THE USE OF OSMED™ TISSUE EXPANDERS IN PAEDIATRIC BURNS RECONSTRUCTION

Lohana P.,* Moiemen N.S., Wilson Y.T.3

Department of Burns, Plastic and Reconstructive Surgery, Birmingham Children’s Hospital, Birmingham, United Kingdom

SUMMARY. Background. Tissue expansion has been a major advance in reconstructive burn surgery. The conventional tissue expander requires serial filling with the possibility of painful procedures, which can be a major challenge and source of anxiety in children. The osmotic self-inflating tissue expander, on the other hand, is a device that does not require external filling, offering apparent benefits particularly in the paediatric population. We used Osmed™ tissue expanders for secondary burn reconstruction in children and teenagers who had sustained burns during childhood. Method. Patients who were treated with Osmed™ expanders for secondary burns reconstruction were recorded. Patient demographics (i.e. burn injury data, indications for surgery), Osmed™ tissue expander data (i.e. operative data, complications, problems encountered during and after treatment, explantation time, final expander volume) and overall success were recorded. Results. Twelve Osmed™ self-inflating tissue expanders were used in patients for secondary burns reconstruction between October 2007 and January 2009. All our patients sustained their burns during childhood. There were three females and one male; the age range was 14-19 yr (mean age, 16 yr). Tissue expanders were removed on average at 6-7 weeks except in two patients. We noted four complications in our cohort. Overall the mean expansion was 65% of the proposed final volume. Discussion. We found the Osmed™ tissue expander simple to implant and well tolerated by our patients. However, none of the devices achieved full expansion and overexpansion was not possible. We believe conventional tissue expanders are still the gold standard, although osmotic expanders may have a role in burn reconstruction in younger children.

Keywords: tissue expansion, self-inflating tissue expander, burns reconstruction, children

Introduction

Burn injuries may result in severe disfigurement, scarring, and contracture, which cause not only functional but also emotional and psychological problems. Hypertrophic scars and contractures may be difficult to treat using local tissue, whilst the use of skin grafts may cause further scarring and pigmentation changes at the donor site. Tissue expansion, on the other hand, aids burn scar reconstruction and offers similar tissue in terms of texture and colour, with potentially less donor site morbidity.

The Osmed™ self-inflating tissue expander is a dehydrated hydrogel consisting of a modified co-polymer of N-vinyl-2-pyrrolidone and methylmethacrylate, a material that is used in contact lenses (Fig. 1).2

Once implanted the device expands by absorbing body fluid in the first 6-8 weeks, which leads to a gradual

*Corresponding author: Mr Parkash Lohana, 29 Cyril Evans Way, Morriston, Swansea SA6 6PU, WALES, United Kingdom. e-mail: lohana28@hotmail.co.uk
Conflict of interest: none.
Financial disclosures: none.
This paper was presented at the European Club for Paediatric Burns (ECPB), Gdansk, Poland in 2008 and at the 42nd British Burns Association (BBA) Meeting, Belfast, UK in 2009.
swelling of the device to a final volume of up to 10-12 times its original size. The first generation of osmotic expanders was originally designed without an envelope. In clinical studies, it was found that the rapid expansion of these expanders could lead to high-pressure peaks and cause tissue hypoxia and skin damage. The design was therefore modified, with the expander being wrapped in a silicone membrane with small pores of a specific number and size, to limit osmotic speed. A study conducted in an animal model, with and without the silicone shell, showed a more gradual increase in volume with the silicone shell than expanders without the shell. This gradual expansion permits better tissue tolerance, especially in areas with thin tissue coverage.

The device is small, requiring only a small incision and pocket for insertion, which can potentially be performed under local anaesthesia. The patient experiences less discomfort because of the gradual nature of the expansion, especially with second-generation expanders. Fewer visits to the clinic are thus required, reducing the number of potentially painful procedures (especially in children) and also the risk of iatrogenic infection. The device is available in different sizes and shapes, and can be used in almost any area of the body. According to the manufacturer, the device has been used for congenital deformities such as anophthalmos, microphthalmos, syndactyly, naevus, cleft palate, breast deformities, and direct closure of the donor site defect in radial forearm flaps. We used Osmed™ for burn scar release and contracture reconstruction in children.

Patients and methods

Osmed™ self-inflating tissue expanders have been used in our department for a variety of clinical indications. This study records patients who elected to have Osmed™ expanders for secondary burns reconstruction.

Patient demographics, burn injury data, indications for surgery, Osmed™ tissue expander data (i.e. operative data, complications, problems encountered during and after treatment, explantation time, final expander volume) and overall success were recorded.

Surgical technique.

The reconstructions were planned as when using conventional tissue expanders. Rectangular-shaped expanders were used in all cases. The site for the expander (or in some cases multiple sites) was selected sufficiently distant from the burn scar to ensure that only healthy, unscarred skin would be expanded. The incision was located so as to minimize any tension in the wound as the expansion progressed. As when using conventional expanders, the expander was placed some distance from the access wound, to reduce the potential for later exposure of the expander. A subcutaneous pocket was created and, following haemostasis, the pocket was irrigated with povidone iodine and saline. One peri-operative dose of antibiotics was administered. We used drains in cases where significant dissection was undertaken.

