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Orthoses of ventilative plastics

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Abstract

Plastics are extensively used as a material for orthoses. However, one remaining problem is the ventilation of the orthosis. This is a real problem in countries such as Japan, where it is hot and humid especially in summer.

The authors have invented a new orthosis "POROPLAST", which is made of mesh plastic sheets, combined in a cross-like weave.

These orthoses provide good ventilation and are very comfortable to wear. They have been fitted to seventy-four cases with satisfactory results.

Introduction

Plastics are extensively used as a material for orthoses. One problem which remains is that of the ventilation of the orthosis. Conventional plastic orthoses with substantial areas of skin contact have sometimes produced skin problems, for example, skin break-down, contact dermatitis, or pressure sores. This is a real problem in countries such as Japan, where it is hot and humid especially in summer.

Small holes may be punched-out of the plastic to decrease these kinds of problems, but this does not necessarily bring the desired results. Faulkner and Pritham (1973) reported the advantages of a below-knee prosthesis made from Light-cast® material, which has the ability to permit the flow of air. Nakamura (1988 and 1989) designed polyester hydrate resin sockets allowing the skin to breathe freely in order to improve the wearing conditions.

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The authors have invented a new orthosis named "POROPLAST", which has good ventilation and is very comfortable to wear. So far, the record of the duration of wear of this orthosis is a maximum of six months. This orthosis is made of mesh plastic sheets, combined in a cross-like weave.

Materials and fabrication

A mesh sheet of thermoplastic high density polyethylene was chosen as the material. This can be moulded easily with heat. Three mesh sizes are used, large, medium and small (Fig. 1). The flexibility of an orthosis can be adjusted by changing the combination of these three types of plastic sheets. In practice, two kinds of sheets are used for an upper limb orthosis, and three for a lower limb orthosis or spinal orthosis.

The required number of sheets are placed on top of each other in such a manner that the meshes are crossed at a certain angle and held in place by cotton stockinette.

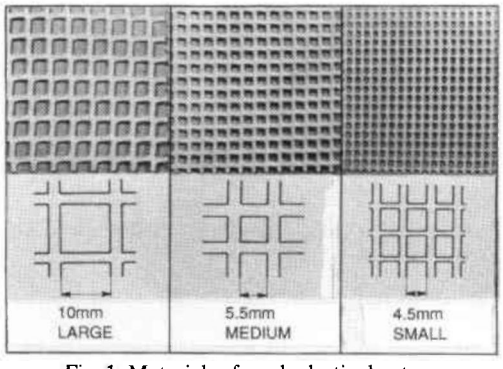

Fig. 1. Materials of mesh plastic sheets.

An OTTO BOCK® heating plate is usually used to soften materials. When the correct temperature is reached, they begin to melt and stick to each other.

Moulding is carried out immediately after the positive model has been covered with the softened material. When the material cools, a trim line is drawn on the moulded plastic and it is removed from the positive model.

Methods of cutting and trimming are the same as for conventional plastic materials. This is carried out after the cotton stockinette has been removed.

Finally the irregular margin of the orthosis is smoothed off around the edge using NEOPLANE® suede, and thereafter, the orthosis is completed by securing straps in the appropriate position.

Case presentations

These fabricated mesh plastic orthoses have been used in 14 cases for the cervical spine, for 26 thoracolumbosacral orthoses, for 6 upper limb and 26 lower limb cases, and for 2 others.

The patient shown in Figure 2 had skin problems which improved after the use of the mesh plastic orthosis. She initially wore a Philadelphia type collar after a cervical laminectomy with excision of a spinal tumour. After a few days she suffered from contact dermatitis. The collar was replaced with the mesh plastic orthosis and soon after her skin problem cleared up.

The cervical orthosis in Figure 3 was used after the tenth postoperative day for a patient with a fracture-dislocation at the fourth cervical vertebra. She was able to sit up and walk earlier with this type of orthosis and was comfortable even in a humid Japanese summer.

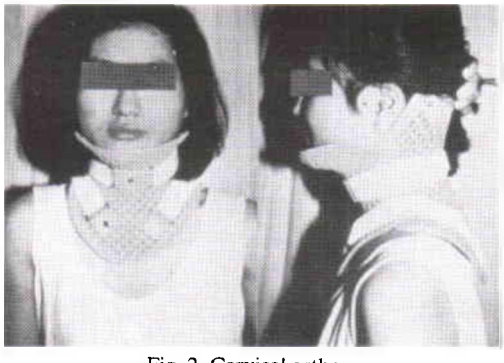

Fig. 2. Cervical orthosis.

The mesh plastic orthosis is used also for lumbosacral immobilization. It was used for a patient after a decompression and fusion operation for L4–L5 spondylolisthesis (Fig. 4). The contact surface of the skin could be observed directly through the mesh.

