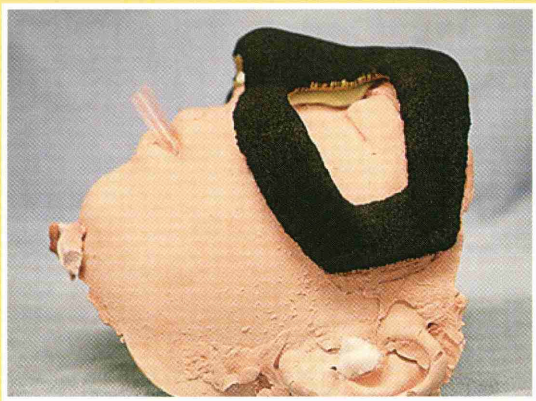


Fabrication Technique for Custom Faceguard with Thermoforming Material

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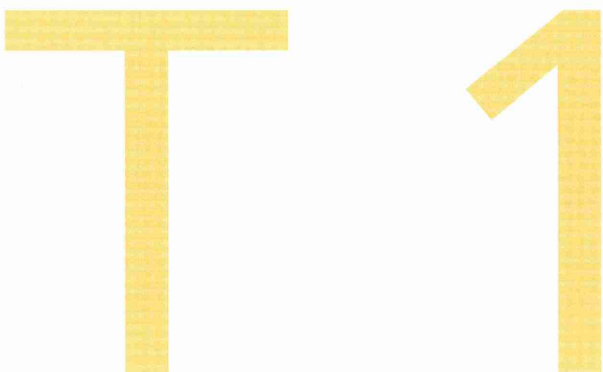


Key words: face guard, maxillofacial injury, mandibular fracture, thermoforming material, facial moulage

Abstract:

Faceguards are well-known protective gear that shield against the maxillofacial traumatic injuries during exercise and sporting activities. Recently, custom faceguards have been introduced as protective equipment for those who return early to play after surgical treatments for maxillofacial injuries such as

nasal bone, zygomatic arch, frontal bone and mandibular fractures. However, there are few reports that illustrate the step-by-step technical points of custom faceguard fabrication. This article comprehensively illustrated the technique of custom faceguard fabrication with thermoforming and soft cushioning materials on a facial cast.



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Introduction

The faceguard (FG) is well-known protective gear that shields against the maxillofacial traumatic injuries during exercise and sporting activities. In recent years, custom FGs have been introduced as protective equipment for those injured participants who return early to play after surgical treatments for maxillofacial injuries such as nasal bone, zygomatic arch, frontal bone and mandibular fractures.¹⁻⁷ In fact, soccer and rugby football players who often sustain maxillofacial injuries use custom FGs to protect their affected areas. The Laws of the Game of Federation Internationale de Football Association (FIFA) have already been modified to permit the use of modern protective equipment such as headgear, facemasks, knee and arm protectors made of soft, lightweight and padded material, because such equipment is not considered to be dangerous.⁸

Even though the demand for custom FGs is expected to grow, there are few reports in published literature that illustrate the detailed technique for custom FG fabrication. This article describes, step by step, the technique for custom FG fabrication with thermoforming and rubber cushioning materials on a cast obtained from a facial moulage.

Fabrication technique

1. Make a facial moulage with an irreversible hydrocolloid impression material (Aroma Fine DF III™, GC Co. Tokyo, Japan) and an impression plaster material (Xanthano™, Bayer Dental Co., Leverkusen, Germany) (Fig. 1-1-4). Place a straw in the patient's mouth to maintain proper air ventilation during the impression procedure. To ensure adequate flow of the hydrocolloid, the volume of water should be twice the amount

(40mL) of the recommended power-to-water ratio (8.4g: 20mL) by the manufacturer. Place the hydrocolloid material over the surface of the face; before it sets, lay cotton and/or gauze on top of the hydrocolloid to facilitate binding to the backing material. Then place the impression plaster over the hydrocolloid and cotton.

2. Measure the girth of patient's head with a tape.
3. Pour the moulage with Type IV dental stone (Fujirock™, GC, Tokyo, Japan) to make the facial cast.
4. Draw the outline of the FG on the cast. Fig. 2 shows the outline of a FG which is commonly used to protect nasal bone, zygomatic arch or frontal bone fractures. It is critical to leave the eyes uncovered to avoid narrowing the field of vision. To protect from a mandibular fracture, the FG should cover the body of mandible completely, the ramus and extend to the condylar head and the coronoid process bilaterally (Fig. 3).
5. To provide adequate space between the FG and the injured area, cover the injured area on the facial cast with a layer of plaster or silicone material for dental laboratory use (Lab Silicone™, Shofu Inc., Kyoto, Japan) approximately 5mm thick (Fig. 4). A sheet of 3.2mm thick thermoplastic material (Aquaplast™ splinting material, Sakai Medical Co., Tokyo, Japan) is softened in a hot water bath at 70-75 degrees Celsius for a few minutes. Then the softened material is applied and molded over on the cast with light finger pressure (Fig. 5).
6. After the material has cooled down, trim it to the desired outline drawn on the cast with a pair of arts and crafts scissors, then finish and polish with fissure bars, tungsten carbide bars and polishing discs.



