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Head Positioner/Restraint for Children Undergoing Radiation Therapy

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INTRODUCTION

Immobilization in the delivery of radiation therapy is one of the most significant problems associated with treating the pediatric oncology patient. Children under the age of three are often uncooperative and afraid, rendering strict immobilization necessary. This becomes critical in the head and neck region, especially when treating around the eye, where precise lead block placement is imperative to protect unaffected tissue. A number of head positioning devices or molds are commercially available, but we have found that they either require complete sedation of the patient, or are not reproducible on a day-to-day basis. Sedation often becomes a daily, time consuming process that must be carefully coordinated for the child's safety, and to ensure they arrive ready for their scheduled therapy. In an effort to treat this group of patients accurately and avoid or limit the use of sedation, a total body restraint system was developed, utilizing a combination of commercial devices and a custom molded face mask.

FABRICATION

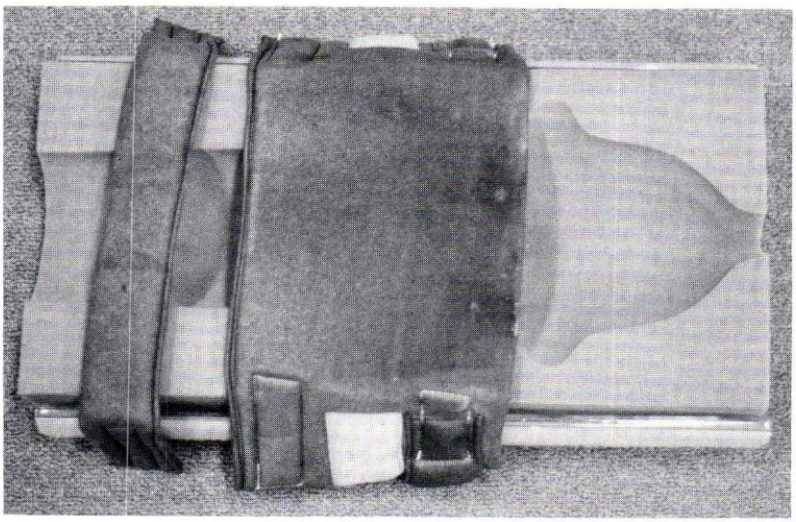
During the initial visit, the child is fitted to the appropriate size commercial components and an impression is taken of the head, neck, and sternum. In order to ensure accuracy of such a procedure it was felt necessary to sedate the patient, using Chloral Hydrate, to the point of sleep.

The child is first strapped into a Hugger®* for immobilization from the chest down. The Hugger® is a pediatric positioning aid used for radiographic exams (Figure 1). It consists of an acrylic base, foam insert with body shape relief, and Velcro® straps to aid in restraint. It is available in infant and child sizes. Since the head portion of the Hugger® was too general a shape for our purposes, it was cut off to allow room for a vinyl covered, firm foam head and neck support** (Figure 2).

*The Hugger is manufactured by Contour Fabricators, Inc., Grand Blanc, Michigan 48439.

**Head and neck support manufactured by Timo Industries, Pittsburgh, Pennsylvania 15230.

Figure 1. (right) The Hugger.



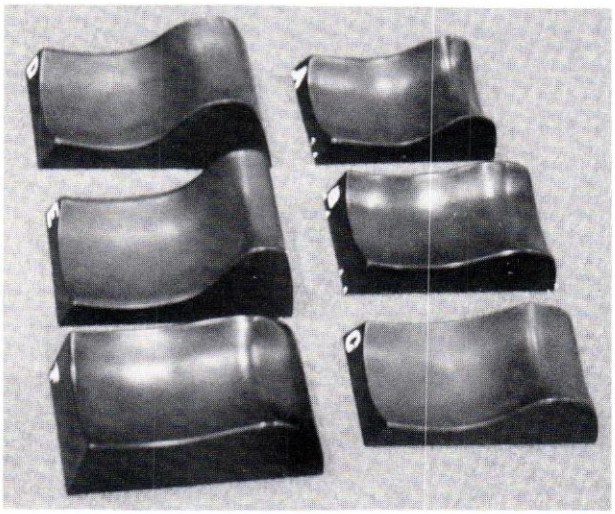
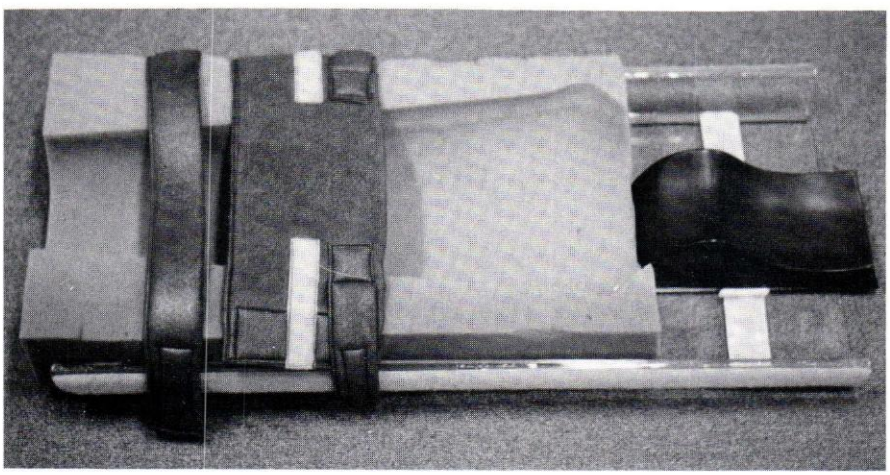


