A Room Temperature Vulcanizing Silicone Rubber Sport Splint

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Athletic hand and wrist injuries may be treated by immobilizing the affected extremity in a rigid splint to protect the injury site for an extended time period. For athletes, this means a reduction in playing time, perhaps being out for an entire playing season. High school football rules no longer restrict players from wearing any type of hard nonyielding splint distal to the elbow (National Federation of State High School Associations, 1994). This regulation makes wearing splints fabricated from plaster of Paris or high-temperature thermoplasts legal during participation in an official game. There are, however, some splinting materials that may be viewed as having more desirable properties when splints are to be used during athletic participation. These materials include Scotchrap™ (Farley & Sublette, 1992; Sadler & Koepfer, 1992), Scotchcast™ (Billotti, McKeag, & Menkes, 1993), low-temperature thermoplasts (Sadler & Koepfer, 1992), and room temperature vulcanizing (RTV) silicone rubber (DeCarlo, Darmelio, Rettig, & Malone, 1992; Robinson, 1992; Sadler & Koepfer, 1992). Current comparable RTV silicone rubber products on the market include RTV11 and 3110 RTV.

Although most leagues accept playing splints made of RTV11 silicone rubber compounds (Sadler & Koepfer, 1992), it is necessary to have documentation from a physician stating the need to use this type of playing splint. Playing splints made of this material are effective immobilizers of excessive undesired movement, yet maintain enough flexibility to prevent further injury to the injured player and other players. This protection is further enhanced when the splint is lined with foam padding. RTV11 silicone rubber, when used in the treatment of hand and wrist athletic injuries, may allow for a safe, expedient return to daily life activities for the high school athlete.

Although various techniques and methods of fabrication have been reported in the literature (DeCarlo et al., 1992; Robinson, 1992), we have refined the fabrication methodology in four ways: (a) using Tubigrip® instead of stockinette or prewrap to cover the forearm for protection of the skin from the RTV11 compound, (b) preparing precise amounts of the splinting mixture rather than mixing half the base and half the kit catalyst agent, (c) precisely adding a fast curing agent at a higher concentration to increase the curing rate, and (d) using Coban™ wrap.
instead of thermoplastic materials as supportive materials between splinting layers. These modifications have enhanced the manageability, efficiency, and precision of the fabrication process. This article describes the fabrication of a protective sport playing splint using RTV11 silicone rubber compounds for hand and wrist athletic injuries.

Silicone Rubber

Both the two-component RTV11 and 3110 RTV silicone rubber base material and catalyst agent are supplied in matched kits. The kits are premeasured in a 100:1 or 10:1 base to catalyst agent ratio by weight. The kit catalyst agents for the RTV11 and 3110 RTV are dibutyl tin dilaurate and catalyst #4, respectively. If the entire kit is to be used, the catalyst agent may be poured directly into the base material without being weighed. However, when less than the full kit is used, both base material and catalyst agent must be measured or weighed to ensure proper blend ratio. The catalyst agent causes a chemical reaction that results in curing the base material. Manufacturers can give information about additional types of catalysts available.

The proportion and type of catalyst selected will determine the cure rate. Hence, changing the base to catalyst ratio varies the curing rates. For a fast curing rate, the recommended catalyst is liquid stannous tin octoate at a concentration range of 0.1%–0.6% (M. John, personal communication, August 23, 1993). A measuring guide for the base material to catalyst agent mix ratio appears in Table 1. A direct relationship exists between the catalyst concentration and curing rate; that is, a higher concentration of catalyst causes a corresponding decrease in curing rate. An inverse relationship exists between the catalyst concentration and working time; that is, a higher concentration of catalyst causes a corresponding decrease in working time.

Indications for Use of RTV Silicone Rubber

Indications for use of RTV silicone rubber as a soft-support, protective splinting material may include upper extremity stable fractures such as carpal, metacarpal, distal radial, and distal ulnar fractures. Other indications are collateral ligament sprains and hand, wrist, and forearm contusions (DeCarlo et al., 1992; Sadler & Koepfer, 1992).

