Effectiveness of a Low Fidelity Cast Removal Module in Orthopaedic Surgical Simulation

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OBJECTIVE: The purpose of this study is to determine if an educational model during a surgical skills laboratory results in a significant reduction in cast saw blade temperatures generated during cast removal.

DESIGN: As part of an orthopedic resident surgical skills laboratory an Institutional Review Board-approved study was performed. A total of 17 study subjects applied a short arm cast. Everyone removed 1 short arm cast with temperatures recorded on the saw blade. Following cast removal, an educational session was conducted on proper cast removal and blade cooling techniques. Everyone then removed a second cast. Blade temperatures were recorded. To assess reproducibility, the 5 PGY-1 orthopedic residents removed a short arm cast 3 months later.

SETTING: Carolinas Medical Center, Charlotte, NC, tertiary care center

PARTICIPANTS: A total of 17 study subjects with minimal casting experience (5 PGY-1 orthopedic residents and 12 senior medical students) applied a short arm cast.

RESULTS: Following the educational session there was a significant reduction in mean and mean maximum blade temperatures ($p < 0.05$). During the second round of cast removal assessment of blade temperatures and specific techniques to cool the blade were observed among all participants. At 3 months′ time, the mean and mean maximum blade temperatures remained significantly lower than before the educational session ($p < 0.05$).

CONCLUSIONS: The intervention in this study reduced the maximum blade temperatures to levels below the threshold known to cause burns. This simple, low cost, and easily reproducible model can easily be disseminated across institutions and simulation laboratories. (J Surg Ed ■:■■■-■■■. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: resident education, surgical simulation, cast removal, cast saw burn

COMPETENCIES: Patient Care, Practice Based Learning and Improvement, Interpersonal Skills and Communication

INTRODUCTION

Thermal injuries during cast removal are a known source of iatrogenic injuries.[1] Abrasions and burns have been reported as complications of cast removal as early as 1949.[2] The incidence of cast saw burns is reported to be between 1 in 50 and 1 in 200 patients undergoing cast removal.[3,4] These injuries are a significant source of litigation in orthopedic surgery, and malpractice claims may result in significant costs to the hospital.[3,5]

Cast saw burns are the result of heat generated by the cast saw blade, which is dependent on temperature and the amount of time the blade is in contact with this skin.[2,6] Multiple studies have tried to identify the cause of thermal injuries generated during cast removal, and methods to reduce their incidence.[1,3,7] Cast saw burns have been found to be associated with inexperienced users, improper technique, and blunt cast saw blades.[3]

Orthopedic surgery residents receive very little training in cast removal.[9] In fact, an orthopedic surgery resident removing a cast in the emergency department is a risk factor for a cast saw injury. Surgical simulation continues to have an expanding role in resident education and provides an opportunity to include cast application and removal.[9,11] The purpose of this study is to determine if an educational model during a surgical skills laboratory results in a significant reduction in cast saw blade temperatures generated during cast removal. We hypothesized that there will

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FIGURE. During cast application, a k-type thermocouple was placed underneath the cast padding to allow for skin temperatures to be monitored during cast removal.

be a significant reduction in the maximum temperatures generated by the cast saw following the educational session.

MATERIALS AND METHODS

As part of an orthopedic surgical skills laboratory an Institutional Review Board-approved study was performed. Seventeen study subjects with minimal casting experience (5 PGY-1 orthopedic residents and 12 senior medical students) applied a fiberglass (Delta; BSN Medical) short arm cast to a costudy subject after consent was obtained. To ensure uniform thickness of the cast, 2-layers with 50% overlap were applied under supervision of the senior author (B.P. S.). Extremities were padded with 2 layers of cast padding (WEBRIL; Kendall, Mansfield, MA). A K-type (Omega, Stamford, CT) adhesive thermocouple was placed on the skin surface underneath the cast padding (Fig), and on the undersurface of the cast saw blade. The casts were then allowed to dry for 10 minutes and then were removed using the Stryker 940 cast cutter saw (Stryker, Kalamazoo, MI) on high speed, which was uniform throughout the study. Cast removal began on the proximal extent of the short arm cast. Everyone removed 1 short arm cast with temperatures recorded at 1-s intervals. Average and maximum temperatures were recorded from the blade as well as the skin surface. The number of skin burns as well the utilization of cooling techniques during cast removal was recorded.

Following initial cast removal an educational session was conducted. The senior author discussed and demonstrated proper cast saw technique and cooling techniques. Proper technique was demonstrated using the "in then out" technique.[5] Cooling techniques included: (1) cooling the blade with water soaked gauze, (2) ensuring the blade had been used less than 10 times, indicated by a hash mark on the blade to track usages, (3) periodically assessing the blade temperature with your fingers, and (4) ensuring the vacuum is attached and on. After completion, everyone then removed a second cast utilizing the new techniques. Blade temperatures and skin temperatures were again recorded. The number of skin burns as well the utilization of cooling techniques was again recorded.

To assess reproducibility and retention, the 5 PGY-1 orthopedic residents removed a short arm cast 3 months after the initial experiment. The data were collected in a similar fashion to the initial experiment performed 3 months earlier.

Before the beginning of the study, all participants rated their experience with removing casts as minimal. None of the participants had undergone prior formal training on cast removal.

T-tests were performed to detect a difference in means with the level of significance set as $p < 0.05$.

This study was funded by an internal institutional grant.

RESULTS

A total of 17 individuals participated in this study including 5 orthopedic interns and 12 fourth-year medical students. Before the educational session, the maximum temperature recorded was 66.3°C on the cast saw blade. Four subjects had blade temperatures that exceeded 60°C, 12 were greater than 47°C, and 15 greater than 43°C.

During initial cast removal, none of the study subjects were observed to utilize cooling techniques or made attempts to assess cast blade temperature. Two thermal burns were recorded among the subjects during this first round of cast removal.

Once each study subject finished the educational session, a second round of cast removal was attempted. Following the educational session, the maximum temperature recorded was 44.6°C. There was a significant reduction in mean and mean maximum blade temperatures (Table 1). There was not a significant difference in the mean or mean maximum skin temperatures.

TABLE 1. The Mean and the Mean Maximum Blade Temperature Were Significantly Lower After the educational Session. There Was Not a Significant Difference in the Mean and Mean Maximum Skin Temperatures

	Pre-educational Session (°C)	Posteducational Session (°C)	p Value
Mean blade temperature	42.1	29.7	<0.05
Mean maximum blade temperature	51.0	40.2	<0.05
Mean skin temperature	29.7	29.0	0.40
Mean maximum skin temperature	30.4	30.7	0.83