Figure 2. (left) Various sizes of head and neck supports.

Figure 3. (right) Modified Hugger with head and neck support in place with Velcro® straps.



Proper size should be utilized to insure accurate alignment of the head with the orbital meatal line perpendicular to the tratement table. The headrest should be at least as wide as the patient's head, otherwise removal of the impression is difficult. The base of the headrest is outlined on the acrylic base of the Hugger® and later secured with self adhering Velcro® straps to ensure consistent and secure positioning for every treatment (Figure 3).

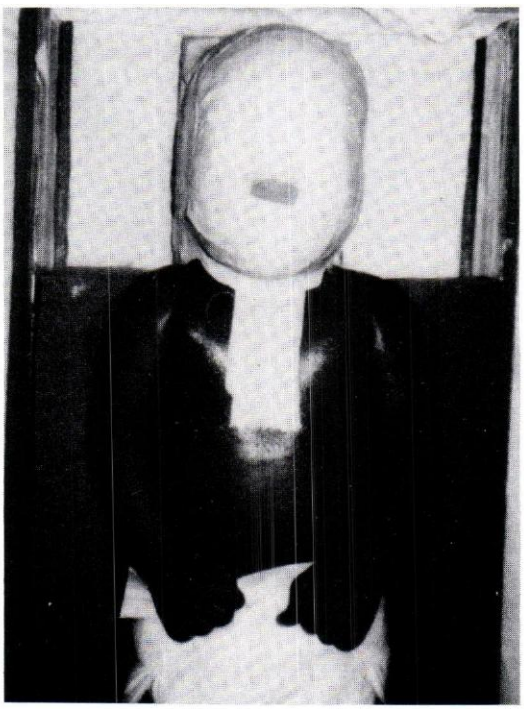


Figure 4. Sedated patient in position while impression is taken.

Once the head is resting in the desired treatment position, a detailed plaster of Paris negative impression is taken of the face, throat, and sternum (Figure 4) (other techniques, such as alginate or moulage might also be used).[1,2,3,4]

A nylon stocking is placed over the head to separate and protect the hair from the plaster. Petroleum jelly can be used on exposed skin and on the sides of the headrest. Details about the eyes, nose, and mouth are best molded by utilizing small strips of plaster bandage applied initially one layer at a time and carefully blended. A small air hole is left at the nostrils for breathing. To finish the impression, tangential strips of plaster bandage are run along the sides and crown of the head down to the acrylic base in such a manner that the sides of the headrest are intimately included. Care must be taken not to run the plaster around the posterior part of the head, but on a tangent from the head to the headrest, in order to facilitate easy removal of the negative impression without the need to cut it.

Once the negative impression is set, the child is placed in a sitting position and the headrest is removed. The stocking is then cut posteriorly and the cast is removed. A positive model is then poured, set, and smoothed of irregularities. A 3/16" low density polyethylene sheet is then vacuum formed over the model and allowed to cool. The completed immobilization system before fine detail modification is shown in Figure 5.

Polyethylene was chosen because it is easily vacuum formed, is translucent enough to pick up trim lines, and is flexible enough to allow easy application to the patient. It is also quite rigid once fully contained by the head and secured with straps. Low density polyethylene can also be cut with a sharp knife for detailed trimming outside the laboratory (Surlyn® may be a good choice of material for future masks, since it shares many of the qualities of low density polyethylene, plus it is transparent).

The mask encompasses the head and headrest down to an intersection with the Hugger® acrylic base. Inferiorly, the plastic extends across the chin and throat and down the sternum. The sternal extension allows smooth continuity across the throat and provides a point of attachment for straps inferiorly. Vents are cut to allow breathing through the nostrils, and an opening outlining the lips is helpful as a reference for proper positioning within the mask.

