Efficacy of DIY Cast Covers: An In Vivo Study

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Background: Casting is routinely used in orthopaedics. Preventing a wet cast is crucial for maintaining structural integrity and reducing unwanted complications like unnecessary skin irritation/ulceration, bacterial overgrowth, and unnecessary emergency department visits. Using experimental models, studies have tested various contemporary methods to prevent a wet cast. One such study found that in comparison the most effective and cost-conscious approach was to use a Do-It-Yourself cast cover using a double-bag technique sealed with tape. There is a paucity of literature on the utility of this technique in vivo. The purpose of this study was to investigate the efficacy of the Do-It-Yourself cast cover on human test subjects.

Methods: Ten volunteers for the study were obtained. Each received one short arm cast and one short leg cast. Each cast was removed after they were deemed dry. These casts were subsequently weighed until they achieved a stable weight. Each cast was then reapplied to the subject's arm and held together with Scotch tape. A trash bag was then applied around the cast and then secured with Duct tape to the skin. This was repeated to create a double seal. These covered, reapplied casts were submerged under water for 2 minutes. After submersion, the cover was removed, and the cast was reweighed. The casts were then submerged completely without any protection for 2 minutes and their fully saturated weight was recorded. Efficacy was determined by comparing the postsubmersion and full-submersion weights. Data was analyzed using the Mann-Whitney test.

Results: The percentage of water absorption prevention ranged from 96.8% to 99.9%, with an average of 99.6% across the entire study sample ($P < 0.0001$). No adverse effects were reported.

Conclusion: Our findings conclude that the double-bag with Duct-tape method is effective at preventing external water absorption. This in vivo study demonstrates that almost all external water absorption can be prevented using this simple and inexpensive technique.

Level of Evidence: Level II, prospective comparative study.

Key Words: cast cover, cast protection, cast care, dual plastic bag method, wet cast, DIY

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Casting is an effective and ubiquitous staple for fracture stabilization, postoperative support, and deformity correction. A standard cast involves an inner core of adequate cast padding with an outer rigid shell of either plaster or fiberglass. However, regardless of the technique and skill of the provider, the cast integrity and function are dependent on proper cast care practices of the patients and their families.

Multiple studies[1,2] have shown that often the primary reason rigid casts need to be switched is due to the cast being wet, increasing the burden on the health care system. It has been well-documented that water exposure deteriorates the cast's structural integrity, potentially compromising the desired function of the cast.[3,4] In addition, due to the cotton inner core, casts retain moisture and never fully dry, leading to adverse patient outcomes such as infections, odor, maceration, and/or dermatitis.[5–7] While some dampness can never be fully avoided due to humidity or patient perspiration, it is imperative that patients and families are aware and take measures to prevent a wet cast. However, many of these patients and their families are unable to take on additional cost to purchase over-the-counter cast cover devices. Cheap yet effective cast protection is paramount. McDowell et al[8] demonstrated on mannequins that sealing a cast with 2 layers of plastic trash bags and Duct-tape was equally as effective and easy to apply relative to store-bought cast covers. To our knowledge, no studies have investigated this dual plastic bag technique on human subjects. The primary aim of this study was to assess the in vivo effectiveness of the common double bag technique that has been a traditional method of cast care. We hypothesize that this Do-It-Yourself (DIY) cast cover will prove to be effective in vivo as it has already demonstrated effectiveness with in vitro studies.

METHODS

This was a prospective nonrandomized, nonblinded IRB-approved experimental study analyzing how effective short arm casts (SACs) and short leg casts (SLCs) sealed with 2 plastic trash bags and Duct-tape are at avoiding water absorption. A total of 20 limbs (10 arms and 10 legs) from 10 adult volunteers (aged 25 to 35) were casted. All study volunteers gave informed consent to participate. Short limb casts were applied in a standardized manner by one investigator.

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Application of Fiberglass Cast

Ten SACs and 10 SLCs were applied to 10 volunteers who had signed consents forms. Each arm or leg was first cleaned and prepped. Three-inch stockinettes (3M, St. Paul, Minnesota) or 4-inch stockinettes (3M) were applied to either the arm or leg, respectively. Three-inch (15.24-cm) Webril (Covidien, Dublin, Ireland) was then applied in a standard manner, providing optimal padding at bony prominences, as well as cast ends. Two 3M Scotchcast Plus Fiberglass Cast Tape rolls (3M) were then subsequently applied. After waiting for 15 minutes, each cast was inspected and deemed to be tactilely dry and of moderate structural integrity. The cast was then removed with a cast saw. The casts were placed in a well-aerated shelf that was temperature and humidity-controlled. These casts were subsequently weighed, using a digital scale (Ruishan Labs, Shanghai, China), over the course of multiple days until they achieved a stable weight. Once the average cast weight measured on subsequent days was within 1 g of the measure, the casts were determined to reach a stable weight.

