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Does cutting a plaster window weaken its strength?

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ABSTRACT

Introduction: A plaster window is usually created over a pressure area, or in some cases a wound or suture line. This can relieve pressure at the site, and provide an opportunity to change dressings, check on drainage, and inspect a wound or ulcer.
There is concern that this can have an effect on its function to provide fracture stability, and weakens the plaster. The biomechanical effects of windowing on plaster strength were therefore investigated, as it has not previously been reported.
Method: A laboratory study was undertaken to compare the bending, kinking and torsion loads withstood by standardised Plaster of Paris (POP), Softcast and Fibreglass casts compared to those with a 60 × 40 mm window fabricated in the centre at clinically defined endpoints using an Instron machine.
Results: The addition of a window significantly weakened the load to failure of POP; Fibreglass, and Softcast by 23.1% (473.1N); 25.9% (401.8N), and 29% (146.6N) respectively, during the 4-point bending tests. During the 3-point kinking tests, load to failure was reduced by 38.5% (297.8N); 35.3% (146.9N), and 51.5% (103.8N) respectively.
All tests were checked for consistency and carried out in a single orthogonal plane for ease of comparison.
Discussion: The addition of a 60 × 40 mm window to a cast made up of POP, Fibreglass or Softcast weakens the cast load to failure by up to 51% against a 3-point loading force.
Though windowing of casts is necessary in certain situations, we advise precautions such as adding further layers of plaster to the window site, keeping the window as small as possible, and advising the patient of the increased risk of weakening and failure of the plaster so that they can take more care.

Introduction

Orthopaedic casts used to treat fractures provide pain relief, support, and correct deformities [1]. Different materials include Plaster of Paris (POP), semi-rigid non-fibreglass (SoftCast), and rigid resin based synthetic cast (Fibreglass) [2].

Some of the issues related to swelling, including pain, impairment of blood supply, neuropraxia, topical reactions, and pressure sores can be alleviated by splitting or bivalving the plaster [3].

Pressure sores can however commonly occur over bony prominences, either due to tight application, a dent in the plaster or inadequate padding. A window may be fashioned by cutting out a portion of the cast over the affected area. This can relieve pressure at the site, and provide an opportunity to change dressings, check on drainage, inspect a wound or ulcer, check a pulse, monitor a pressure sore or apply a bone stimulator [1,4].

It is generally accepted that once a wound check has been performed, a similar amount of dressing or padding is applied before re-applying the window by tape. This is to prevent unnecessary swelling through the window and pressure at the edges.

There is however concern that fabricating a window to a plaster can have an effect on its function to provide fracture stability, or weaken the plaster. The biomechanical effects of windowing on plaster strength have not previously been investigated.

Aim

To establish the mechanical properties of windowed plaster of different material compared to full casts to establish whether strength is affected.

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Null hypothesis

There is no change in strength of a windowed plaster compared to a full plaster cast.

Methods

We first defined the modes of failure, then move on to how the casts were prepared and tested to these defined points of failure.

Clinical parameters of failure

The forces to which a cylindrical orthopaedic splint may be exposed, and the point at which a splint fails to maintain a clinically acceptable reduction of the fracture, or protection to the patient can be defined as described previously [5].

These included:

"Bending" – 4 point bending (Fig. 1). Resistance to bending measured as 'stiffness';

"Kinking" – 3 point bending (Fig. 2). Resistance to kinking measured as 'hardness';

"Twisting" – Torsion (Fig. 3). Resistance to twisting measured as 'torsional stiffness'.

The clinical failure point of a splint in each mode was defined as 10deg bending, kinking to 30% of the splint diameter, and 10deg of torsion [5]. Destruction was defined as a fall in resistance of ≥40% of maximum load resistance [5]. After destruction, a splint that would not retain its final deformed shape against the force of gravity was defined as unstable.

Design of laboratory trials

Plaster of Paris splints were fabricated to a single specification: On a 60 mm diameter 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 were wound onto the tube in successive opposing directions with 50% overlap, to give 8 layers. An additional turn was allowed at each end to reinforce the area of plaster to be supported in the jigs.

