

# Pediatrics Tips & Tricks: Pros and Cons of Waterproof Cast Liners in Pediatric Injuries

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## Introduction

Cast immobilization is a commonly used method to protect pediatric injuries of the upper and lower extremities, both following closed reduction as well as surgical fixation. Introduced in 1852, Plaster of Paris-impregnated bandages rapidly became the standard casting material until the emergence of fiberglass casting tape in the 1970's.<sup>1</sup> Fiberglass is waterproof and offers several novel advantages over plaster, including its greater radiolucency, lower setting temperature (reducing the associated risk of cast burns), availability in multiple colors, as well as its lightweight nature without compromise of strength or yield.<sup>1,2</sup> In recent decades, the development of waterproof cast liners have allowed patients the added comforts of hand washing, bathing, showering, and swimming. Despite these benefits, many practitioners have been reluctant to adopt waterproof liners in the acute and follow-up treatment of pediatric injuries. Here, we synthesize the recently-available literature and studies comparing the efficacy and safety of waterproof liners to standard cast liners.

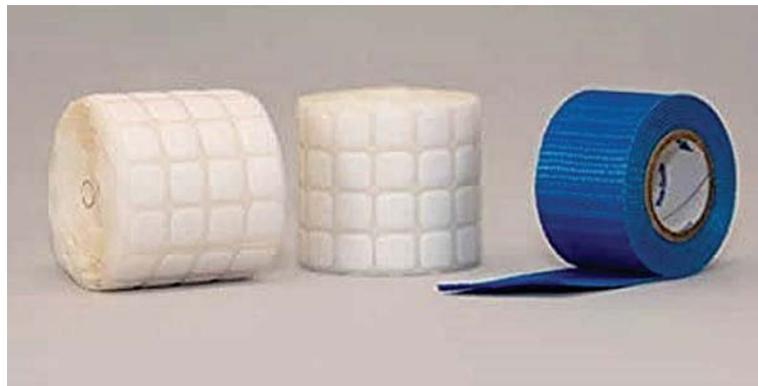
## History

The first widely-adopted waterproof liner was introduced in 1990 utilizing Gore-Tex® fabric as cast padding (W. L. Gore & Associated, Inc, Flagstaff, Arizona). Composed of stretched polytetrafluoroethylene (PTFE), this material was found to protect fracture alignment and allow improvements in patient satisfaction and hygiene while also protecting against the attendant risks of prolonged immobilization.<sup>3,5</sup> Since then, numerous brands of water-resistant undercast padding have become available,

including Delta Dry®, AquaCast® (Figure 1), Wet or Dry®, Procel®, Water Pruf®, Infina Under-Cast®, and Nemoa® Cast.<sup>6</sup> These materials have evolved to become durable, stretchy, mesh-like, wrinkle-free, and lightweight. To date, relatively few studies have been performed to compare different waterproof liners. Stevenson and colleagues were the first to compare Wet or Dry® with Delta Dry® liners, and found that the Wet or Dry® demonstrated significantly better performance with odor and water resistance, whereas Delta Dry® was found to provide greater ease of application, moldability, durability, and padding level.<sup>6</sup>

## Advantages

There are numerous proposed benefits supporting the use of waterproof liners over cotton or synthetic liners in pediatric patients. First, synthetic and cotton liners often retain moisture after application of the fiberglass, increasing the risk of dermal and integumentary complications including maceration, infection, itch, burns, and contact dermatitis.<sup>7</sup> Furthermore, waterproof liners allow patients the opportunity to rinse casts daily, shower and bathe, and swim without restriction. Numerous studies have confirmed the finding that waterproof liners engender greater patient satisfaction, less skin problems, and fewer unscheduled cast changes due to water exposure.<sup>3,8,9</sup> Guillen *et al.* were the first to directly compare patient outcomes amongst two groups of pediatric patients with upper extremity injuries utilizing cotton versus water-resistant cast padding.<sup>10</sup> Patients found that waterproof liners resulted in less odor and sweat scores, preferring them 75% of the time compared to cotton liners. Moreover, waterproof



**Figure 1.** AquaCast® Liner with Saw Stop Protective Strip. Available at: <http://www.aquacastliner.com/>

liners resulted in better skin conditions as rated by a blinded physician.

