

# Splinting Method for Preventing Thermal Injuries in Patients with Malleolar Fractures of the Ankle after Operative Treatment Performed Under Regional Anesthesia

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## Abstract

After performing open reduction and internal fixation (ORIF) for treating malleolar fractures of the ankle, surgeons typically use plaster splints during postoperative recovery of patients. Use of regional anesthesia during ORIF has been noted as a risk factor for burns in patients using plaster splints, possibly owing to inability to feel pain after undergoing regional block. We describe a successful postoperative splinting technique used for preventing thermal injuries in this patient population. We reviewed medical records of patients between 2011 and 2013 at our institution with malleolar ankle fractures who had undergone ORIF under general anesthesia, peripheral nerve block, or a combination of both. Patients without follow-up were excluded; therefore, 154 were included. No thermal injuries were noted, operative reduction of the fracture was maintained, and the cost of each splint was \$13.19. Use of the current technique in applying plaster splints may help effectively prevent postoperative thermal injuries.

## Introduction

Use of plaster splints in patients immediately after performing open reduction and internal fixation (ORIF) for treating malleolar fractures of the ankle is common and can help maintain alignment of the bone, protect the lower extremity during weight bearing, and improve the healing of soft tissues.<sup>1</sup> However, complications associated with use of plaster splints have included compartment syndrome owing to tight circumferential placement of the splint and pressure spots resulting in breakdown of the skin.<sup>2</sup> In particular, skin burns have been commonly reported in patients using plaster splints at temperatures as low as 40°C,<sup>3-6</sup> which result from an exothermic reaction

between the plaster material and water.<sup>7,8</sup> Gannaway and Hunter<sup>1</sup> noted increased risk for thermal injuries in patients with soft-tissue injuries, compromised vascular or neural structures, and postoperative changes in the ankle.

Notably, patients placed under regional anesthesia during operative treatment have been described as at risk for thermal injuries, possibly caused by the inability to feel issues with splints owing to altered sensation in the skin, which can persist for several hours postoperatively.<sup>2,9</sup> At our institution, patients typically receive regional anesthesia with ORIF in an attempt to reduce high levels of postoperative pain associated with malleolar ankle fractures.<sup>9-11</sup> We describe use of a successful technique for postoperative splinting in preventing thermal injuries in patients with malleolar ankle fractures who had undergone ORIF under regional anesthesia.

## Technique

Approval from our Human Research Review Committee was obtained for this study (HRRC #15-186). A retrospective chart review of patients who underwent ORIF for treatment of malleolar ankle fractures between 2011 and 2013 was performed. Type of anesthesia administered (ie, general or peripheral nerve block) and development of any thermal-related skin complication or loss of alignment requiring revision treatment were noted. Patients without postoperative follow-up were excluded from the study; subsequently, 154 patients were included, aged 19 to 68 years.

Before undergoing ORIF, each patient had received intravenous sedation followed by peripheral nerve block, in which sterile preparation was performed. Results of ultrasound were used to visualize the nerve to be blocked and avoid intraneural injection. Patients who would receive calf tourniquets during ORIF were placed in the

supine position, in which the injured leg was elevated on a pillow and flexed at the knee. In patients for whom thigh tourniquets were planned during ORIF, patients were placed in lateral position, with the sciatic nerve visualized inferior to the gluteal fold. General anesthesia was occasionally used as an adjunct to the nerve block, depending on the judgment of the anesthesiologist, patient request, and patient comorbidities. Patients who did not receive general anesthesia received sedation analgesia in addition to the peripheral nerve block.