Openings are made on both sides of the mandible to allow manipulation of the jaw while applying the mask, and Velcro®

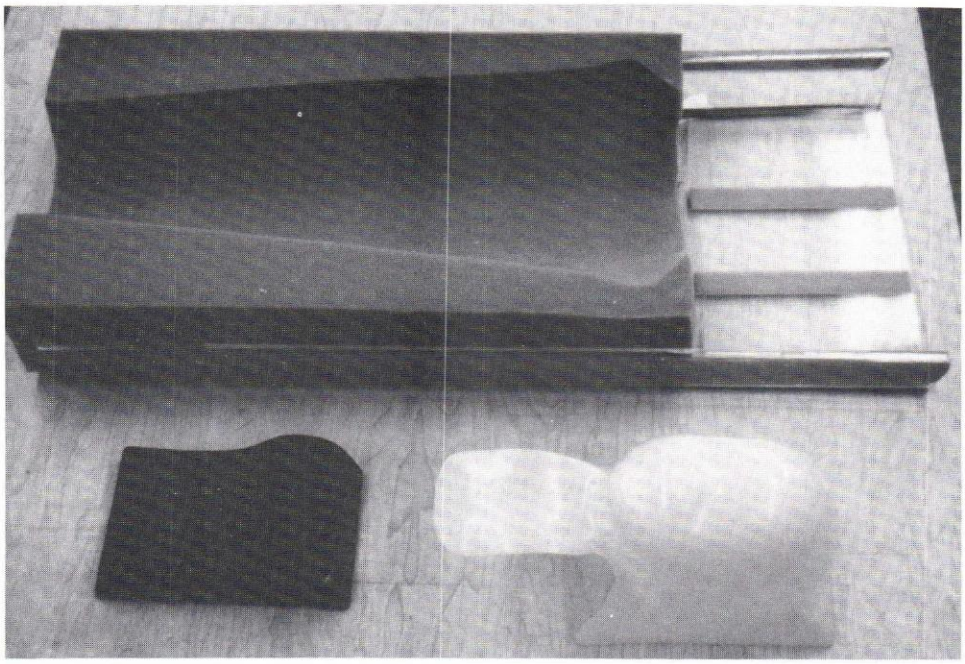


Figure 5. Three main pieces of the immobilization system before final fit.

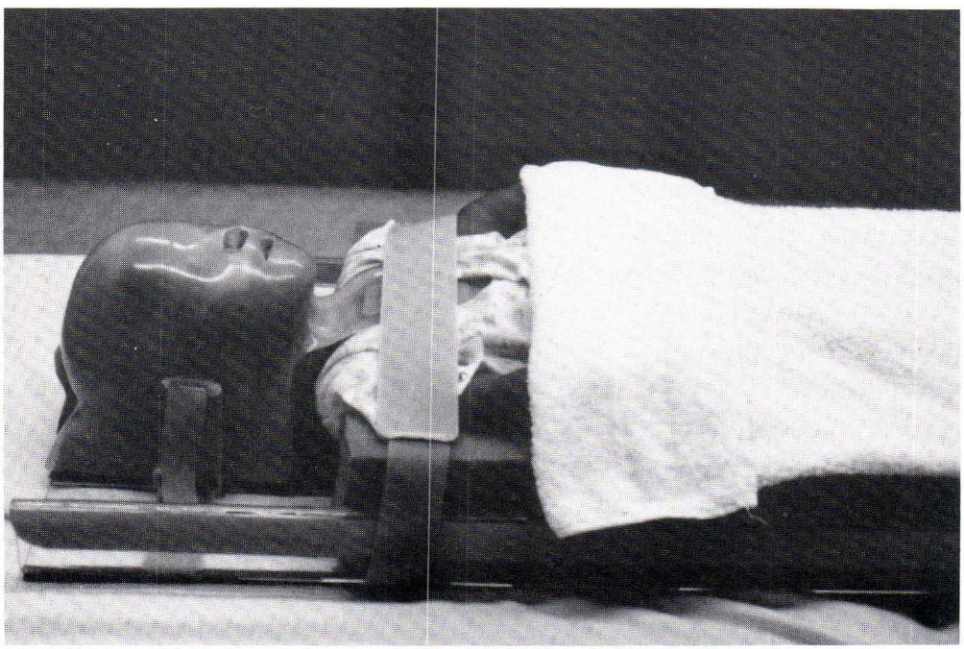


Figure 6. The positioning/restraint system on a patient.

straps are attached to the acrylic base and mask in such a manner as to firmly secure the two. Self adhering Velcro® can be used wherever necessary to maintain the integrity of the Hugger® and headrest for future normal use; metal fasteners are thereby avoided. The entire system in position on a child is shown in Figure 6.

With the restraint system fully constructed, the simulation and treatment planning process are initiated. Since these processes are lengthy, some sedation may be needed. Radiographs, measurements, and tumor volume are then defined. Normally, marks are placed on the skin to serve as consistent reference points; however, with the present system, these marks can be placed on the mask. Patient and family are thereby spared from a cosmetic and psychological point of view. This also helps in that patients do not lose their skin marks from perspiration or washing. When necessary, the shape of the treatment field is cut out of the mask to allow the radiation beam to pass through without losing skin sparing (Figures 7 and 8). After calculations and treatment planning are completed, the patient is ready to begin treatments. The treatments are re-created or set up exactly as outlined in the simulation.