On explantation, we measured the final volume by submerging the expander in a graduated measuring jug con-

Table I - Distribution of OSMED™ expanders, clinical applications, and outcomes

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age at burn (yr)</th>
<th>TBSA</th>
<th>Age at expander application (yr)</th>
<th>Indication</th>
<th>Site</th>
<th>Initial volume</th>
<th>Proposed volume</th>
<th>Actual volume</th>
<th>Explantation time</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>3</td>
<td>55%</td>
<td>13</td>
<td>Contracture</td>
<td>Ant. trunk</td>
<td>30 ml</td>
<td>300 ml</td>
<td>190 ml</td>
<td>8 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>55%</td>
<td>13</td>
<td>Contracture</td>
<td>Ant. trunk</td>
<td>30 ml</td>
<td>300 ml</td>
<td>*Not recorded</td>
<td>3½ wks</td>
<td>*Infection</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>38%</td>
<td>14</td>
<td>Contracture</td>
<td>Left arm</td>
<td>20 ml</td>
<td>200 ml</td>
<td>120 ml</td>
<td>7 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>38%</td>
<td>14</td>
<td>Scar</td>
<td>Back</td>
<td>30 ml</td>
<td>300 ml</td>
<td>150 ml</td>
<td>7 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>38%</td>
<td>14</td>
<td>Contracture</td>
<td>Axilla</td>
<td>30 ml</td>
<td>300 ml</td>
<td>150 ml</td>
<td>7 wks</td>
<td>*Localized abscess</td>
</tr>
<tr>
<td>M</td>
<td>13</td>
<td>93%</td>
<td>15</td>
<td>FTSG (Donor site)</td>
<td>Left groin</td>
<td>30 ml</td>
<td>300 ml</td>
<td>120 ml</td>
<td>2 wks</td>
<td>*Infection</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>12%</td>
<td>18</td>
<td>Scar</td>
<td>Ant. chest</td>
<td>20 ml</td>
<td>200 ml</td>
<td>150 ml</td>
<td>6 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>12%</td>
<td>18</td>
<td>Scar</td>
<td>Ant. chest</td>
<td>20 ml</td>
<td>200 ml</td>
<td>140 ml</td>
<td>6 wks</td>
<td>*Superficial infection</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>12%</td>
<td>18</td>
<td>Scar</td>
<td>Right flank</td>
<td>30 ml</td>
<td>300 ml</td>
<td>240 ml</td>
<td>6 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>12%</td>
<td>19</td>
<td>Scar</td>
<td>Sternum</td>
<td>30 ml</td>
<td>300 ml</td>
<td>200 ml</td>
<td>6 wks</td>
<td>No</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
<td>12%</td>
<td>19</td>
<td>Scar</td>
<td>Ant. chest</td>
<td>30 ml</td>
<td>300 ml</td>
<td>220 ml</td>
<td>6 wks</td>
<td>No</td>
</tr>
</tbody>
</table>

a - Final volume not recorded, as expander was removed in an emergency situation; b - Required early removal; c - Drained under local anaesthesia; d - Underwent two operations 6 months apart; e - Treated with antibiotics.

TBSA - Total body surface area
taining normal saline. The volume displacement corresponded to the total expander volume and was recorded to the nearest 10 ml marking on the jug.

Results

Twelve Osmed™ tissue expanders were used in four patients for post-burn scar/contracture revision between October 2007 and January 2009. In one child, with very extensive scarring (following 93% TBSA flame burns), the expander was inserted to expand an unburned area in the groin as a donor site for a full-thickness skin graft (FTSG). All our patients sustained their burns during childhood. There were three females and one male, with an age range of 14-19 yr (mean age, 16 yr). One patient had two episodes of surgery six months apart. Post-operatively, the patients stayed in hospital for 0-3 days and were reviewed at 1 week and 3 ± 1 weeks post-operatively. Tissue expanders were removed on average at 6-7 weeks except in two patients; one of these was removed at 2 weeks and another at 3½ weeks (Table I). One patient was non-compliant throughout the procedure and self-discharged on the scheduled operation day.

We noted four complications. One patient had a superficial infection, which was treated with antibiotics; one developed a localized abscess, requiring aspiration under local anaesthesia (with preservation of the expander); and two developed infections, which required early removal of the expanders. The outer layer of one implant was found ruptured at the time of explantation (this patient had not suffered any of the complications outlined above), but interestingly it had not deflated (Fig. 2). Overall, the mean expansion was 35% less than the proposed volume, even in expanders which did not require premature removal (Fig. 3).