The other splints were fabricated using 3M Soft Cast Casting Tape (3M Healthcare Limited, Loughborough, UK), and 'Hygia' fibreglass cast (Woosam Medical) on a 60 mm tube to create a cylindrical plaster made up of 12 layers with 6 wraps and 50% overlap.

A single window was cut using an oscillating plaster saw in the centre of the cast to a size of 60 × 40 mm (Fig. 4), and was kept at an orthogonal plane of 90° to the forces being applied during testing.

An initial trial protocol was undertaken, including loading to destruction. Bending and Kinking trials were conducted on a screw-driven Instron© (Illinois Tool Works Inc) machine, onto which, accordingly sized thermoplastic jigs were mounted.

Torsion trials were conducted after securing the splint over a 60 mm internal steel jig mounted on an Instron Biaxial Tester with an M8 bolt with washers at either end, tightened to 12 Nm. The full details are listed in a previously described trial [5].

Ten control tests (30 in total) were carried out on full casts assigned to 4 point bending, 3 point kinking, and to torsion respectively. Windowed tests were then undertaken assigned to the same test modes at 10 tests per mode. Thus, 10 windowed test plasters were compared against 10 non-windowed controls for each mode of failure. Deflection and load readings were taken for all protocols.

Test protocols

Bending protocol: A three-cycle test was performed to test cast stiffness in 2 orientations (90° change). In each orientation, successive 1 mm deflection cycles employed a higher loading rate to assess for hysteresis and weakening. A fourth cycle then deflected the splint to the clinical failure point, and beyond to the destruction point for POP. For Fibreglass and Softcast tests, 2 mm deflection cycles were employed to investigate for hysteresis, then a further 3 deflections were carried out at the 4 mm clinical failure point to examine any weakening that may occur.

Kinking protocol: Test cycles were completed as per the above schedule, but employing the kinking instrumentation and corresponding failure point criteria.

Torsion protocol: A three-cycle test was performed to test cast torsional stiffness. Successive −5 to +5° deflection cycles employed a higher loading rate to assess for hysteresis and weakening. A fourth cycle then deflected the splint to the clinical failure point, and beyond to the destruction point.

For each splint, we recorded the maximum stiffness at three different load rates in orthogonal rotational orientation, followed by the load at clinical failure, and the maximum load.

The mean and standard deviation of these parameters were calculated and compared between groups. Statistical analysis was carried out with *t*-tests, using Graphpad Instat software (La Jolla,

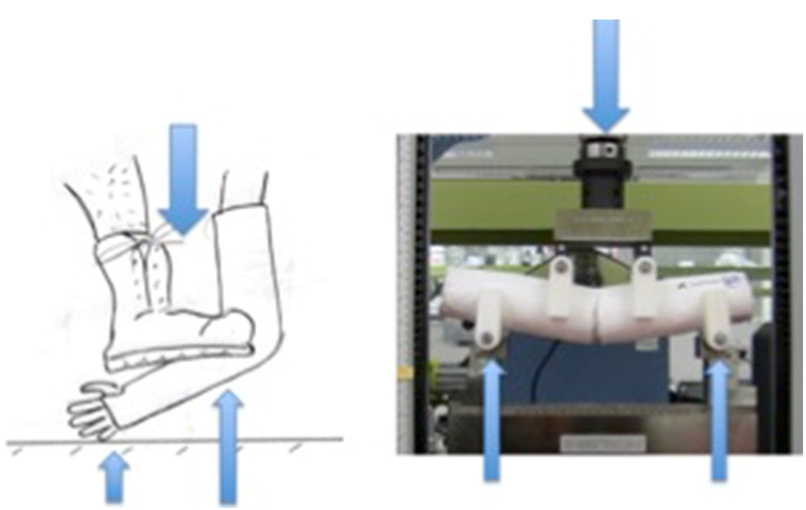

Fig. 1. Bending Test Setup (4 point).