.

The research protocol was explained to each subject. Subjects cut through the left lateral loop strap, completing one trial for each of the four different loop straps (Figure 5). Subjects were instructed to completely cut through the loop strap as quickly as possible while limiting the amount of helmet movement. A new loop strap of each of the four types was used for the four trials with re-calibration before every trial. Re-calibration was necessary because the model had to remove the helmet. Subjects were positioned to the left side of the model's head. Time began when the subject picked up the tool and the reflective marker was revealed. Time ended when the subject placed the tool down, covering the reflective marker. The model who stabilized the helmet observed the subject to make sure they did not touch the facemask and to ensure the loop strap was completely cut.

Figure 5: Subject cutting loop strap.

Dependent Measures

Three dependent measures were assessed in this study: time, total range of movement, and mean movement. Task completion time was measured from the moment the reflective marker was revealed as the tool was picked up, until the subject placed the tool over the marker hiding it from view. Lateral helmet flexion was measured. Total range of movement was calculated using the difference between minimum and maximum angles produced during data collection. Mean movement was the average degrees of lateral flexion produced while cutting through each loop strap.

Statistical Analysis

Three separate one-analysis of variance (ANOVA) tests were calculated to identify significant differences among the four types of loop straps for time, total degrees of movement, and mean movement. The independent variables were the four loop straps. Significant findings were identified as ($P < 0.05$). All statistical analyses were performed using SPSS (version 13.0 for Windows, SPSS Chicago, IL).

RESULTS

Results for the dependent variable (time, range movement, and mean movement) revealed no statistical significance. A complete ANOVA summary is presented in Table 1. Results for time of loop strap removal indicated no significant differences between loop strap types ($F_{3,39} = 1.91$, $P = 0.33$). Despite the lack of statistical significance, there were measurable differences in loop strap removal time between brands. Results indicated that the Riddell™ loop strap (22.6 ± 9.8 sec) was the quickest to cut through, followed by the Shockblocker™ (32.88 ± 20.5 sec), Schutt™ (35.18 ± 17.7 sec), and ASI (36.19 ± 6.8 sec).

Results for range of movement (total degrees of lateral flexion) revealed no significance between loop strap types ($F_{3,39} = 2.47$, $P = 0.077$). Although statistically insignificant, the Riddell™ loop strap produced the least amount of range movement ($4.32^\circ \pm 0.43$), followed by the Shockblocker™ ($4.61^\circ \pm 0.97$), Schutt™ ($4.64^\circ \pm .98$), and ASI ($5.99^\circ \pm 2.64$).

Results for mean movement (average degrees of lateral flexion) revealed no significant difference between loop strap types ($F_{3,39}=.36$, $P=.78$). Although there were no statistical differences between loop strap types; the Shockblocker™ and ASI ($2.22^0 \pm 3.8$) produced the least amount of mean movement followed by Riddell™ ($2.97^0 \pm 1.9$) and Schutt™ ($3.43^0 \pm 2.4$).

Table 1: Loop Strap ANOVA Summary

Dependent Variable	SS	df	MS	F	P
Time	1164.72	3	388.24	1.19	.33
Mean Movement	10.64	3	3.55	.36	.78
Range Movement	16.83	3	5.61	2.47	.08

DISCUSSION

Previous facemask removal research has dealt mainly with differences in the amount of time to complete this important task, rather than differences between loop straps from various manufacturers.^{2,13} Our research showed that the Riddell™ loop strap was the easiest to cut through followed by the Shockblocker™, Schutt AG™, and ASI. These results contradict Block et al who reported that the Schutt AG™ was the quickest strap to cut through followed by the Riddell™ and Shockblocker™.¹⁰ In their study, the Shockblocker™ loop strap took (80s) longer to cut through than the Schutt™. However, with differing methodologies and subject population, it is difficult to make direct comparisons.