Application of Cast Cover

Once the stable weight was reached, each cast was then reapplied to the subject's arm and held together with Scotch tape (3M). A plastic trash bag (Hefty, Lake Forest, IL) was then wrapped and deflated around the cast ensuring no visible portion of the cast was visible. Then, the 1.88-inch Duct-tape (Duck Brand, Avon, OH) was applied circumferentially ensuring adequate purchase of the skin as well as the plastic bag overlying the proximal cuff of the cast. A second bag was then wrapped and deflated around the Duct-tape, with the aim of just covering all the tape. Again, Duct-tape was placed circumferentially in a similar manner as before, to create the double seal. This method of sealing is visualized in Figure 1.

The protected cast were then fully submerged under water for 2 minutes. Two minutes was chosen based on previous research that analyzed water absorption prevention in casts.[8] After submersion, the cover was removed, the tape was removed and the cast by itself was reweighed. The unprotected cast was then submerged completely without any protection for 2 minutes and its fully saturated weight was recorded. This process was repeated for all 20 casts.

Data and Statistical Analysis

Water prevention efficacy was determined by calculating the amount of water absorbed. First, the difference between the control values and corresponding submersion weights was calculated. Second, these numbers were converted from grams (g) to milliliters (mL) based on a specific weight of water (1 g/mL). Due to differences in data distribution, a nonparametric Mann-Whitney test was conducted for each covered cast in comparison with the uncovered cast. For this study, the level of significance was $P < 0.05$.

RESULTS

At the 2-day interval, the casts were determined to have reached a stable weight with an average change in weight between subsequent days of 0.2 g (range, 0 to 2.8 g). At this stable weight, the SACs weighed on average 196.7 g (range, 190.5 to 201.6 g), while the SLCs weighed on average 452.7 g (range, 370.0 to 484.1 g). In total, the casts weighed on average 324.7 g (range, 190.5 to 484.1 g) at baseline. After applying the dual plastic bag cover secured with Duct tape, the protected casts were submerged for 2 minutes. After cover removal, the average cast weight was then 326.9 g (range, 192.3 to 505.7 g). The SAC average weight was 197.5 g (range, 192.3 to 202.1 g) while the average SLC weight was 456.4 g (range, 370.5 to 505.7 g). After submersion without protection, the SACs weighed on average 584.1 g (range, 526.8 to 626.0 g), while the SLCs weighed 1141.4 g (range, 930.0 to 1311.5 g) leading to a postsubmersion study average weight of 862.8 g (range, 526.8 to 1311.5 g).

This meant that the protected casts absorbed an average of 2.2 mL of water (range, 0.1 to 24.5 mL) after 2 minutes. The control or uncovered cast group had an average of water absorption of 538.1 mL of water (range, 336.3 to 828.4 mL). Analysis shows that on average, this technique was able to prevent 99.6% (range, 96.8% to 99.9%) of water absorption. After this was determined, the nonparametric analysis comparing the efficacy of the double plastic bags with Duct-tape showed significant effectiveness ($P < 0.0001$) in preventing water absorption.

DISCUSSION

The purpose of this study was to examine how effective dual sealing with plastic bags and Duct-tape was at preventing water absorption in vivo. The American Academy of Orthopaedic Surgeons (AAOS) current "Cast Care" guide provides a brief recommendation to either "use two layers of plastic or purchase waterproof shields."[9] Despite this, there continues to be a paucity of literature examining this area, providing less than clear instructions and recommendations to both health care providers, and subsequently patients and their families.

Traditional casts are a ubiquitous feature in orthopedic care for their robust ability to maintain fracture reduction but are limited by their susceptibility to water. Water exposure is the most common reason for recasting in the ER, as past studies have shown that fiberglass casts retain moisture and lose structural integrity, compromising fracture stabilization.[3,4] In addition, negative patient outcomes such as skin irritation and/or infection can occur secondary to moisture retention.[10]

Dual plastic bag seal has been a traditional means of protecting the cast, but its validation has been lacking in the literature, especially on studies involving human subjects. Our findings suggest that when securing 2 plastic bags with Duct-tape, the cast will be protected from 99.6% of the external water exposure. Albeit zero water absorption is ideal, however, a volume of 2.2 mL as seen in this study is clinically negligible. Combined with the low cost

