EXPERIENCE WITH CUSTOM SILICONE SUSPENSION SLEEVES FOR SELF SUSPENDING TRANS-HUMERAL AND TRANS-RADIAL PROSTHESES

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Upper limb amputees attending our prosthetic clinic with trans-radial amputations have been routinely fitted with hard shell self-suspending sockets for many years. It has not been until more recent times and the development of the use of silicone materials that it has been possible to design an effective self-suspending prosthesis for some trans-humeral amputations.

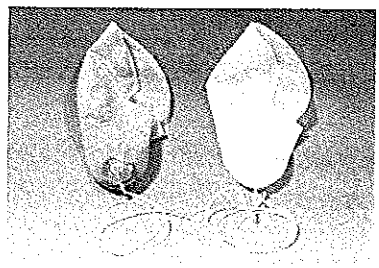
While it is possible to make and fit a hard shell self-suspending socket for a suitable trans-humeral amputation practical difficulties arise in fitting and retaining suction. The socket has to be an extremely accurate fit with absolutely no possibility of leakage. Unlike the lower limb suction socket gravity is acting against the socket at all times, a one way valve as used in lower limb sockets to expel air is of no use, any loss of suction will result in the loss of prosthesis retention and the need to reapply the socket. The range of mobility of the arm and the subsequent change of cross sectional shape throughout this range of movement compounds this problem.

Donning of this type of socket can be difficult with one hand, as a pull in will always be necessary. Applying a suitable bandage wrap and applying the prosthesis correctly is not an easy task for a one-arm person. Hence, although first fitted more than two decades ago the hard shell self-suspending socket has never really been successfully used.

A number of years ago one of the authors experimented with the use of polyethylene trans-humeral sockets for self-suspension. When bubble draped over a trans-humeral cast and suitable thinned this material is flexible and to a certain extent will accommodate changes in volume.

Suspension with this type of socket was excellent but the problem of donning still arose and unexpectedly it proved extremely difficult to remove the sockets after a period of time. If the amputee removed the socket within a few minutes, it could be removed without difficulty. If left long enough for normal body perspiration to build, it proved very difficult to remove the socket and sometimes patients participating in the trial had to pour a soapy water mixture inside the socket to allow removal. Because of these difficulties, the polyethylene socket was rarely used.

Six years ago a female trans-humeral attending our clinic said she would desperately like to be rid of the uncomfortable and non-cosmetic suspension straps on her prosthesis. Thinking back to problems previously encountered, it was obvious that a socket material that was easy to don/doff would have to be extremely flexible and perhaps have the ability to stretch. Silicone rubber seemed to be a material that would fit the requirements.



Custom trans-humeral liners

Self-suspending trans-humeral

A negative plaster of Paris wrap cast was taken and the positive cast produced from this reduced in circumference. Through trial and error, this reduction was worked out at 25%. This may seem a rather large amount but it must be remembered that the silicone sleeve produced is only 1.5-umm in thickness and stretches very easily.

Materials used in the lamination of the sleeve are Otto Bock or any other brand of similar chemical cure silicone, ladies stockings for the lay up material and braided nylon cord obtained from the local boat chandlers.

A PVA barrier is applied over the modified positive cast in the normal way and one layer of stocking applied. The braid of the cord is unravelled and laid longitudinally along the laminate (the cord is non elastic and hence prevents longitudinal stretch of the liner. The second layer of stocking is applied and covered with a PVA sleeve and the silicone mix poured. When cured the liner is cut from the cast (the cast is left intact and can be used for duplicate liners).

The next stage is a patient fitting where the liner is applied to the stump and tested for retention. If everything is satisfactory a layer of "cling film" is applied over the liner, tension applied to the cord (to simulate the lanyard tension and shape the stump correctly) and a plaster wrap taken to produce the outer humeral shell.

Various types of humeral shell have been used, frame or full lamination depending on individual requirements. A number of methods of securing the pull in cord have been tried but we now routinely use the excellent small lanyard securing cleat produced by Össur, Iceland.

Results using this type of suspension have been excellent. No skin problems have been experienced. Donning and doffing is easy. Retention has not been a problem. The original patient fitted has now been using her prosthesis continually, 14-16 hours every day, for almost 6 years. She wears her prosthesis during exercise sessions, including step aerobics, and has had no failure of retention.

Since that time many more trans-humeral through to elbow disarticulation levels have been successfully fitted. Most have been lightweight prosthesis intended mainly for cosmetic purposes but a small number of myo-electrically controlled externally powered devices have also been successfully fitted. The silicone sleeves last on average 6-12 months before requiring replacement.

Silicone sleeve for longer stumps

A total of round 40 silicone sleeves have been fitted with no rejections. Universally the statement has been "why couldn't I have had this sooner" or "please never ask me to return to straps again".

"Off the shelf" silicone liners are now commercially available but these have originally been developed for lower limb use and are much thicker and more difficult to don. It must be remembered that unlike most lower limb amputees the unilateral arm amputee has only one hand to assist in donning the liner. The remaining muscle and soft tissue at trans-humeral amputation level is usually mobile and floppy. When trying to don these thicker liners it can be very difficult to stabilise the tissue. Several of our amputees have tried these sleeves and all but one prefers the thinner custom-made version.

Problems experienced with commercial liners have been difficulty in donning, and blistering of stump tissue.

Most trans-humeral stumps have fairly "floppy" tissue and it is difficult for the amputee to don the thicker commercial sleeve straight. When tension is applied to the pull in lanyard or shuttle pin the sleeve is straightened and a constant tension applied to one side of the stump tissue. I believe that this is what causes the blistering problem

One disadvantage of the custom made sleeve is the time involved in manufacture and the fact that at least two casting sessions are required. It is the opinion of the authors that it would be possible to develop a standard range of "off the shelf" liners which, like those developed for lower limb amputation levels, would fit the majority of stumps. If this were to happen it would be possible to produce a complete prosthesis in a shorter time with only one plaster cast required.

Trans-humeral congenital

Silicone self-suspension

More recently further development of the technique has taken place on trans-radial applications, both adult and children. An example of this is a young woman who requested a more cosmetic translation line between her supra-olecranon self-suspending socket and her arm that would not show through her wedding dress. Using the thin silicone liner for suspension, we were able to produce a suitable prosthesis. The technique has been particularly useful when used on infants both trans-humeral and trans-radial and examples will be shown during the presentation

While this type of suspension has much to recommend it, like all upper limb prescriptions, careful consideration must be given to the actual needs of the amputee both psychological and functional

If function is a high priority and body power is the preferred method it may be, for some, that little is to be gained in using silicone sleeve over harness suspension. If externally powered components are used then consideration should be given to the additional mass and the subsequent rotational forces applied to the socket. It is very difficult to effectively stabilise the rotational forces within a trans-humeral socket relative to the humerus without the assistance of suspension straps.