Injury, Int. J. Care Injured 47 (2016) 2258–2265

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Is softcast (3M) strong enough for potentially unstable paediatric forearm fractures?

Nimesh Patel, MRCS[a,*], Lance Wilson, MBE(Mech) ME Sc PhD[b], Guy Wansbrough, FRCS (Tr+Orth) BEng[c]

[a] Department of Trauma and Orthopaedics, Torbay Hospital, Torquay TQ2 7AA, UK, UK
[b] Royal Children's Hospital, Brisbane, Australia
[c] Queensland University of Technology, Brisbane, Australia

ARTICLE INFO

Keywords:
Plaster of Paris
Softcast
Paediatric forearm fracture
Mechanical failure
Stability

ABSTRACT

Introduction: The majority of paediatric forearm fractures are treated using a circumferential splint, with prior manipulation as necessary. Plaster of Paris is often chosen for its ease of application, cost and proven reliability.
Softcast is an alternative, providing a comfortable and water-resistant splint that can be removed without a plaster saw, and is in widespread use for immobilising buckle fractures. *Softcast* has not been recommended for acute unstable fractures. We established whether a *Softcast* splint could provide sufficient mechanical stability to control an unstable paediatric forearm fracture.
Methods: A laboratory study was undertaken to compare the 3 point (kinking) and 4 point bending, and torsion loads to defined clinical failure points withstood by standardised 4-wrap POP compared to *Softcast* splints with 6-wrap, 4 wrap and reinforced 4-wrap configurations.
Results: The load at clinically relevant failure of a 6-wrap *Softcast* forearm splint was 504 N in 4 point bending, 202 N in 3 point bending (kinking), and 11Nm in torsion (equalling 30.4%, 26% and 42.2% of the equivalent values for a circumferential 4-wrap POP). The 6-wrap *Softcast* was however stronger in all modes than a fibreglass-reinforced *Softcast* splint (previously recommended for acute fractures). Furthermore, the load to failure in all modes exceeds that which can be exerted by body weight in many paediatric patients.
Softcast demonstrated complete recovery of its original shape on unloading, whereas POP was permanently deformed. 6-wrap Softcast splints were 4% lighter than POP.
Conclusion: A 6-wrap *Softcast* splint provides adequate mechanical stability and protection for paediatric patients up to approximately 20 kg, avoiding high-risk activities. The primary risk is not of fracture angulation and loss of position, but temporary indentation of the splint, causing discomfort or pain. Considering its ease of removal, *Softcast* may be preferable for younger paediatric patients. Its cost may be offset by reducing the number and duration of hospital visits.

Introduction

The majority paediatric forearm fractures are treated with a circumferential splint with prior manipulation if necessary. This is usually with Plaster of Paris (POP) due to its low cost, reliability and proven mechanical reliability [1].

It can however be heavy and bulky for young children. If split after application, POP may require completion, and will require formal removal when treatment is completed. This requires additional materials and staffing as well as further hospital visits. A plaster saw is also required for removal, which can cause anxiety and distress to the child, as well as superficial abrasions.

The technique of application, and thickness of POP splints has been developed empirically since its introduction one and a half centuries ago, and involves; subjective assessment of patients' body weight and anticipated activity and environment. Combining this with the plaster technician's experience, dictates the design and weight of the splint applied.

While studies have compared the failure strength of available materials, none have defined the clinical forces applied, the modes of failure, or the clinically relevant failure points, which must be resisted by a completed orthopaedic splint.

* Corresponding author.
E-mail address: Dr.nimeshpatel1@gmail.com (N. Patel).

http://dx.doi.org/10.1016/j.injury.2016.07.027
0020-1383/

Softcast is a synthetic semi-rigid cast, which is stronger than splints, backslabs and bandages [2]. Its safety and reliability has been shown in the treatment of stable buckle (Torus) fractures, but usage in unstable forearm fractures has not been biomechanically studied [3].

It has the potential advantage of being a full splint, which can be removed and unwrapped out of hospital like a normal bandage, avoiding further visits into the hospital, and based on evidence with buckle fractures, this is preferred by parents [4].

We therefore defined the clinically relevant failure strength of Softcast fabricated to different specifications compared to POP casts to ascertain whether Softcast can safely provide fracture stabilization when used by younger paediatric patients.

We aimed to investigate whether the mechanical properties of Softcast are sufficient to stabilize a paediatric forearm fracture and protect the patient from further injury against clinically defined failure parameters.

Materials and methods

This study was undertaken in the engineering laboratories of The Queensland University of Technology (QUT), Brisbane. Authors GW and LW defined engineering parameters, and trials were conducted by QUT senior test engineer (LW).