During pilot testing, we observed that subjects who cut the loop strap in the anterior position completed the task more quickly than those who tried a posterior cut (behind the facemask bar). Therefore, each subject was instructed to cut anterior to the loop strap during data collection. A limitation in this study is that the anvil pruner was not sharpened after the subjects practiced cutting through the straps. Sanville et al tested 50 athletic training students and found that tools become dull with repetitive use, rendering them ineffective.¹⁴ However, since all four loop straps were cut in succession, tool dulling would have had little effect on cutting time within each trial.

The amount of time taken to cut through loop straps in different environmental conditions has also been studied. Our study was performed in a controlled laboratory environment. This is a limitation because it did not stimulate a realistic field situation. Facemask removal was tested using the anvil pruner and Trainer's Angel™ under three temperature conditions; hot (helmet placed in 175° F water bath for 24 hours), cold (helmet placed in a 0° F freezer for 24 hours), and at room temperature in a study by Kleiner and Sonnenberg.⁴ The trainer's angel took the longest during room temperature followed by cold then hot. The anvil pruner took the longest in the cold then room temperature and then hot. This study concluded that certified athletic trainers working in a cold environment should be aware of the increased difficulty with facemask removal.

Little research has been done on movement during facemask removal with different types of loop straps. The video analysis in our study was 2-dimensional, with movement analyzed in the lateral-flexion plane which is how most movement occurs during facemask removal.¹ Previous research has indicated that at the C5 spinal segment 4.5 and 9.0 cm of lateral head flexion produces 7.5° and 11.5° change.^{1,6} Only one subject was used and movement was only taken at the C5 level. Results of our study showed lateral head flexion at the C5 segment to be 4.32° for the Riddell™ loop strap, 4.61° for the Shockblocker™, 4.64° for the Schutt™, and 5.99° for the ASI. Lateral flexion mean head movement resulted in 2.22° for the Shockblocker™ and ASI, 2.97° for the Riddell™, and 3.42° for the SchuttAG™. Since a mere 1-2 mm of displacement can reduce the amount of space for the spinal cord and may damage the cord itself, these results are concerning.⁵ This concern is heightened when considering that our results reflect the degree of lateral flexion while cutting through just one loop strap. If all four loop straps had been cut for each trial, the degree of movement would have been greater. In the presence of a cervical spine injury, this amount of movement could increase the risk of permanent disability. Given the sensitive nature of the spinal cord, cervical displacement caused by movement generated during facemask removal should be further explored.

One study quantified the combined movement of the lateral flexion, flexion-extension, and rotation planes averaging between 132° and 152°.¹ This represented the total degrees of movement observed in a 25 second sample during face-mask removal. The researchers reported concern with this finding, expressing the opinion that a large amount of movement may be damaging. Unfortunately, an exact figure on how much facemask, helmet, or head movement can occur without endangering the athlete has yet to be determined. Even small differences in movement between loop strap types may contribute to spinal column damage. Although most movement occurs in the lateral-flexion plane, a limitation in our study is that only lateral-flexion was measured; other planes were not. Also, the model in this study was told not to move. In a real situation, an injured athlete may not be as composed or accommodating.

Based on our results, we are confident that in an emergency situation, athletic trainers or EMTs will be able to effectively cut through various brands of loop straps with an anvil pruner and remove the facemask to gain access to the athlete's airway. Our analysis revealed measureable, but statistically insignificant differences between task completion time and movement produced while cutting through the four types of loop straps. Clinically, the movement generated during the cutting task was concerning as it could increase the severity of a cervical spine injury. Given that we examined time and movement characteristics while cutting only one loop strap, which we believe affected the statistical significance of our results, we recommend that future researchers cut all loop straps for greater clinical relevance. We also recommend further investigation of helmet movement with different tools as new products and equipment that may affect the management of a cervical spine injury become available.

Acknowledgements

We would like to thank Tom Martin for his valuable assistance during data collection.

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