Discussion

The concept of tissue expansion is well established. In 1957 Neumann first reported the use of tissue expansion in reconstructive surgery, by expanding a rubber balloon in the temporo-occipital area for ear reconstruction. Skin expansion represents one of the major advances in reconstructive techniques in recent years, especially in burn surgery. This method certainly has benefits for burn patients with extensive scarring, amongst whom the use of a split-thickness skin graft may result in recurrent scarring, contracture, and a poor aesthetic outcome. In contrast, tissue expansion not only provides tissue of a similar colour and texture but also minimizes donor site morbidity.

In 1982 Austad and Rose described an expander, a balloon, which was filled with a hyperosmolar saline solution and absorbed tissue fluid through an elastic silicone membrane. The authors abandoned the model because the fluid caused necrosis of the adjacent skin when the balloon leaked. In 1998 Wiese created a self-inflating tissue expander consisting of a modified co-polymer of methylmethacrylate and N-vinyl-2-pyrrolidone, which takes up water by osmosis. This was successfully tested in animals and designed and engineered by OSMED GmbH in Ilmenau, Germany.

Berge et al. used expanders in 10 patients in preparation for direct closure of the donor site defect of the radial forearm flap. They recorded a 90% success rate and low complication rates, less expansion-related discomfort, and satisfactory cosmetic results. In 2004 Ronert et al. reported their experience with osmotic expanders in 55 patients.

They used mainly round osmotic tissue expanders in
breast reconstruction and a rectangular shape for defect coverage, such as scar revision, excision of tumour on the face, and congenital naevus. The reported success rate in cases of rectangular expanders was 88.5%. Two expanders had to be removed because of infection and another because of unrelated health problems. They concluded that the osmotic expander was fast and simple to implant, reliable, and achieved excellent results in breast reconstruction and coverage of skin defects.\(^1\)

Tissue expansion is a widely accepted and effective approach in reconstructive burn surgery. In the paediatric population, tissue expansion enables the reconstructive surgeon to achieve functional and aesthetic goals that were previously unattainable.

However, despite its versatility, tissue expansion has been associated with significant complications since its inception.\(^2\) In contrast to initial reports of complication rates of tissue expansion in infants and children that were as high as 40%, recent series report overall complication rates in the range of 13 to 20%.\(^10^-1^4\) The success of any tissue expansion procedure depends on the appropriate clinical indication and individual risk factors.\(^1\) Hudson and Grob summarized simple rules for successful tissue expansion (size and form of expander, use of antibiotics, incision for the insertion of expander, size of the expander pocket, drainage, wound closure technique, expander filling, placement of the port and commencement of tissue expansion).\(^3\)

In this series, we experienced a high complication rate (infection in 4 out of the 12 expanders). One of these was a non-compliant patient who self-discharged immediately following the procedure, returned after two weeks with infection of the expander pocket, and subsequently required removal of the expander. This was a case of poor patient selection for the procedure. One case of superficial wound infection was successfully treated with antibiotics. The other two complications (localized abscess and infection requiring removal of the expander) were both judged clinically to have been associated with minor post-operative haematomas. Drains were used only in cases where significant dissection had taken place; possibly, despite the subcutaneous pocket being smaller than that used for a conventional expander, if access for meticulous haemostasis is limited, post-operative drainage should still be used routinely. We would therefore not regard the infection rate as an inherent problem of the device, but rather a reflection of our learning curve in its use.

We found the outer layer of one implant ruptured at the time of explantation (Fig. 2). This can be regarded as an additional advantage of this device, in that rupture of the silicone shell did not lead to deflation in comparison to conventional expanders.

Besides the potential advantages, we experienced several limitations, the most notable being that none of the expanders achieved full expansion, despite being left in situ for up to 8 weeks. More recent advice from the manufacturers, updated since we undertook this study, recommends leaving the expanders in situ for up to 100 days. This is based on in vitro studies of expansion in 0.9% sodium chloride. We will therefore leave any future expanders implanted for longer time periods than in the patients reported here. It remains to be seen whether the results from the in vitro studies will be repeated in the in vivo situation.

Following insertion, expansion commences soon thereafter and cannot be delayed, as for example when there are concerns about primary wound healing. Additionally, once the expansion has begun it cannot be interrupted, other than by removal of the device; this could present difficulties if any impending problems are noted with the wound or overlying skin viability.

Overexpansion (a technique often employed with conventional expanders) is not possible. All these factors mean that the trade-off for a simpler procedure to insert the expander and the avoidance of multiple injections, is reduced flexibility both during and at the end of the expansion process.

In addition to the experience reported here, we have also used Osmed\textsuperscript{TM} tissue expanders in adults for other indications, encountering the same issue of incomplete expansion within the 8-week period. In our practice we still recommend conventional expanders, except in special circumstances such as younger children, patients with needle phobi, and those who cannot attend frequent hospital visits. We therefore believe that the main role for Osmed\textsuperscript{TM} expanders in reconstructive burns surgery is in children, especially those with high levels of anxiety, a condition that would make the use of conventional tissue expanders difficult.

Mots-clés: expansion, expadeur, auto gonflant, reconstruction des brûlures, enfant

BIBLIOGRAPHY


This paper was approved on 28 January 2012.