Several complications exist related to the application and utilization of casts in pediatric injuries; chief among them is the occurrence of unplanned cast changes. DiPaola *et al.* performed a prospective study of 1135 casts applied at a single institution, evaluating the incidence, etiology, and complications related to unplanned cast changes.<sup>11</sup> The authors found that, of the sixty casts requiring an unplanned change, 47% were changed for wetness. Sawyer and colleagues similarly reported a total of 168 pediatric emergency room visits for cast-related problems over a 5-year study period at their institution.<sup>12</sup> The most common reason for visit was because of a wet cast. Taken together, these results suggest a high cost and economic burden related to wet cast complications, which could be ameliorated with more widespread adoption of waterproof lining in cast application. Indeed, Wolff and James demonstrated a decrease in the incidence of unscheduled cast changes from 14% to 2.9% with use of waterproof casts.<sup>5</sup> Similar results were found by Haley *et al.* (33% of unscheduled cast changes with cotton casts versus 10% with Gore-Tex® casts).<sup>7</sup>

Waterproof-lined casts have demonstrated an ability to maintain fracture alignment that is comparable to traditional cotton-lined casts. In a review of 59 pediatric patients with unstable, 100% displaced distal radius fractures, Gore-Tex® and cotton casts were equally effective in their ability to maintain long-term reduction after closed reduction.<sup>15</sup> Another study demonstrated that waterproof casts may be effectively used to immobilize sprains, stable fractures, and unstable fractures more than 2 weeks post-reduction.<sup>3</sup> Similar findings have been noted in the setting of pediatric forearm fractures.<sup>6</sup>

The application and use of waterproof cast liners is similar to that of traditional cast liners, with few notable exceptions: patients should allow gravity to drain the wet cast for at least 15 minutes, swimming in untreated water (oceans and lakes) is not recommended, and patients should avoid getting the cast wet before removal.<sup>13</sup> Patients and their families should be appropriately educated regarding these special precautions, in addition to other standard cast restrictions. Because of the similarities in cast application, minimal additional training is needed for practitioners and technicians seeking to adopt waterproof liners. Notably, a stockinette is not used during application of a waterproof cast.

## Disadvantages

There are several proposed disadvantages of waterproof casting reported by some practitioners. Chief among them is the additional cost incurred with waterproof liners as compared to traditional liners. Gore-Tex® cast liners, for instance, are reported to cost \$30 to 50 more per cast.<sup>3</sup> The average cost of Procel® liners is also 3.5-4.5 times more expensive than cotton liners for short-arm, long-arm, and short-leg casts.<sup>3</sup> To our knowledge, a high-powered, formal cost analysis has not been performed to evaluate the cost efficiency of utilizing waterproof casts. In principle, however, the reduced frequency of unscheduled cast changes, as well

as unexpected emergency room and office visits, far outweigh the additional expenditures related to waterproof liners. A standardized practice of waterproof casting could thereby significantly reduce the economic and time burden on the health care system incurred by unexpected cast damage.

Use of a waterproof cast liner is not without some risk. Shannon *et al.* reported a 10.7% rate of minor skin problems in their series of 112 patients with waterproof-lined casts, as compared to 26.6% of patients with standard casts.<sup>3</sup> These included complications such as blistering, erythema, and contact dermatitis; all problems resolved with no additional intervention, and no significant cutaneous problems were observed. In addition, one study reported significantly higher cast pressures when a pediatric blood pressure cuff bladder was inflated within waterproof-lined casts as compared to cotton-lined casts.<sup>14</sup> The authors concluded that consideration should be given for using cotton cast padding in the acute fracture setting to better accommodate soft tissue swelling. However, other studies have supported the safe and effective application of waterproof casts immediately after closed fracture reduction.<sup>15</sup> Waterproof casting is therefore widely considered to be safe with appropriate cast application and parental monitoring, both in the immediate and follow-up treatment of pediatric fractures.

