International Journal of Research in Orthopaedics
Tomar L et al. Int J Res Orthop. 2024 Nov;10(6):1419-1424
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20243146

Review Article

Fiberglass cast application in immediate post-operative period after an ankle fracture surgery: review of safeguards

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Received: 03 May 2024
Revised: 18 June 2024
Accepted: 11 October 2024

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ABSTRACT

An ankle fracture after stabilization may normally need post-operative support immobilization in a cast in the early phase to allow for the associated soft tissue ligamentous injury to recover. The cast may allow for an early rehabilitation of the operated ankle fractures with protected weight bearing potential. A cast immobilization in the immediate post-operative period following an ankle surgery has used gypsum plasters with great caution and care. The concerns of poor wound healing, infection, pressure ulcer, skin maceration due to soakage, development of compartment syndrome and thrombosis may present in the immediate post-operative period for ankle fractures following a cast application. The technique for fiberglass cast application in the immediate post-operative period may provide an advantage. The cast application needs an emphasis to understand the safeguards, avoid any abnormal pressure and do monitoring of wound care to attain a favorable desired outcome. The aspects of cast application have been reviewed to present the necessary safeguards.

Keywords: Fiberglass cast, Ankle fracture, Post-operative immobilization, Cast, Complications in cast, Plaster application

INTRODUCTION

Ankle injury involves disruption of joint ligaments which adds to the instability of ankle mortise. The ankle fractures are one of the commonest injuries affecting both the young and elderly age group.[1] post-operative immobilization after an ankle fracture surgery has been considered to be imperative for an initial support for the associated injured soft tissue envelope to recover. Ankle fracture involving articular surface usually requires operative intervention with fixation and simultaneous post-operative immobilization.[2] The immobilization in practice involves use of Robert Jones bandages, bulky dressings, posterior slabs, gypsum cast and more recently fiber cast application.[3] The composite cast involving a gypsum cast as an inner layer and a synthetic cast as an outer layer have been applied too for post-operative management of the ankle fracture.[4] A removable cast immobilization has also been advocated for operated ankle fractures, though early mobilization caused more wound complications and required individualization of treatment.[5] There are contradictory results and no clear recommendations for the support splints in post-operative management of ankle fractures.[5] In elderly with an unstable ankle fracture, a close contact casting has given similar functional outcomes than a surgical management.[6]

The cast fitted injured ankle during post-operative immobilization has unclear biomechanical traits.[7] A well fitted cast following an ankle surgery allows a faster rehabilitation, minimizing the period of postoperative convalescence, and reducing the disability induced by trauma.[8] The application of circumferential cast however may entail complications.[4] The associated complications

in the immediate post-operative period for ankle fractures may include poor wound healing, infection, pressure ulcer, skin maceration due to soakage, development of compartment syndrome and thrombosis.[9,10] Most surgeons therefore, prefer initial application of splints and back slabs to accommodate for post- operative swelling.[3,11,12] The change of cast and wound inspection may be an area of concern. The slab or cast prevents an inadvertent equinus posturing of the foot avoiding subsequent contractures.[11] Frequent regular follow up in the outpatient clinic may be required. An additional cost of treatment may be incurred due to cast change.

A fiberglass cast application in an uncomplicated foot and ankle injury did not cause any severe complications in a period of 30 days of application.[10,12] We review the techniques for the immediate post-surgery fiberglass cast application for the postoperative immobilization following an ankle fracture surgery and detail a preferred technique for fiberglass cast application in the immediate postoperative ankle fracture support immobilization.

We elaborate about the advantages, concerns, feasibility options, and tips for an effective cast application. One should though, ensure that any impending compartment syndrome and wound inspection are regularly monitored. The recommendations for the necessary safeguards have been enlisted.

REVIEW

We reviewed the literature containing the terms “cast,” “fiberglass cast,” “ankle,” “fracture,” “complication,” “plaster application,” “post-operative,” and “immobilization,” from the search engine “Google Scholar” for the articles published till April 2024. The terms “Cast, Fiberglass cast, Ankle, Fracture, Complication, Post-operative, and Immobilization” were used to make a search strategy with words included in the title and abstract.

The abstracts were then reviewed manually. Since studies exclusive to ankle injuries in immediate post-operative fiberglass cast application were sparse, hence a manual selection of the studies followed to identify the relevant data. The inclusion criteria were studies describing post-operative immobilization in ankle fractures. We excluded articles that focused on complications in general other than cast related issues in the ankle fracture management. Studies in languages other than English were also excluded.

TECHNIQUE

Patients with ankle fracture, either a malleolar, bi-malleolar or tri-malleolar, needs careful planning for surgical fixation in the immediate post trauma period subject to permissible skin condition. Tourniquet can be used in the cases for reducing blood loss and for bloodless surgical field except for vascular compromised extremity.

Patients may undergo surgical exposure for ankle fracture by either a medial, lateral or combined approach. Under fluoroscopic guidance, fracture reduction and fixation are done. After closure of wound and approximation, an immediate post-operative immobilization has to be provided.

