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Use of Cast Saw Injury Protection System to Teach Safe Cast Removal

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Introduction

One of the earliest skills orthopaedic trainees are expected to master is placing and removing casts. Depending on the program, this may be done independently as early as the intern year. When either skill is done poorly, there can be serious consequences and patient harm. One major concern is the risk of iatrogenic injury from the use of cast saws in inexperienced hands.

Cast-saw blades are designed to cut through the rigid cast material while leaving the more mobile, underlying soft tissues intact. Despite their purposeful design, iatrogenic cast-saw injuries can occur. User technique, cast thickness, cast-saw blade sharpness, and patient cooperation have all been reported as risk factors for injury. Use of the "in-and-out" technique is regarded as the safest way to prevent injury, as this technique minimizes the distance and duration that the blade has contact with the skin, thus reducing the chance for thermal or abrasive injuries to occur.[1] This technique relies on the user's ability to determine when the blade penetrates the cast material and then quickly withdraw it before it contacts the skin. Multiple studies in laboratory settings and clinical settings have demonstrated that educational modules alone are insufficient to eliminate blade-to-skin contact.[2,3] Therefore, we designed a system using a traditional cast saw that could provide user feedback for both safety and training purposes.

The Cast Saw Injury Protection System (CSIPS) uses a conventional cast saw, a conductive stockinette material, and an audiovisual alarm that is activated when the cast saw comes into contact with the stockinette material. We recently demonstrated that this system reduced the number of blade-to-skin contacts by 70-90% (depending on user experience) and significantly reduced blade-to-skin contact time.[4] These results have prompted us to proceed with utilizing the CSIPS system in cast-saw training to enhance patient safety. Thus, we have developed educational versions of the system to train users (Figure 1A, B).

Currently, we plan to use the CSIPS as part of our pediatric orthopaedic resident education in fracture reduction and casting skills. Cast removal skills are incorporated in the dedicated simulation lab session

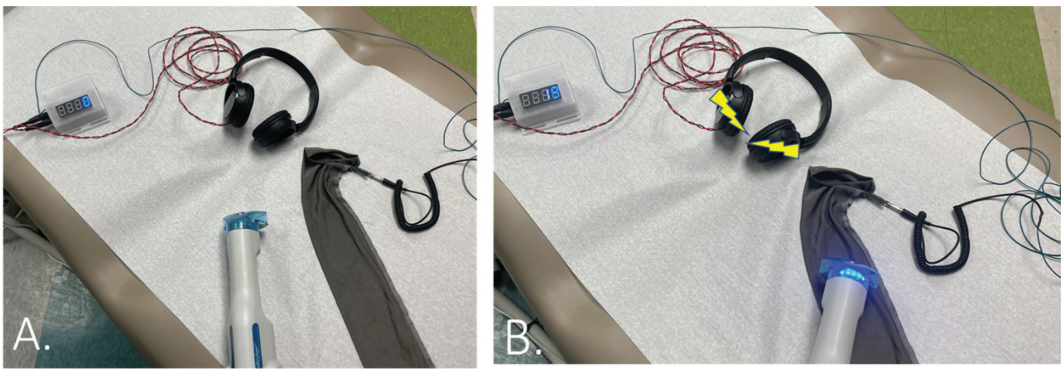

Figure 1. A. *Current Cast Saw Injury Protection System (CSIPS) at rest.* ***B.*** *When the cast-saw blade contacts the stockinette, a visual (note the blue light at the saw blade) and auditory alarm (denoted by the lightning bolts in the headphones) alerts the user.*

that is part of our intern skills month curriculum taught every February. Additionally, all residents take part in an annual casting workshop hosted in our pediatric orthopaedic clinic. This workshop is led by our orthopaedic technicians and senior residents. This workshop is designed to train the younger residents in proper casting and splinting techniques as they prepare to take independent call at our adult and children's hospitals. The CSIPS will be incorporated in both settings using models in the intern simulation lab and live subjects in the casting workshop. We have not incorporated this into any form of competency-based assessment, but we plan to record these data for each resident yearly, starting with the intern skills month to monitor skill development over time. Objective data that we plan to record is the number of skin contacts, duration of skin contact, and the number of high-risk touches, which we define as elevated temperatures and duration of blade-to-skin contacts known to cause thermal injury. This feedback will be given to the residents each year at the annual casting workshop.