Materials and Supplies

The following materials and supplies are needed to complete the orthotic fabrication process (see Figure 1).

- Towel, or paper towels, and gowns

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Measuring Guide for RTV11 Silicone Rubber Base Compound Weight to Stannous Tin Octoate Catalyst Agent Concentration</th>
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</thead>
<tbody>
<tr>
<td>RTV11</td>
<td>Stannous Tin Octoate Concentration (cc)</td>
</tr>
<tr>
<td>Weight (cc)</td>
<td>0.1%</td>
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<tr>
<td>60</td>
<td>.06</td>
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<td>120</td>
<td>.12</td>
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<td>480</td>
<td>.48</td>
</tr>
<tr>
<td>540</td>
<td>.54</td>
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Note: The approximations in the table are to be used as a guide when determining the base material to catalyst agent mix ratio. 60 cc = 2 oz.; 1 ml = 1 cc; 16 oz = 1 lb = 454 g.

- Disposable single-use latex gloves
- 7.0 cm (2.75 in.) Tubigrip® elasticized tubular bandage, 38.1 cm (15 in.) in length
- 5.1 cm × 105.1 cm (2 in. × 65 in.) Sof-Kling™ conforming bandage; 1–2 rolls
- 5.1 cm × 457.2 cm (2 in. × 180 in.) self-adhesive Coban® wrap; 2 rolls
- 500 cc emesis basin
- Four to six 14 cm (5.5 in.) long Chieftain® tongue blades
- Bandage scissors
- 25 mm × 9.1 mm (1 in. × 10 yd) Transpore® surgical tape
- 60 cc (2 oz.) catheter tip syringe
- 3 cc 21 gauge .8 mm × 40 mm syringe and PrecisionGlide® needle
- One 454 g (1 lb) RTV11 silicone rubber kit
- 113.5 g (4 oz.) bottle of stannous tin octoate catalyst
- 1 cm × 40.6 cm × 61 cm (3/8 in. × 16 in. × 24 in.) self-adhesive contour foam, blue medium density


Manufactured by Johnson and Johnson Medical Inc., Arlington, TX 76004-0150.

Manufactured by 3M Health Care, 3M Center, St. Paul, MN 55144-1000.

Manufactured by Premium Plastics Company, 465 West Germak Road, Chicago, IL 60616.

Manufactured by American Hospital Supply Division of American Hospital Supply Corporation, 1450 Waukegan Road, McGaw Park, IL 60085.

Manufactured by Smith & Nephew Rolyan, N93 W 14475 Whitaker Way, Menomonee Falls, WI 53051.

Manufactured by 3M Health Care, 3M Center, St. Paul, MN 55144-1000.

Distributed by Becton Dickinson and Company, Franklin Lakes, NJ 07417-1884.

Distributed by Becton Dickinson and Company, Rutherford, NJ 07070.

Distributed by Smith & Nephew Rolyan, N93 W 14475 Whitaker Way, Menomonee Falls, WI 53051.
Figure 1. Materials required for silicone rubber splint fabrication. Top row (left to right): latex gloves, Tubigrip®, Sof-Kling™ conforming bandage, self-adhesive Coban™ wrap, 60-cc syringe, 3-cc syringe. Middle row (left to right): emesis basin, tongue blades, Transpore™ tape, bandage scissors, RTV11, stannous tin octoate catalyst. Bottom row (left to right): self-adhesive contour foam, prewrap, Conform™ tape, trainer’s tape, elastic bandage.

- 7.0 cm (2.75 in.) prewrap
- 5.1 cm (2 in.) Conform™ tape
- 3.8 cm (1.5 in.) trainer’s tape
- 5.1 cm (2 in.) width elastic bandage: 1 roll.

Construction

1. The clinician and injured player should wear gowns to protect themselves from any RTV11 spillage that adheres to skin and clothing. The surface and mixing container in the work area should be clean and dry before use and towels should be placed on the work surface area. Once the container is opened, a pair of tongue blades taped together at one end can be used to mix the material to deaerate the RTV11 base compound.