The new orthosis can be modified for use at the hip. It was used after resection and replacement of the femoral head for a malignant tumour. The area of the hip was reinforced by impregnating a fibrous bandage with acrylic resin and placing it between the mesh sheets.

POROPLAST can also be used for ankle-foot orthoses. It has been used after arthrodesis of the ankle joint for talipes equinus deformity as a sequel of cerebral palsy.

Comparative study on the ventilatory effects

In order to evaluate the ventilation effect of the new orthosis, it was compared with conventional orthoses in respect of differences in perspiration and skin surface temperature.

A polypropylene plastic orthosis and a mesh plastic one were put respectively on each foot of a patient under the same conditions for a certain duration of time.

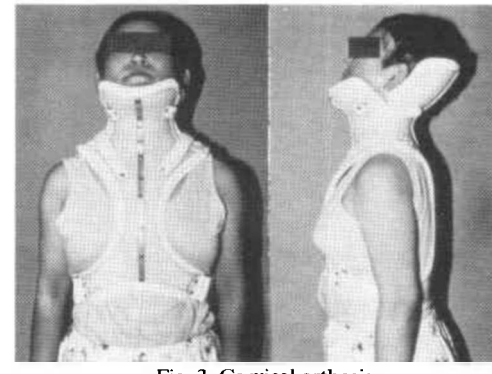

Fig. 3. Cervical orthosis.

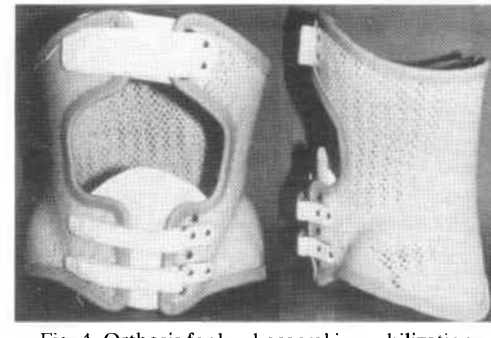

Fig. 4. Orthosis for lumbosacral immobilization

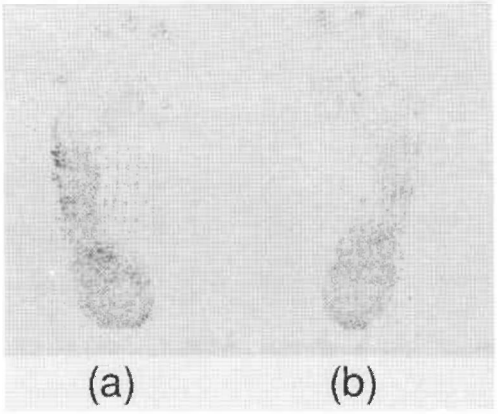

Fig. 5. Perspiration test.
(a) Conventional Orthosis (b) Mesh Plastic Orthosis

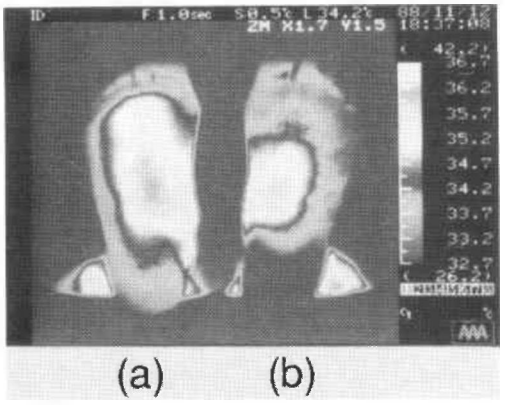

Fig. 6. Skin surface temperature using ultra-red thermogram.
(a) Conventional Orthosis (b) Mesh Plastic Orthosis

A special paper was used which indicates the degree of perspiration. The greater the quantity of perspiration the darker the paper is stained (Fig. 5). This displays that the mesh plastic orthosis reduces perspiration when compared with the conventional orthosis.

Next, the skin surface temperature was measured graphically using an ultrared thermocamera (Fig. 6). It can be clearly seen that the increase of skin temperature in the mesh plastic orthosis was lower than that in the conventional type.

Results

From these results it can be seen that the mesh plastic orthosis is more effective in ventilation. It has the additional advantage of permitting the observation of the contact surface of the skin. A further advantage is its light weight.

It is believed that this mesh plastic material can be adapted to produce orthoses for any part of the body and it may be utilized extensively in prosthetics as well as in orthotics.

Conclusion

This preliminary study demonstrates that this new type of orthosis has great advantages in ventilation and in weight. It has been tried clinically on 74 cases with satisfactory results particularly with regard to skin problems.

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