Fig. 1-1-4 Facial moulage with irreversible hydrocolloid impression material and impression plaster material.

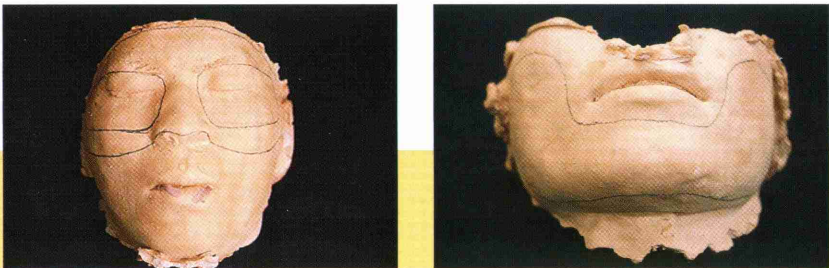


Fig. 2 Outline of the FG in a case of nasal bone fracture.
Fig. 3 Outline of the FG in a case of mandibular fracture.



Fig. 4 Mold the thermoplastic material on the facial cast.



Fig. 5 Cover the injured area on facial cast with a silicone material to provide space between the FG and the injured area.
Fig. 6 Attach rubber cushioning materials on surfaces of thermoplastic material.

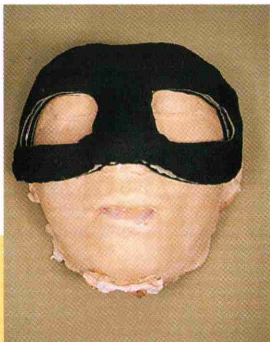


Fig. 7 Sew the edges of cushioning liner materials to the FG.
Fig. 8 Posttreatment, 18 year-old male patient wears a custom FG to protect the injured nasal bone area.



7. Use adhesive (Aronalpha™ superglue, Toagosei Co. Ltd., Tokyo, Japan) to adhere 3.2mm- and 1.6mm-thick rubber cushioning materials (Neoprene™ rubber cushioning material, Sakai Medical Co., Tokyo, Japan) to the inner and outer surfaces of the trimmed thermoplastic material from Step 6, respectively. The cushioning materials need to be trimmed as well (Fig. 6).
8. Sew the edges of the cushioning liner materials of FG with 5mm stitch width with a needle and cotton yarn (Fig. 7).
9. The FG is secured on the face of the patient using two stretch bands with the hook and loop fasteners (Velcro™ sew on tape, Velcro USA Inc., NH, U.S.A.) (Fig. 8).

Discussion and Summary

This technique described here offered several advantages compared to previous reports^{1, 3, 7} on the FG fabrication methods. First, the direct method to form the FG on the patient's face can result in a poorly-fitted FG even with any type high-performance FG material because of soft tissue displaceability. In this respect, the indirect method of forming the FG on the facial cast is considered to have a better fit of the FG. The facial moulage can be made with precision impression materials which allows the dentist to customize a FG more accurately for each patient. The indirect technique is also more comfortable for the patient because it eliminates the need for the patient to withstand the prolonged time to form

and to finish his/her FG. Furthermore, since the working temperature of the thermoplastic material used in this fabrication technique is relatively low, the expensive vacuum and/or pressure thermoforming machines are not needed. This fabrication technique makes the specialized equipment and facilities unnecessary.

This custom FG design has a better shock absorbing quality. Namely, the combination of the hard thermoplastic material and the soft cushioning material yields an outstanding shock absorbing capability. According to previous research, this type of FG was measured to have 85-88 % of shock absorption when an impact load over 2,700 N was applied on the FG by a free-falling object.⁹ The impact absorption of the FG made with hard thermoplastic material only was 28 to 30 %. When adding the cushioning material on the outer surface of hard thermoplastic material, the impact absorption increased to 26 to 39 %, slightly better than without the cushioning material. It seems that lining the inner surface of the FG with cushioning material is significantly more effective in improving the shock absorption capability. The Laws of the Game of the FIFA indicated that the outer surface of FGs must be padded with soft material to avoid hurting other players. Thus, this custom FG design described here not only protects the injured player with inner lining of cushioning material but also contributes to improve the overall safety for all players by covering the outer surface of FGs with the same material.

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