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Editorial

Plaster of Paris: Past, present and future

No other object is as closely associated with the branch of orthopaedics as Plaster of Paris or POP as we commonly call it. Orthopaedicians have been associated with POP just like cardiologists with ECG and the plastic surgeons with Humby's knife. Its use is ubiquitous and we put it to such a myriad of uses that the list is endless.

1. History

The name Plaster of Paris (POP) had its origins from the fact that it was extensively mined from Montmartre in Paris district. But its use predates the industrial revolution, they have been found on the insides of pyramids. The need to immobilise the fracture to prevent pain and deformity and all the while allowing mobilisation has been the perennial problem in orthopaedics. Splints made of bamboo and wooden sticks were used in the ancient times but they couldn't be relied upon to hold the reduction. More materials were tried like wax, starch, cardboard but all ended in failure. This was the time POP was beginning to be used in construction and by sculptors, surgeons observing its properties hit upon the idea of using it in orthopaedics. Patients with fractures in the long bones of leg were placed in long narrow wooden boxes and the gaps filled with POP. This was however bulky and alternatives were sought. The idea of incorporating POP in bandages was hit upon by two surgeons, Antonius Mathijssen and Nikolai Ivanovich Pirogov in the 1850's. The results are for us to see.

2. Evolution of POP and its uses

The uses of POP have only evolved with time. It started out as a method to immobilise and hold reductions in the management of adult and paediatric fractures, for which it still continues to be used. Sarmiento¹ has shown that the management of low energy fractures of humerus and tibia is possible without functional compromise with a POP cast even in the age of AO and ORIF. In Paediatric orthopaedics POP has revolutionised the management of club foot. What was once considered a surgically treatable condition is now managed by serial casting due to the innovation of Kite and Ponseti.² In DDH Hip spica is used once reduction is achieved either by

closed or open methods. Plaster has also been used to treat fracture and deformities in spine. Hibbs introduced post-operative immobilisation using POP jacket in patients of Pott's spine. He also introduced turnbuckle cast that is used in the management of scoliosis.³ Risser also introduced a method for treatment of scoliosis by casting.⁴ Plaster of Paris is used in postoperative immobilisation and also in the management of some amputees. Casting over stumps has allowed immediate rehabilitation using prosthesis.⁵ POP was used in the immediate management of Open fractures until the evolution of external fixator. It has also been used in the management of neuropathic joints and diabetic ulcers.⁶ It is used in the correction of deformities like fixed flexion deformity of the knee.

3. Plaster of Paris – properties and complications

Plaster of Paris is calcined gypsum (roasted gypsum), ground to a fine powder by milling. When water is added, the more soluble form of calcium sulphate returns to the relatively insoluble form, and heat is produced [$2(\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}) + 3\text{H}_2\text{O} \rightarrow 2(\text{CaSO}_4 \cdot 2\text{H}_2\text{O}) + \text{Heat}$]. The setting of unmodified plaster starts about 10 min after mixing and is complete in about 45 min; however, the cast is not fully dry for 72 h.⁷

The biggest advantage of POP is the property that allows itself to moulding. This allows POP to be contoured according to the limb that it is applied to. It is sufficiently rigid and allows immobilisation to allow healing to take place. However it is not without its complications. Prolonged immobilisation in a POP makes the skin under the cast vulnerable. The dead skin is not removed and leads to scaling. Other complications like ulceration, maceration, itching can result. Even burns can be caused by the exothermic reaction. Staphylococcal infection of the underlying skin can result in dermatitis. Cast syndrome, associated with body jacket casts, involves obstruction of the third portion of the duodenum from duodenal constriction caused by stretching of the superior mesenteric vessels. The symptoms are nausea, vomiting, fever, and electrolyte imbalance. The most dreaded complication however is compartment syndrome and the resulting sequelae Volkmann's Ischaemic contracture. The nerve palsies have also been associated with poor plaster

techniques. The other chronic complication is the “fracture disease” that results from prolonged immobilisation, leading to osteoporotic bones and stiff joints. Complications when casts are used in fracture treatment are loss of reduction, malalignment, delayed and non-union. Localised hypertrichosis has also been reported as rare complication of internal fixation and POP application.⁸

Recently parameters like cast index and gap index have been developed that predict cast failure.⁹ Cast index is the ratio between the inside diameter of the cast on the lateral view to the inner diameter of the cast on AP view. Gap index is the space between plaster and skin measured as a ratio to inner diameter of the plaster. Higher cast and gap index have been associated with higher failure rate.

However most of the complications can be avoided by adhering to a good plaster technique. They include proper padding especially of the bony prominences, avoiding casts when the limb is swollen, maintaining functional position of joints and preventing pressure points when moulding the cast. To prevent compartment syndrome, care must be taken in children and in patients with soft tissue injury (including burns), multiple trauma, paralysis or paresis, head injury, or altered sensorium (due to medications, substance abuse, or psychosis). Evaluation of neurovascular status and recording of abnormalities are essential.

The factors that cause thermal burns are a dip water temperature of >75°F (24 °C), use of more than eight layers, and use of a pillow (inadequate ventilation). Plaster residue in the dip water did not increase the exothermic reaction. Moisture on the outside of the cast decreased the temperature of the plaster.¹⁰ According to Halanski et al, the surface of the cast was 2.7 ± 1.9 °C cooler than the internal temperature. A dip water temperature of <24 °C did not result in a temperature high enough to cause burns, regardless of the number of layers. A dip water temperature of >50 °C, a twenty-four-ply cast thickness, use of a plastic pillow, overwrapping of a curing plaster cast with synthetic, and use of a splint folded on itself were associated with temperatures causing burns.¹¹

4. Recent uses and alternatives

Plaster of Paris or calcium sulphate has found other uses as well. It has been used as bone graft substitute and to fill up bone defects.¹² It has been used in spinal surgery as a bone graft substitute. POP is also being investigated as an antibiotic delivery mechanism.¹³ However POP usage has been declining in its use as casting material after the advent of fibreglass or polyurethane tapes and splints. Plaster has certain technical advantages over synthetics. Plaster can be tucked or pleated. Plaster requires less tension for application. Gloves are not required. Plaster absorbs fluids, including pus, blood, and sweat. If a cast saw is not available, the plaster cast may be removed by soaking and unrolling or using simple hand-cutting instruments. However, compared with fibreglass, plaster may be difficult to store in humidity and is more difficult to keep clean. Plaster casts are heavier than fibreglass, exhibit more breakdown for short-leg casts,

and are judged to be more restrictive and less comfortable.¹⁴ However in a country like India where the cost considerations come in to play POP still remains the choice of material in casting.

5. Conclusion

From the early days of orthopaedics when fracture management was mostly conservative to the present era of technological advancement where every fracture is managed aggressively and immediately with internal fixation, POP has been our constant companion, and we can safely hazard a guess that it will remain so in the future. This places a responsibility on the orthopaedic residents to learn proper plaster techniques and not look down upon this simple and effective method for the treatment of fractures. A consideration may also be given in more emphasis of closed management of fractures using POP as a part of orthopaedic curriculum in a developing country like India where access to surgical facilities are limited especially in remote places. We take liberty to state that the days of identifying orthopaedicians in hospital corridors by looking at the white POP stains on trousers and shoes will not be history.

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