Figure 1: Per-operative arrangement of gamzee roll, soft roll, and plaster cast material.

Figure 2: Per-operative clinical photograph of operated ankle which (a) shows lateral sutured incision, (b) shows medial sutured incision, (c) shows anterior sutured incision, and (d) shows sterile gauze dressing for wound coverage.

The material for cast application requires adequate gamzee padding, soft cotton roll and fiberglass casts (Figure 1). The cast applied in the immediate post-operative period needs thorough wound cleaning, appropriate antiseptic dressing and sterile gamzee padding before application (Figure 2). Two assistants may be required to temporarily stabilize and hold the leg at the time of cast application (Figure 3).

Figure 3: Peri-operative image with fluffy gamzee roll applied with assistant holding the leg in stable desired position supporting the ankle and knee.

Figure 4: Peri-operative image with additional soft roll applied over the fluffy gamzee roll.

A soft fluffy gamzee roll was used for initial circumferential coverage of the operated limb from toes distally to cover proximally along the ankle till the tibial tuberosity. Special emphasis needed to give a smooth and uniform pressure application without wrinkles or constriction band formations while applying the innermost layer. This was supplemented with a soft cotton roll cast padding which was started from toes in a cephalad direction towards the tibial tuberosity (Figure 4).

The roll was incised till the skin at the level of ankle anteriorly to prevent pressure sore formation. The heel pad was additionally padded to avoid any pressure on the heel. This was followed by two or three five-inch fiberglass cast application from toes onwards towards knee region depending on the girth of the limb and the weight of the patient. The cast bandages are dipped in lukewarm water and the curing time should allow the smooth application. An emphasis on avoiding abnormal pressure application, providing proper padding of the bony prominences, along with sugar tonging splintage around the ankle should be followed (Figure 5).

Figure 5: Peri-operative image with sugar tonging splintage along the ankle.

Figure 6: Peri-operative image with cast molding in setting time for the ankle cast.

The gentle cast molding by manual pressure after application may be followed (Figure 6). After cast application and tourniquet deflation, the immediate post-operative limb saturation needs to be evaluated. The sign of refilling of distal toes was considered an adequate perfusion of the operated limb (Figure 7). Weight bearing potential was based on the nature of injury, stability of reduction, fixation technique and associated medical comorbidities.

Postoperative protocol

The patient who has been given below knee fiber cast application in the immediate post-operative period for support and immobilization needs in-hospital monitoring. They are assessed for clinical symptoms of pain, distal toe swelling, calf pain, capillary refill time or abnormal paresthesia in the immediate postoperative period.

Figure 7: Peri-operative image of completed cast with visible adequate perfusion of operated limb.

A window dressing was created on the first postoperative day and the operated wound was inspected for soakage, induration, blistering of skin for the close soft tissue surveillance. They were followed in the outpatient clinic at subsequent one week, two weeks and six weeks after discharge from hospital for the wound inspection, suture removal, and any need for the change of cast.

The functional assessment was done and evaluated for the ability to mobilize with walker support, visual analogue score for pain assessment and ability to do normal activities of daily living. Toe touch weight bearing was allowed in the postoperative period with walker support and progression to partial and full weight bearing potential on clinic-radiological assessment.

DISCUSSION

Despite advances in the techniques for operative intervention and fixation for ankle fracture management the post-operative immobilization with the cast has generally remained the same. Cast immobilization has been an integral component of ankle fracture management for support and immobilization.[3,6,13]

The cast application is not about application alone but needs close observation for any complication.[14] The technique for offloading of the cast for calcaneal fractures or diabetic foot utilizing metal stirrups, posterior stirrup, or tongue shaped splintage have given satisfactory results.[15,16] The proper padding during application of fiberglass cast avoids skin irritation and associated complications.[10] The improper application may cause pressure sores and thermal injuries.[7,10,17-19]

Surgeons have relied on the time-tested application of gypsum cast for post-operative immobilization.[20] However, the bulkiness of cast, the weight of cast and frequent loosening were areas of concerns with gypsum cast requiring change of cast.[3,10] The wet cast also acts as a blotting paper with abnormal blood staining of the cast which may erroneously aggravate the patients' psychological dilemma for a bleeding concern and an abnormal feeling of a continuous loss of blood in the immediate post-operative period. There are high chances of cast breakage with inadvertent weight bearing or abnormal posturing during post-operative mobilization or toilet activities.[10]

The material of choice for casting remains the traditional gypsum plaster cast as it has excellent skin conformability, low cost and easy availability.[19] The fiberglass cast which was originally developed by Solar Laboratories firm from California, US was further developed by Merck, Sharpe and Dohme in 1973.[21] It has undergone further refinements to a 3rd generation fiberglass cast.[19] The fiberglass cast has many advantages over a gypsum cast. The fiberglass cast was found to be superior to plasters in impact resistance, flexural strength and abrasion resistance.[21]