Description of Simulation Exercise

Simulation Lab Use: For our intern skills assessment, we use a commercially available pediatric upper extremity model (Sawbones USA, Vashon Island, WA), but any upper or lower extremity model could be used. For this simulation experience, the electroconductive stockinette is applied directly to the limb and standard cast padding material (cotton or synthetic) and casting tape (plaster or fiberglass) are applied based on the standard casting materials and protocols. This application directly on the skin is different than the clinical application, which would be between layers of cast padding to alert the user prior to reaching the skin level. However, in this simulated setting, placing the stockinette directly on the model's skin allows the trainer or trainee to see the number of times they come in contact with the "patient's skin" and also will record temperatures at the skin level.

The alarm from the protective system is then attached to the cast saw. The system accommodates most styles of cast saws and blades, but the universal blade attachment may need modifications depending on the saw model (Figure 2A, B). The alligator clip is placed on the stockinette, and the system is turned on and zeroed. The cast is then removed in a bivalved fashion as one would be clinically removed. The number of times that the blade touches the stockinette and the duration of the contact are recorded. The auditory and visual feedback trains the learner to minimize the contact between the blade and stockinette in a manner reminiscent of the childhood game "Operation."

Casting Workshop Use: The set-up for using the device for a cast workshop simulation makes use of the time-old tradition of having residents place and remove casts from one another. This exercise can be done with

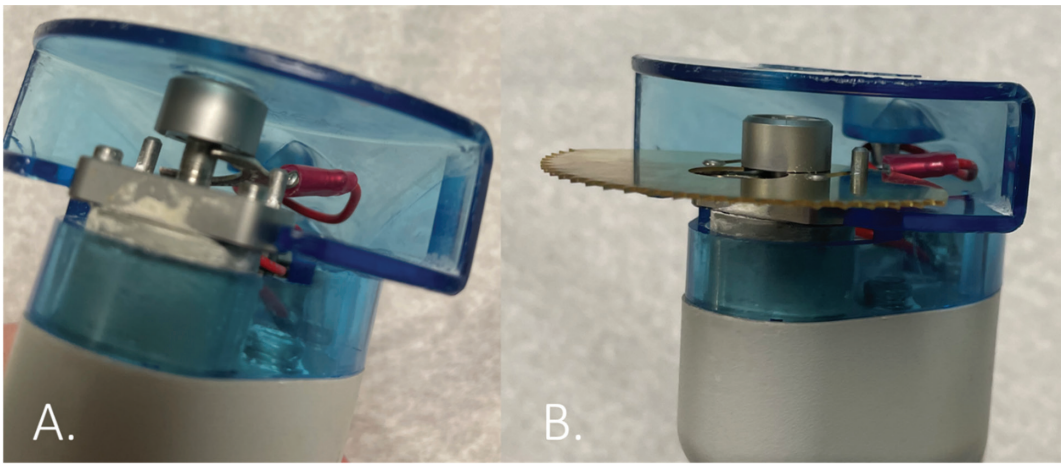

Figure 2 A & B. *Close up of the* ***A.*** *Saw blade Electrode* ***B.*** *Electrode in place with the blade.*

standard casting material (stockinette, cast padding, and casting tape). A standard cast saw can be used and retrofit with the CSIPS in most circumstances. The benefit of incorporation of the CSIPS into this training exercise is that it makes the process safer and provides real-time auditory and visual feedback. The setup and testing are similar to the simulation lab testing, except that the electroconductive stockinette is placed between layers of cast padding so that the alarm is triggered prior to the cast-saw blade contacting the skin (Figure 3A-D). Once the cast and CSIPS device is in place, the trainee is asked to remove the cast. The total time to remove the cast and the number of times the device is triggered can be recorded and compared over time to assess improvement