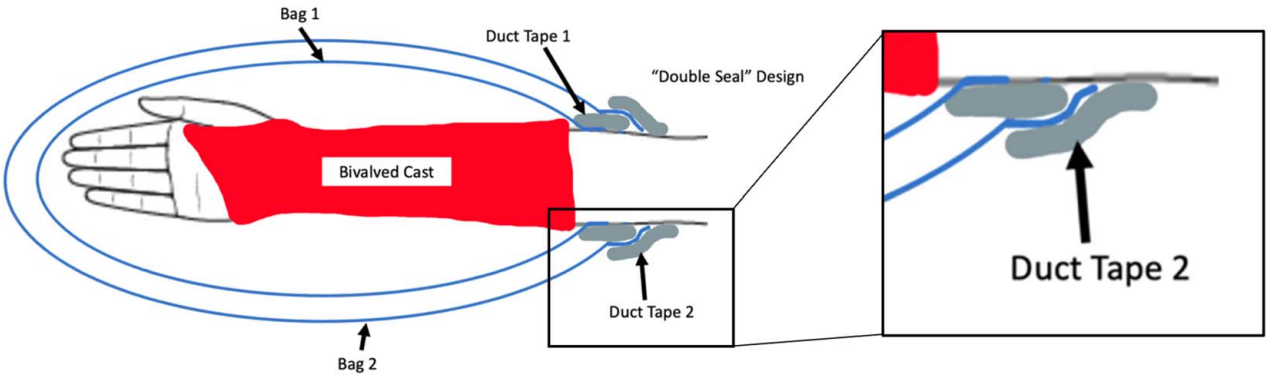

FIGURE 1. Demonstrates a cross-section of a short arm bivalved cast that has been appropriately sealed with 2 plastic bags and Duct-tape, interlocking each other. A magnified view of the dual plastic bag method demonstrates a proper seal: the first duct tape seals the first plastic bag to the skin, while the second duct tape strip attaches the second, overlying plastic bag and skin. Duct tape should not touch the cast material. full color online

of $0.30 per application reported by McDowell et al,[8] this technique is both valid and cost-effective. This study further supports the AAOS cast care recommendations.[9] To our knowledge, this was the first study to investigate preventing water absorption using human volunteers.

This further validates the McDowell et al[8] study that investigated various cast coverings, and their relative efficacies based on in vitro testing on mannequins. They found that the double plastic bags with the Duct-tape method as well as commercial cast cover products were exceptional at preventing water leakage into the cast, as well as their individual ease of use. However, based on cost analysis, the dual plastic bag technique was superior due to the use of ubiquitous materials, and easily customizable features.

This study has limitations. No randomization according to volunteer age, body mass index, or forearm size occurred. All casts were applied in a similar fashion by one investigator, but no formal standardization of Webril occurred. In addition, our method of fully submerging the casts involved limited motion to ensure adequate coverage and potential contact time against the plastic bag. However, this minimal activity is not necessarily applicable to real-life situations in the shower where patients are more mobile. In addition, full submersion of casts such as in a bath, pool, or other water source should not occur, and providers should provide adequate counseling. Another study design limitation is the need to weigh the dry cast. By removing and reapplying the casts, led to one instance of a poorly fitting SLC, which led to an extreme value of absorption (24 mL). This suggests that even with less-than-optimal application of the dual plastic bag method, 96% of water absorption can be prevented.

In addition, this study did not assess other factors that may or may not affect the efficiency of this cast cover. This includes a comparison of upper extremity sizes, the amount of hair on the extremity, the variety of motions that patients have during use, or the analysis of different cast/splint material. Furthermore, while this study demonstrates that this cast protection technique is effective, it cannot determine how much water is tolerated and how much water would require a cast replacement. Future studies should investigate the threshold of water absorption that would lead to skin irritation, and damage, and require a replacement of the cast.

No complications were noted during the study. Theoretical complications exist such as skin irritation or dermatitis secondary to the adhesive. In addition, hair removal is a possible sequela. Participants ranged from hairless to significant hair on arms and legs, but there was no apparent difficulty with application or removal. Patients and families should be advised of these risks. In addition, the AAOS recommends that if a child, or other member who is unable to adequately care for themselves, a sponge bath or other local means of hygiene is a reasonable alternative during their cast immobilization.[9] We are in agreement with this recommendation when caring for a child in a cast and the DIY method outlined is meant as a secondary barrier to water and mode of protection during hygiene not as a primary water blockade to allow full immersion such as when submerged in a bath or a swimming pool. Regardless of cast type, material, or patient characteristics, parental and patient education on cast care is important.[10]

In conclusion, this study aimed to assess a cost-effective and simple means of avoiding external water exposure to a fiberglass, thus avoiding complications common with wet casts. With cast care, the goal is to reduce unnecessary water exposure, to prevent associated maceration, skin irritation and/or infection, and loss of reduction. This in vivo study demonstrated that this DIY cast cover can prevent on average 99.6% of all external water absorption. We believe that these findings provide some insight and evidence that a home DIY method of using 2 plastic trash bags sealed with Duct-tape balances cost and cast protection.

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