## Conclusion

Waterproof casting represents a safe and effective alternative to traditional cotton or synthetically-lined casts in the treatment of upper or lower extremity pediatric injuries. There are several benefits of waterproof lining, including improvements in patient hygiene, greater patient satisfaction, ability to maintain fracture reduction, and reduced frequency of unexpected cast changes. While waterproof liners are more expensive, the added cost is likely offset by the reduction in cast changes as well as emergency room and office visits. We therefore support a more widespread adoption of waterproof liners in appropriate pediatric patients with extremity injuries.

## References

- Pope, M. H., G. Callahan, and R. Lavalette. 1985. "Setting Temperatures of Synthetic Casts." *The Journal of Bone and Joint Surgery: American Volume* 67 (2): 262-64.
- Calhoun, J. 1983. "Setting Temperatures of Plaster Casts." *The Journal of Bone and Joint Surgery: American Volume* 65 (2): 279.
- Shannon, Elizabeth G., Rachel DiFazio, James Kasser, Lawrence Karlin, *et al.* 2005. "Waterproof Casts for Immobilization of Children's Fractures and Sprains." *Journal of Pediatric Orthopedics* 25 (1): 56-59.
- Selesnick, Harlan. 1993. "A More Comfortable Cast?" *The Physician and Sportsmedicine* 21 (5): 106-16.
- Wolff, C. R., and P. James. 1995. "The Prevention of Skin Excoriation under Children's Hip Spica Casts Using the Goretex Pantaloon." *Journal of Pediatric Orthopedics* 15 (3): 386-88.
- Stevenson, Aaron W., Abhay D. Gahukamble, Georgia Antoniou, Bradley Pool, *et al.* 2013. "Waterproof Cast Liners in Paediatric Forearm Fractures: A Randomized Trial." *Journal of Children's Orthopaedics* 7 (2): 123-30.
- Haley, Chad A., E. Schuyler DeJong, John A. Ward, *et al.* 2006. "Waterproof versus Cotton Cast Liners: A Randomized, Prospective Comparison." *American Journal of Orthopedics (Belle Mead, N.J.)* 35 (3): 137-40.

- Kruse, R. W., M. Fracchia, M. Boos, et al.** 1991. "Goretex Fabric as a Cast Underliner in Children." *Journal of Pediatric Orthopedics* 11 (6): 786–87.
- Selesnick, H., and G. Griffiths.** 1997. "A Waterproof Cast Liner Earns High Marks." *The Physician and Sportsmedicine* 25 (9): 67–74.
- Guillen, Philip T., Corey B. Fuller, Barth B. Riedel, et al.** 2016. "A Prospective Randomized Crossover Study on the Comparison of Cotton Versus Waterproof Cast Liners." *Hand (New York, N.Y.)* 11 (1): 50–53.
- DiPaola, Matthew J., Joshua M. Abzug, Peter D. Pizzutillo, et al.** 2014. "Incidence and Etiology of Unplanned Cast Changes for Fractures in the Pediatric Population." *Journal of Pediatric Orthopedics* 34 (6): 643–46.
- Sawyer, Jeffrey R., Conrad B. Ivie, Ambré L. Huff, et al.** 2010. "Emergency Room Visits by Pediatric Fracture Patients Treated with Cast Immobilization." *Journal of Pediatric Orthopedics* 30 (3): 248–52.
- Shirley, Eric D., Kathleen Joan Maguire, Abigail Louise Mantica, et al.** 2020. "Alternatives to Traditional Cast Immobilization in Pediatric Patients." *The Journal of the American Academy of Orthopaedic Surgeons* 28 (1): e20–27.
- Roberts, Aaron, K. Aaron Shaw, Shawn E. Boomsma, et al.** 2017. "Effect of Casting Material on the Cast Pressure After Sequential Cast Splitting." *Journal of Pediatric Orthopedics* 37 (1): 74–77.
- Robert, Christopher E., Jimmy J. Jiang, and Joseph G. Khoury.** 2011. "A Prospective Study on the Effectiveness of Cotton versus Waterproof Cast Padding in Maintaining the Reduction of Pediatric Distal Forearm Fractures." *Journal of Pediatric Orthopedics* 31 (2): 144–49.