Figure 3 A-D. A. *Standard stockinette is placed (If normal routine).* ***B.*** *Standard layers of cotton or synthetic padding are placed minus one layer of padding.* ***C.*** *The CSIPS stockinette is placed.* ***D.*** *One overlapping layer of cast padding is applied followed by the casting tape (fiberglass or plaster).*

in technique (see accompanying video). Feedback is also provided from the observing faculty.

Summary

Due to the novelty of using this device for teaching, we do not have extensive experience with training residents or students. However, feedback provided using the device has been overwhelmingly positive with most users—even experienced ones. We feel that using this device provides objective, real-time feedback to trainees which is not possible with other methods of teaching this skill. Additionally, the clinical utility of the device would allow for further validation. To increase the "difficulty" of the exercise, the trainee can be asked to remove casts from more complicated models such as a clubfoot model. We have found that nearly every resident injures the model's limb when removing standard Ponseti clubfoot casts using a cast saw (unpublished results). Whether they can be trained to remove these casts with the system has not been demonstrated; however, it would effectively demonstrate the risk associated with trying to safely remove these casts. Moving forward we are working on iterations of the initial system that are capable of recording blade-to-skin contact and duration of skin contact. Future plans also include versions of the device that will monitor blade temperature and have the option to turn off the alarm portion to record the number of touches with and without the alarm, which could be of interest to orthopaedic educators. These features would allow a much more comprehensive evaluation of the trainee's cast removal technique and allow educators to teach this essential skill with more objective feedback.

Disclaimer

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US Patent: Cast Saw Protective System – USPTO – 16/166,565; Consulting: Guidepoint Medical Consulting; Co-editor: Elsevier – *NeuroOrthopaedics* textbook; Scientific Safety Board-Alcyone Medical

Stocks: Medtronic, Zimmer, OP; spouse co-founder Wellnite Inc.

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Appendices

Appendix 1. Materials and Supplies with Cost

Fixed Materials

Cast Saw with Vacuum: $4,000–$5,000
Pediatric Arm (Sawbones SKU 1530-13): $138
CSIPS Device: TBD

Disposable Materials

Cast-Saw Blade: $45–$60
Cast Padding: $3.00 per roll
Casting Tape: $3.50 per roll
Stockinette: $15 for 25 yards
Pediatric long arm cast total cost: $13
Adult long arm cast total cost: $19.50

Resident Name:_____ PGY:_____ Date of collection:_____

Resident Casting Experience/Comfort

1. How many casts have you independently (i.e., without direct supervision) placed on patients?
None 1-25 26-50 51-75 76-100 >100

2. How comfortable are you with placing a cast independently?
Very uncomfortable Somewhat Uncomfortable Comfortable Very Comfortable

3. How many casts have you independently (i.e., without direct supervision) removed from patients?
None 1-25 26-50 51-75 76-100 >100

4. How comfortable are you with removing a cast independently?
Very uncomfortable Somewhat Uncomfortable Comfortable Very Comfortable

Cast Placement Evaluation: Short Leg / Long Arm
Faculty Evaluator:
Total time:
Circle one: Required constant correction Required minor correction Performs independently Expert
Errors:
Feedback:

Cast Removal Evaluation: Short Leg / Long Arm
Cast Type: Short Leg / Long Arm
Total time:
Number of CSIPS recorded contacts:
Duration of total CSIPS contacts:
Maximum blade temperature:
Feedback:

Cast Placement Evaluation: Short Leg / Long Arm
Faculty Evaluator:
Total time:
Circle one: Required constant correction Required minor correction Performs independently Expert
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