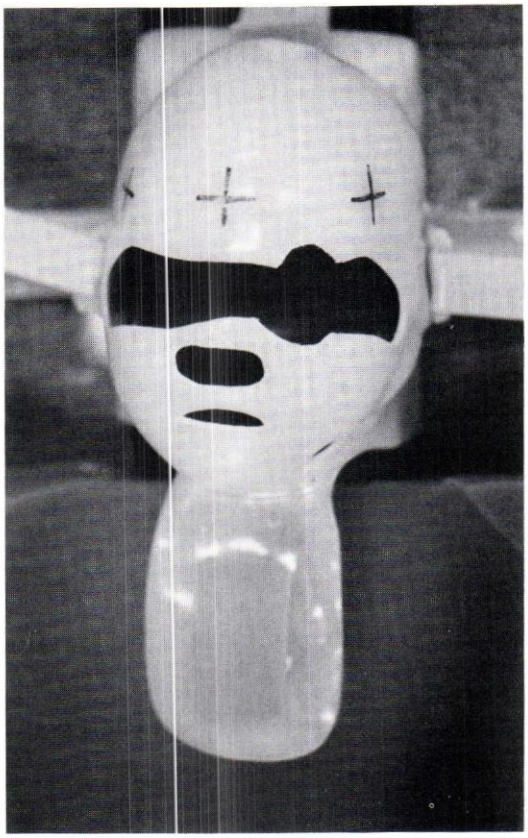


Figure 7. Close up of modified face mask.

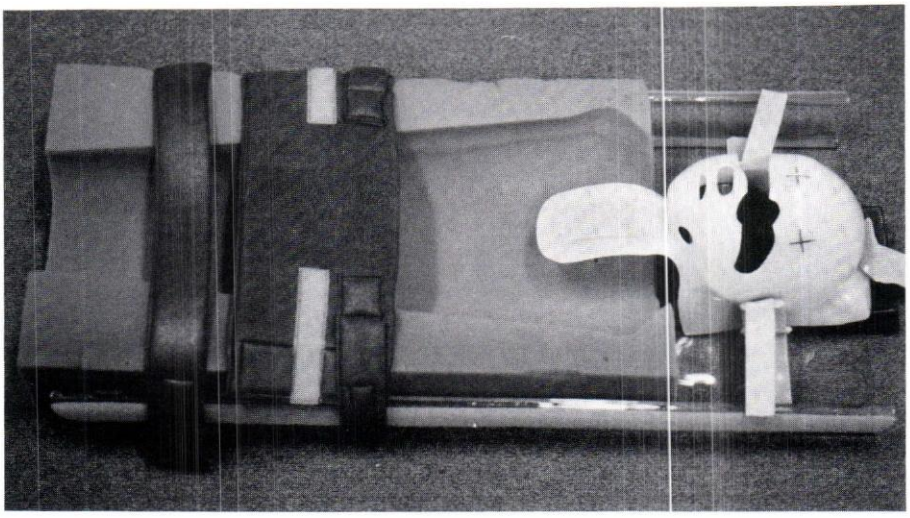


Figure 8. Immobilization system with treatment area cut out and reference marks on face mask.

DISCUSSION

Positioning/Restraint devices have been made for three children ranging in age from six months to two and one-half years. Two had the diagnosis of Ewing's Sarcoma, and the other had Retinoblastoma. All three children were very difficult to manage, afraid, and uncooperative.

Several advantages were noted throughout the course of treatments. Lateral opposed treatments could be utilized with ease due to the head being held in the straight supine position. Setup and treatment time was also minimal due to the patient's inability to move once positioned, thus avoiding any interruptions. In addition, in case of patient distress, the device can be easily and quickly removed, due to its simplicity and use of Velcro® straps. Portal films showed excellent reproducibility of the treatments with the use of the restraining system. The treated area needed mimimal adjustment, and, in all three cases, adjustments were needed only twice during the five and one half weeks of treatment. Each adjustment was 0.5 cm or less.

In summary, the total body restraint system with face mask is a practical and effective means of treating children undergoing radiation therapy. This is supported by the improved accuracy of delivering the radiation therapy and the need for minimal adjustments during the course of therapy. Marks made on the mask itself can be used for aligning the treatment beam instead of marking the patient's skin. Little or no sedation is necessary on a day-to-day treatment basis. Fewer interruptions saved a great deal of time and effort by everyone involved, thus making the system very cost effective and less traumatic to the patient and family.

AUTHORS

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