**Effect of Pressure Applied During Casting on Temperatures Beneath Casts**

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**INTRODUCTION:**

Although rarely reported in the literature, complications related to cast application are frequently observed, with burns and pressure sores occurring in common practice [1,2]. Numerous variables have all been observed to affect skin temperature under a cast, including water temperature [3], material type [4], number of layers of casting material [5], the use of a supportive pillow [6], ice application, and cast splitting [7]. However, the effect of applied pressure during cast and splint application has not been addressed. Many casts are not rolled on and left alone, but are molded by applying pressure in order to hold a fracture in alignment. This study focuses on how molding pressure affects temperature during cast or splint application. Our hypothesis is that the temperature rise will be greater at pressure points related to molding of the cast, making these areas more susceptible to burns under standard casting conditions.

**METHODS:**

A simulated elbow in extension was created from a mannequin arm covered with fiberglass weave (~5 mm thick to flush mount three pressure sensors (Series 9LX, range 0-2250 mmHg, Keller America Inc., Newport News VA): one at the dorsal surface of the wrist where a manual mold would be applied during casting of a Colles’ fracture, one along the volar forearm where counter-pressure would be applied, and another in a neutral location opposite the wrist sensor. Thermocouples (K-Type, Omega Engineering, Inc., Stamford CT) were placed within 1 cm of each pressure sensor. A remote thermocouple recorded ambient temperature. Temperature was maintained at a range of physiologic skin temperatures (~33-36°C) via heat tape (Clayborn Precision Heat Tape, Truckee CA) (Fig 1a). A 3 inch stockinette was applied followed by approximately 3 to 4 layers of cast padding. The dip water was maintained at 40°C, the average as measured from the hot water tap in our hospital’s operating rooms.

The study was divided into three groups:

- **Fiberglass Only (FO):** Two 3” fiberglass rolls (3M Scotchcast Plus) were applied uniformly to an estimated 8 ply thickness.
- **Plaster Only (PO):** A plaster splint (Specialist 4” Fast Setting, BSN Medical), twelve layers thick, was placed on the specimen and secured with an ACE bandage.
- **Plaster/Fiberglass Combination (PF):** A plaster splint (Specialist 4” Fast Setting, BSN Medical) was fashioned twelve layers thick, placed on the specimen, and secured with a layer of cast padding, then over-wrapped with one roll of 3” fiberglass.

For each group, testing was performed without pressure (five trials) or with a 3-point mold applied (ten trials) and held until the cast began to dry, then removed and become rigid. Each set of data was recorded via LabView software (National Instruments Inc., Austin TX) which was time synched with a four channel datalogger (Model HH147, Omega Engineering Inc.) for temperature recording. To normalize data, the change in temperature relative to the initial value was determined at the peak temperature and analyzed using a three-way ANOVA followed by a Tukey-Kramer post-hoc pair-wise comparison (SAS, Cary NC).

**RESULTS:**

Ambient room conditions averaged 25°C and 57% relative humidity. The average starting temperature of the arm surface was 35.1°C (35.5 at wrist, 36.0 at neutral, 33.9 at volar). Applied pressure was greatest at the dorsal wrist sensor, averaging 369 mmHg (range 331-451 mmHg). The counterforce applied at the volar forearm resulted in pressures on the dorsal wrist sensor, averaging 264 mmHg (range 231-345 mmHg). The change in skin temperature relative to the starting values (ΔT) was statistically higher with pressure than without, also higher at the wrist sensor versus volar and neutral sensors, and higher for PF versus FO or PO (p<0.001); PO was also higher than FO (p<0.0003) (Fig 2). The ΔT at the wrist sensor with pressure applied was even greater than the wrist without pressure and than volar or neutral sensors, regardless of pressure (p<0.0001). Pressure application did significantly increase ΔT for the volar sensor (p<0.0001), but not for the neutral sensor (p>0.09).

**DISCUSSION:**

In this study, the effect of a previously ignored variable during cast application – mold pressure – was investigated while other variables such as cast padding, casting material layers, and dip water temperature were standardized to values more commonly used in clinical practice [1]. As hypothesized, pressure applied to a curing cast does significantly cause the temperature to increase at sites where pressure is applied. However, this may only be clinically relevant when plaster and fiberglass are used together.

Limitations of the study mainly involve the experimental limb model. The rigid nature of the model may make the interpretation of pressure data seem more significant, since a human specimen (skin & subcutaneous tissue) would have some innate compliance and thus should allow displacement of tissue away from sites of pressure. Additionally, the effect of pressure at joints in flexion or under different external loads (i.e. short leg casts) was not examined. Regardless of our study suggests that pressure application be considered as a factor that can lead to increased temperatures under casting materials. Furthermore, using a plaster splint followed by a fiberglass over-wrap can cause dangerous temperatures, particularly if a mold is applied. Waiting until the plaster has fully dried before applying the fiberglass layer is recommended to minimize the risk of thermal injury.

**REFERENCES:**