After each patient underwent ORIF under regional anesthesia, a splinting technique was applied on the affected lower extremity (Figure 1). One non-adherent Telfa bandage (Covidien, Mansfield, MA) was placed over the closed surgical incision. Held in place using a roll of sterile 10.2-cm (4 in) Webril, an abdominal pad was placed over the incision and another was placed dorsally across the ankle joint. The hip was flexed to allow 90° of flexion at the knee, relaxing the gastrocnemius complex to achieve a neutral position of the ankle. A layer of bulky cotton was rolled from the tip of the big toe proximally to the tibial tubercle and secured with 14.2-cm (6 in) cotton Webril. A 10-ply strip of 12.7- by 76.2-cm (5 by 30 in) plaster was cut to the appropriate length and placed on the posterior leg, extending from 5.1 cm (2 in) distal to the popliteal fossa to the tip of the big toe. Plaster was dipped into room-temperature water and wrung to remove excess liquid. The wet plaster was placed over the cotton Webril to keep the Webril at 5.1 cm below the popliteal fossa, allowing the knee to flex. Excess plaster proximally and distally was removed with scissors. A separate 5-ply strip of 12.7- by 76.2-cm plaster (to be used as a stirrup) was dipped into water and wrung. The apex of the stirrup was centered over the plantar aspect of the foot, overlying the dorsal plaster strip. Elastic bandages of 10.2 and 14.2 cm were used to cover the distal and proximal aspects of the splint, respectively. The splint was held in place until the material hardened, with the ankle in a neutral position. The leg remained uncovered for a minimum of 30 min, elevated on a folded blanket set atop a pillow. In general, excess plaster material was removed and the plaster was never placed directly on the skin. Cost per plaster splint was \$13.19.

Of the 154 patients, none were found to have thermal injuries at any postoperative visit. Additionally, none of the patients required a return to the operating room owing to loss of alignment while in the postoperative splint. Before undergoing ORIF and subsequent splinting, a total of 137 patients had received peripheral nerve block alone or a combination with general anesthesia, and 17 patients had received general anesthesia. Most patients (110) were treated at outpatient clinics, and all patients were operatively treated using a thigh or calf tourniquet (Table 1).



**Figure 1.** Result of the current technique used for applying a postoperative plaster splint on one of the 154 patients who underwent open reduction and internal fixation under regional anesthesia for treating malleolar fractures of the ankle. Notably, excess plaster material was removed (ie, not folded back on itself) and the plaster was not placed directly on the skin.

**Table 1.** Demographic and clinical variables for 154 patients who underwent open reduction and internal fixation with anesthesia for treating malleolar ankle fractures between 2011 and 2013

Variable	Patients (n = 154)
Male	87
Female	67
Location of operative treatment	
Inpatient clinic	44
Outpatient clinic	110
Type of anesthesia administered	
General anesthesia	17
Peripheral nerve block	57
Combination of both	80
Placement of tourniquet	
Thigh	134
Calf	20
Anatomical structure treated	
Lateral malleolus	31
Medial malleolus	28
Medial and lateral malleoli	55
Syndesmosis	7
Lateral malleolus and syndesmosis	20
Medial malleolus and syndesmosis	2
Medial and lateral malleoli and syndesmosis	6
Medial, lateral, and posterior malleoli	3
Medial, lateral, and posterior malleoli and syndesmosis	1
Lateral and posterior malleoli	1

## Discussion

Use of a plaster splint in patients who underwent ORIF for treating malleolar ankle fractures is common and has been shown to help improve postoperative function of the injured ankle.<sup>1</sup> However, complications such as burn-related injuries to the skin have been noted, and risk indications such as patients who underwent regional anesthesia during ORIF have been discussed.<sup>2,9</sup> In the current study, a total of 154 patients administered regional anesthesia during ORIF were successfully treated postoperatively using the described plaster splint technique, in which no patient developed burns or loss of alignment of the bone.

More recently, an *in vivo* study reported significant increases in skin temperature after exposed to prolonged periods in plaster splints, which may emphasize the importance of technique used in minimizing risk for thermal injury.<sup>12</sup> Studies have described technical variables that affect skin temperature, including plaster thickness and orientation, amount of cotton used in the plaster, and use of pillows and blankets.<sup>13</sup> Notably, in the current study, excess plaster material was removed (ie, not folded back on itself) and the plaster was not placed directly on the skin.

Results of the current study may reveal use of a safe and cost-effective technique for applying postoperative plaster splints to prevent thermal injuries in patients who underwent ORIF and received peripheral nerve block.

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## Conflict of Interest

The authors report no conflicts of interest.

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