Design of laboratory trials

Plaster of Paris splints were fabricated to a single specification: On a 60 mm diameter × 250 mm length solid tube, a single pass of 10 cm "Webril" wool was wound onto the tube with 50% overlap. Then four passes of 10 cm "Gypsona" POP was wound onto the tube in successive opposing directions with 50% overlap, to give 8 layers (Fig. 1). An additional turn was allowed at each end to reinforce the area of plaster to be supported in the jigs. Once hard, they were dried for 5 days to ensure they were all equivalent as on some occasions they were fabricated over several days, therefore some would otherwise be 'wetter' than others.

The test splints were fabricated using 3 M Soft Cast Casting Tape (3 M Healthcare Limited, Loughborough, UK) on a 60 mm diameter × 250 mm length tube to create a cylindrical plaster, and tests on moulded Softcast were carried out on splits made up on an oval tube as follows:

i 8 layer Softcast with 4 wraps and 50% overlap (x9)
ii 12 layer Softcast with 6 wraps and 50% overlap (x3)
iii Reinforced 8 layer Softcast including 2 longitudinal strips of fiberglass splint material included between layers 4 and 5. (x3)
iv 8 layer moulded Softcast (x3)

All splints were weighed after drying and each splint type underwent a trial protocol, including loading to destruction.

Twenty-one control tests using POP were carried out. Nine were assigned to 4 point bending, 9 were assigned to 3-point kinking, and 3 were assigned to torsion. 54 Softcast tests were carried out. Deflection and load readings were taken for all protocols. See Table 1 for breakdown of assignment of splints. The test instrumentation is detailed in Appendix A, and assignment of splints is detailed in Table 1.

Clinical parameters of failure

The forces to which a cylindrical orthopaedic splint may be exposed, and the point at which a splint fails to provide a clinically acceptable reduction of the fracture, or protection to the patient can be defined as follows:

4. point bending

A torque was applied about the transverse axis of the splint. Pure bending is achieved using 4-point bending tests. We referred to the resistance to bending as "Stiffness".

10deg was set as the clinical failure point (end point) for angulation during trials. Residual angulation of 5deg after unloading was also considered clinical failure. (Fig. 2)

3. point bending (Kinking)

Force was applied at two separate points perpendicular to the splint with an opposite force applied between these points. Kinking forces were applied by 3-point bending test with a narrow "blade" jig centrally. We referred to resistance to kinking as "Hardness".

The clinical failure point was defined as collapse of 33% of the initial splint diameter. (Fig. 3)

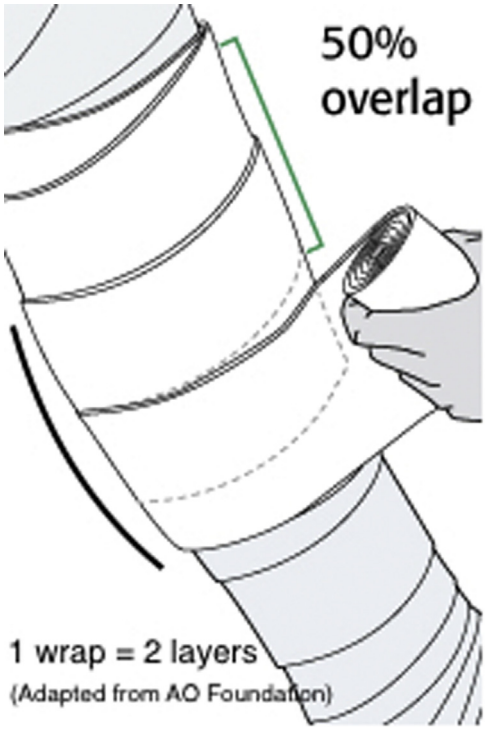

Fig. 1. Preparation of Plaster.

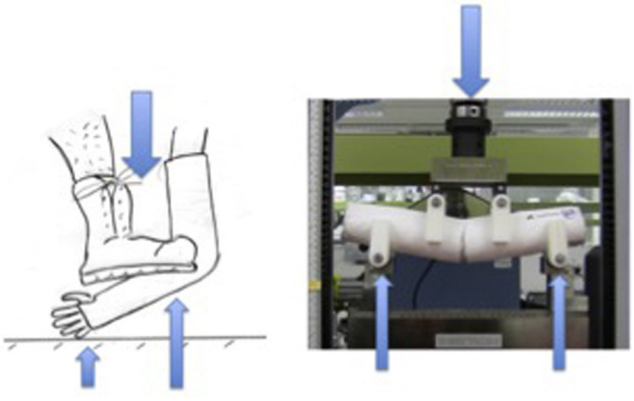

Fig. 2. Bending Setup.