The fiberglass cast has an intrinsic property of low elastic modulus and wider range of elastic deformation.[22] The synthetic cast has smaller exothermic potential and it does not create dangerous temperatures during setting of plaster.[4] Casting with a cold-water dip fiberglass gives a prolonged cast cure time than the normal or hot-water processing of the cast.[23] It helps to reduce the frequent out-patient department visits and a rapid early rehabilitation protocol can be implemented.[3] This method may be also cost effective as it reduces the overall burden of hospital expenditure of the patient. Though, the initial cost of application may be more as compared to a gypsum plaster of Paris cast.[9]

The fiberglass cast allowed for a protected weight bearing potential of varying intensity depending on the type of fracture, stability of fixation, associated medical comorbidities, and psychological status.[8,13] The relative contraindications for the immediate protected weight bearing include syndesmotic injury, polytrauma, ipsilateral or contralateral limb injury, plafond fractures, compound injury with bone loss, and psychiatric moribund patient.[8] With the technique used, one advocates immediate post-operative ambulation with walker support. Toe touch walking for the initial two to three weeks and subsequently after clinic-radiological assessment, progression to partial weight bearing for next four weeks and full weight bearing after radiological assessment of union. The fiberglass cast generates higher intra-cast pressures than gypsum cast.[14] There are various methods used to study and identify the pressure over the operated limb after a plaster application. The use of the modified

Sengstaken-Blakemore tube connected to manometers has been done for pressure evaluation in a cast or a slab in the immediate post-operative period.[11] The cotton wool normally tends to accommodate the swelling. The maximum swelling increase in the ankle region has been noted in the initial two hours after surgery. The issue of edema induced skin pressure within a fiberglass cast has been an area of concern when applied in the immediate postoperative period.[14]

A study on short arm cast was conducted to document the skin pressure effects of fiberglass cast application and methods to reduce the tension were studied.[24] The authors concluded a significant reduction of pressure by cast bivalve, spread and soft-roll cut and cautious use of Ace wrapping.[24] The disadvantage of losing the reduction was discussed in their study. The univalve split plaster cast technique was advocated for postoperative immobilization following an ankle surgery providing an advantage to allow and accommodate for the immediate postoperative swelling while maintaining surgical correction and alignment with plaster of Paris cast material.[9] Splitting of cast has been shown to relieve pressures by 65%.[25]

A biomechanical study on the effect of valving of the fiberglass cast for upper extremity swelling after surgical procedure was done.[26] They had concluded that the structural integrity of fiberglass cast was compromised and altered by valving. The study demonstrated significant decrease in bending stiffness and load of failure of fiberglass casts with both the univalve or bivalve technique.[26] The alleviation of pressure in a situation of significant compartmental pressure syndrome may warrant cast removal and it should be done and advocated even at the expense of cast integrity. The author's personal choice has been to change the plaster instead of cast bi-valving, and do the removal of cotton, wound inspection and reapplication of fiberglass cast if any need arises. A clinical prospective randomized study will further empower the efficacy of the cast application procedure.

Functional bracing of unstable ankle fractures has less definitive evidence.[27] Alternate option of functional ankle bracing for operated ankle injuries have been considered to allow for an active and passive ankle range of motion exercises.[1] However, the early post-operative wound complications are increased as compared to cast immobilization with functional brace.[5,20,27] Though, the long-term functional outcomes are similar.[1]

The development of a 3D technology printed fabricated casts has added a new unexplored dimension. The 3D printed casts are open lattice, ventilated designs and anatomically accurate.[28] A custom fit immobilization may provide even pressure distribution during the entire treatment period.[7] Studies on forearm fracture immobilization by 3D printed cast gave equitable to better treatment experiences with favorable efficacy.[7,28]

CONCLUSION

The fiberglass cast in the immediate postoperative period for an appropriately identified indication can be judiciously used after an ankle surgery. The careful observation for any impending compartment syndrome will allow an uncomplicated recovery. The clinical impact with its positive and negative aspects remains an area of further research. The postoperative cast application remains a "surgeon's art" based on the scientific knowledge.

Recommendations

Adequate padding of the bony landmarks and the bony prominences. A uniform and even application of the gamzee padding. Splitting of roller padding at the anterior aspect of ankle region and protection with a gamzee pad. Heel protection with an extra gamzee pad for the cushioning of tendon Achilles region. Fiberglass cast should be applied with uniform pressure distally from toes to tibial tuberosity proximally. Holding the cast in desired position without pressure till it sets. When in doubt in view of any impending complications, plan removal, recheck and change of the cast. There can be no substitute to an astute clinical acumen foreseeing the hazards with a cast application. The early mobilization and wound complications go hand in hand and require careful assessment and an individualized approach for an operated ankle injury

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Tomar L, Govil G. Fiberglass cast application in immediate post-operative period after an ankle fracture surgery: review of safeguards. Int J Res Orthop 2024;10:1419-24.