Suggested techniques for producing a partial prosthesis from silicone rubber
(A Do-it-yourself Prosthesis)

There is often a lengthy period between the occurrence of a severe accident and the time when the surgeon considers that the patient is fit to proceed to a limb-fitting centre.

Further delays may thereafter occur until an artificial limb is finally fitted. It would also appear that limb-fitting centres are mainly concerned with return to function of a limb and this would seem quite a reasonable emphasis. They also seem to function more effectively after cases of total, rather than partial, amputation.

With certain people, especially young girls, obvious physical deformity may effectively obstruct any possibility of their being able to lead a normal social life during the treatment stages. Since more than two years may elapse before a return to apparent physical normality, the risks of a patient's developing undesirable physical or mental mannerisms associated with the deformity are considerable.

Recently, two cases of severe injury of the hands arising from works accidents have been observed, and the degree of mental suffering associated with the mutilation was so impressive that it was decided to fabricate some form of artificial hand which would be lifelike and acceptable to the patient.

Using 'cold curing' silicone rubber, a relatively new material which was fortunately readily available, a prosthesis having some good qualities was produced.

Case History

In June 1964, a female worker of eighteen was injured when a number of detonators exploded. Her right hand was severely damaged with gross destruction of second, fourth and fifth fingers, and partial destruction of thumb and third finger.

The skin of the third and fourth fingers was brought over to cover the absent fingers and a free graft was inserted into the cleft between the two remaining stumps.

Figure 1 shows the result of this operation.

The young girl was dismissed from hospital in September with notice to return in several months' time for further plastic surgery. It was not possible to give her any definite idea when her treatment would finally be completed, and there did not seem to be any mechanism whereby rehabilitation could be initiated in the interim.

At this time a report was received from a welfare supervisor that 'Ann' was causing much concern to her family by developing the habits of a recluse, as a result of embarrassment about her deformity. To encourage her to venture into the world, a course of physiotherapy at this medical department was tentatively arranged. It was surprising to find that a postural mannerism had developed in an attempt to conceal her right hand and that some degree of atrophy had developed around the muscles of the right shoulder in the span of three months.

Rehabilitation of the girl was now thought to be of more than minor significance, and it was decided that this should be initiated by encouraging her to resume her previous social life.

To this end, a device which would resemble a normal hand and be cosmetically acceptable was thought to be of prime importance in the restoration of self-confidence. After experimentation with different materials, a foam rubber was used and appeared satisfactory.

Silicone Rubber

Room temperature vulcanizing (R.T.V.) silicone foam rubber is one branch of a relatively new family of synthetic materials which are rapidly becoming more frequently used.

The cured rubber is obtained quite simply by mixing the basic silicone polymer with a catalyst and foaming agent. Curing then proceeds at room temperature and the reaction is completed in a matter of minutes. The quality of rubber can vary from a soft sponge to a solid mass, depending upon the ingredients.

The simplified chemistry of the reaction can be summed up as a linkage of the terminal hydroxyl group of the polymer with the ethyl group of the silicate catalyst. The silicone polymer chain is thus lengthened and cross linkages take place giving the mass a rubbery structure.
The normal molecular weight of the silicone polymer varies from 40,000-500,000 and the variable ‘n’ allows a wide range of rubber qualities.

Chemical changes occur in the virtual absence of heat and a sponge rubber can be cured in fifteen minutes.

The rubber may be coloured to resemble skin tones. It is pleasant to touch and is believed to be completely inert. Resilience and strength can be controlled and the weight of the moulded hand ranged from 120-200 grm.

The estimated cost of material varies from 12s. to 16s.

**Methods of Making a Prosthesis**

1. The simplest method involves nothing more than putting basic ingredients together and mixing (polymer+catalyst+foaming agent).

   The activated mix is then poured into a glove, ensuring that some of the material flows into each finger.

   The patient then inserts the damaged hand into the glove and the fingers of the glove are held in the position of rest for 7-10 minutes while curing takes place.

   The hand can be withdrawn when the curing finishes and an ideally fitting socket is left.

   This method is suitable for most purposes but may form bubbles of rubber on the outer surface if gloves of open weave fabric are used. **Figure 2** shows a glove filled by this method.

2. In an attempt to improve on the above method a plaster (Quick Setting Stonehard) mould of a hand of similar shape to the patient’s was prepared and the hand shown on **Figure 3** was run off, using the technique of mixing and pouring described before, but using the mould instead of the glove to form the cast. The surface detail is quite remarkable and the hand appears extremely lifelike.

   This hand was roughly shaped to match the amputation stump **Figure 4** then inserted into the glove and a socket formed by pouring a little of the mix into the glove, then inserting the stump. An excellent union could thus be obtained.

   The artificial hand is light in weight and quite inert to damaged or
healing skin. The colour can be toned to that of the recipient's skin, and it can be worn with an open weave summer glove. The shape does not alter in hot water or in the presence of heat.

It is, however, useless from the functional aspect and should not be considered as a replacement for the usual functional prostheses, but rather as an inexpensive temporary (or dress) hand which will aid in physical and mental recovery.

This was certainly the result in the case of the girl described in this article, who was able to return willingly to her previous social round following the fitting of this cosmetic aid.

Reference


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IN 1865 there were fifteen deaths from yellow fever in Swansea. The Heculesa left Cuba on 26 July with cases of the disease on board, there were successive new cases and on 9 September when the ship entered port, one of her seamen was dying and two were convalescent from the disease. She remained tied up until 28 September. From 15 September, six days after the ship's arrival, until 4 October, six days after her removal 'Swansea witnessed the entirely new phenomena of yellow fever attacking in succession some twenty inhabitants of the town, besides others who suffered less definitely, or more mildly'. Earlier the same year there had been cases of cholera in Southampton, it was presumed from the Mediterranean traffic.

It is quite understandable therefore that the Medical Officer of the Privy Council should have directed attention to the possibility of the import of infectious diseases in connection with an industrial process. This was the rag trade (a phrase taken more literally than at the present time). Rags, both home and imported, were used for paper manufacture, shoddy making, manure making and, at the time of the American Civil War, a year or so previously, rags had been made into flock in place of cotton refuse. There were suggestions that outbreaks of smallpox in 1838 at Wraysbury and Colnbrook and in the summer of 1864 at Thetford in Norfolk arose from infected rags from abroad.

The investigation was carried out by Dr John Dyer Bristowe, whose report records the development of the concept of finding matched groups to form a control in a retrospective survey:

'In the aggregate the evidence adduced . . . seems to me to show that smallpox and other infectious diseases are very rarely introduced into paper mills by rags, but to show at the same time that their introduction is possible, and even occasionally takes place.

'If we were to take the evidence of some half a dozen selected mills, we might well suppose (as well from the general belief of the workpeople themselves as from the imperfectly but honestly related and suggestive facts which I have quoted from them) that smallpox was of frequent occurrence in paper mills as arising from rags. But when we find that in half a dozen other paper mills, with an equally long experience, using the same quality of rags, and apparently similarly circumstances in almost all respects, no evidence whatever of the introduction of smallpox, and such like diseases, can be obtained; the contrast naturally creates the suspicion that the difference may be in fact due to the circumstances that, at one mill there has been a habit of referring all attacks of smallpox to rags, in another attributing them to causes external to the mill; and, at all events, renders it more important than it might otherwise have seemed to be to test the quality of the evidence in support of the