2. A latex glove is then applied to the patient’s hand, followed by Tubigrip® to the patient’s forearm (see Figure 2). This prevents the silicone rubber mixture from adhering to the patient’s skin. The therapist should also wear latex gloves during the splinting process for the same reason.

3. The patient’s extremity is placed in a protected

Figure 2. Application of latex glove and Tubigrip® to injured site.

\(^{1}\)Available from Cramer Products, Inc., PO Box 1001, Gardner, KS 66030
\(^{2}\)Available from Bike Athletic Company, PO Box 606, Knoxville, TN 37901-0606
\(^{3}\)Available from Johnson and Johnson Consumer Products, 199 Grandview Road, Skillman, NJ 08558
\(^{4}\)Distributed by General Medical Corporation, Richmond, VA 23228
position on the table. The position of the extremity is determined by the nature and healing status of the injury.

4. A 60-cc syringe is used to draw 120 cc of the silicone rubber base material from the container and place it in an emesis basin. Bleeding the syringe in the can before drawing the base material decreases the amount of air trapped in the syringe and reduces the likelihood of inaccurate measurements. The tongue blades are used to slowly stir the material to deaerate. When the material is smooth, a 3-cc syringe is used to transfer and slowly add 0.50 cc (i.e., 0.4% concentration) of stannous tin octoate catalyst to the emesis basin containing the base material. Again, bleeding the 3-cc syringe in the stannous tin octoate bottle before extracting the catalyst reduces the amount of unwanted air bubbles in the syringe. Stirring thoroughly with the tongue blades thickens the mixture. This amount of splinting mixture is sufficient for one layer of the splint.

5. The mixture should be applied to the patient’s arm; the tongue blades can be used to evenly spread it over the surface being splinted (see Figure 3). It may be helpful to have an assistant help spread the mixture evenly, due to the rapid curing rate. The patient may need to alter his or her position during this process to allow even coverage of the injured surface.

6. After the first layer of splinting mixture has been applied, the surface should be wrapped with a layer of Sof-Kling™ bandage. Without overstretched the bandage, one full wrap should be applied and overlapped. When overlap wrapping, tension should be applied only to obtain the desired compression in a proximal to distal direction. This layer must be applied before the previous layer of splinting mixture has cured, to ensure bonding of the two materials.

7. A second and third layer of splinting mixture are applied in the same manner, alternating with a layer of Coban™ wrap between the splinting layers (see Figure 4). The wrap is overlapped during wrapping as discussed in step 6. The outermost layer of the finished splint is Coban™ wrap. It takes approximately 5 to 10 min to measure, mix, apply, and wrap one layer of silicone rubber mixture. Any excess silicone rubber compound mixture left on the towel should be applied to the outer Coban™ wrap layer.

8. The splint is allowed to set on the patient’s arm for 15 to 30 min before removing (see Figure 5).

9. When the splint is set (it will feel slightly tacky to touch), it should be removed by cutting the splint with bandage scissors in a single line, along the opposite border of the site of the patient’s injury (see Figure 6). Removal over the radial and ulnar styloid process may be uncomfortable for the patient, so special care is required when cutting in these areas.

10. The splint is allowed to dry for an additional 30 to 45 min.
11. The latex glove and Tubigrip®, if they are attached to the inside of the splint, are removed and excess or uneven borders are trimmed with the bandage scissors. The splint is now cured (see Figure 7).

12. A layer of self-adhesive contour foam padding is applied to the exterior of the splint (see Figure 8). Excess foam is trimmed from the splint’s borders and the splint is wrapped in an ace bandage for 15 min to ensure proper adhesion of the foam padding to the splint. The splint is now ready for wearing. To secure the splint during competition, the athletic trainer may employ one of the following two methods: (a) wrap it with prewrap to protect the splint, followed by Conform® tape and trainer’s tape, or (b) wrap it with an elastic bandage followed by trainer’s tape.

Discussion

Occupational therapists need to be knowledgeable about new splinting materials available as well as flexible, creative, and responsive to the individual needs of the patient (Breger-Lee & Buford, 1992). The elastic, protective qualities of the RTV11 silicone rubber playing splint make it an appropriate solution for occupational therapists working with orthopedic athletic hand and wrist injuries. The splint provides continued support to the injured site and acts as a shock absorber upon contact with other players. The use of this material is a viable way to facilitate the young athlete’s return to one aspect of daily life activities, the athlete role. With a physician’s referral, this method of splinting might be considered and applied as part of treatment.

We do not advocate using the silicone rubber playing splint in lieu of a rigid splint during the bone healing phase of fractures. However, once there has been sufficient radiographic evidence of bone healing, the RTV11 type of playing splint may be worn during an official game to allow the athlete legal playing status. The splint can be used for an entire season if needed. However, because RTV11 is nonporous, it must not be used as a permanent splint. The splint should only be worn for a maximum of 4 hr at a time and should be removed after practice or competition. When the player is not participating, a thermoplastic splint held in place with hook and loop fastener or a bivalve fiberglass cast should be worn if indicated.

We have used both stockinette and Tubigrip® as the initial layer over the patient’s forearm when making the splint. Because the Tubigrip® is thicker than the stockinette, it decreases permeability of the silicone mixture through the material, which in turn minimizes adherence of the mixture to the skin surface. We prefer to use Tubigrip® instead of stockinette because it provides greater comfort to the athlete during the initial removal of the splint.

These changes in the fabrication method make fabrication more manageable and efficient. The mixing of precise, separate layers of RTV11 allows for greater control of the base and catalyst mixture during each step. In addition, the accelerated curing rate facilitates the fabrication
efficiency because it decreases the total fabrication time to about 10 to 20 min while the curing rate is decreased to 15 to 30 min. The accelerated curing rate is made possible because accurate measurements of higher concentration of catalyst agent to base material can be made with the measuring guides shown in Table 1. The use of Coban™ wrap instead of thermoplastic material also facilitates fabrication. Coban™ wrap conforms more easily than thermoplastics, therefore reducing the application time of the support material. Another advantage of Coban™ over thermoplastics is that it is less rigid but still provides adequate additional support to the splint.

During the 1993 football season, several high school athletes wore the RTV11 silicone rubber playing splint during official games. One was a 17-year-old right-handed linebacker who injured his right wrist in a game when he suffered a direct hit with a helmet. The radiographic film showed an avulsion fracture of the ulnar styloid. A short arm fiberglass cast was applied for 3½ weeks. At this time, the physician recommended a silicone rubber protective playing splint because healing had progressed adequately. An RTV11 silicone rubber splint was fabricated for him and he used it to play for the entire 3-month season without reinjury. Upon follow-up at the end of the season, radiographic studies indicated that the patient’s ulnar styloid fracture had healed even while he was playing with the splint.

A second athlete, a 17-year-old right-handed defensive back and flanker, injured his left thumb when breaking up a pass during a game. The radiographic film showed an extra-articular fracture of the thumb metacarpal with minimal angulation. A thumb spica splint was applied for 3 weeks. Upon physician referral, a RTV11 silicone rubber playing splint was fabricated for him at 3 weeks postinjury to allow him to participate in the playoffs. At follow-up 6 weeks postinjury, radiographic studies indicated that the patient’s metacarpal fracture had healed while he was using the RTV11 splint during the playoffs.

Summary

The use of the RTV11 silicone rubber compound allows for a playing splint that complies with athletic regulations. Proper application of the RTV silicone rubber provides an excellent, reliable protective playing splint allowing for functional athletic performance of the injured player during the game. The RTV11 method presented allows the playing splint to be fabricated and ready for use within 2 hr. The main reasons for keeping within this time frame are the preparation and application of separate RTV11 layers and the ability to use a fast-curing agent such as stannous tin octoate at a high concentration. Use of the RTV11 silicone rubber playing splint enhances an expedient, safe return of the high school athlete to the playing field.

Acknowledgments

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References