IS EXPANSION OF ARTIFICIAL DERMIS A RELIABLE RECONSTRUCTIVE OPTION?

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SUMMARY. Reconstruction of full-thickness defects with the use of artificial dermis has been well established in the recent literature. The capacity of artificial dermis to expand over a period of years, months, or even days is described. Three such cases are reported. Two female patients, aged 21 and 30 years, with post-burn contractures of the chest with right breast hypoplasia and abdominal wall post-burn contractures respectively, and a 14-year-old male with a giant congenital naevus on the forearm are presented. After excision of the contractures and the congenital naevus, the patients underwent staged reconstruction with the use of artificial dermal template and split-thickness skin autografts at monthly intervals. The 21-year-old female also had a tissue expander placed submuscularly which six months later was replaced by a permanent silicone implant. Gradual expansion of artificial dermis within three weeks resulted in reconstruction of a breast of natural shape, size, and volume. In the second patient the artificial dermis was expanded over a period of months, until full-term pregnancy, while the third patient took years to achieve expansion naturally as he grew up. In conclusion, artificial dermis can be expanded over various periods of time (days to years), providing a reliable and safe alternative reconstructive method, particularly in areas where expansion is an absolute necessity for a good functional and aesthetic result.

Keywords: artificial dermis expansion, burn reconstruction, abdominal wall, pregnancy, breast

Introduction

Full-thickness burns of the anterior chest wall and abdomen that occur in childhood result in severely contracted scars that restrict chest and abdominal wall expansion. These scars, especially in young females of reproductive age, can lead to disfigurement, abnormal contour and malposition of the breast, breathing difficulties, and complications during pregnancy. Similar problems of disfigurement and decreased overall quality of life can also be caused by inadequate reconstruction of other full-thickness defects in adolescence. Various methods of reconstruction have been used so far. Here we report the use of expansion of the artificial dermal template Integra (Skin, Johnson & Johnson Medical, Division of Ethicon, Inc., Somerville, NJ) by surgical intervention (use of a tissue expander) and nonsurgical intervention (expansion due to pregnancy and age) and its results. All the patients presented with a satisfactory aesthetic and functional outcome regarding the shape, colour, contour, and elasticity of the reconstructed area.

Materials and methods

Between the years 2004 and 2009 three patients were reconstructed with expanded artificial dermis in the Department of Plastic Surgery Microsurgery and Burns Unit of the G. Gennimatas General State Hospital in Athens: a 21-year-old female with post-burn contractures in the chest and right breast hypoplasia, a 30-year-old female with post-burn contractures in the torso, including the abdominal wall, and a 14-year-old male with a giant congenital naevus on the forearm measuring 15 x 12 cm.

The first patient presented with post-burn contractures of the anterior chest wall and unilateral breast hypoplasia, due to thermal injury she had suffered at the age of 27 months, that were left to heal by secondary intention. Her main complaints were discomfort caused by deep breathing, due to reduced compliance of the thoracic wall, and breast disfigurement.

The patient was managed in three stages. The first stage consisted of the excision of the contractures and the submuscular insertion of a 450-ml anatomical tissue ex-
pander under the pectoralis major muscle. The expander, partly infiltrated with normal saline, and the anterior chest wall were covered by Integra artificial skin. One month later, the outer silicone layer of Integra was replaced by a split-thickness skin autograft and the expander was further infiltrated with normal saline. During the third stage, six months later and after overexpansion of the tissue expander had been completed, the expander was removed and a permanent 350 ml silicone implant was subsequently inserted (Figs. 1a,b,c).

The second patient presented with contracted post-burn scars of the torso, including the anterior and lateral abdominal and chest walls. The patient had suffered thermal burn injury at the age of three, which healed by secondary intention. The main symptoms were abdominal discomfort and difficulty in deep breathing, during exercise, due to reduced compliance of the thoracic and abdominal walls. Spirometric volumes were found to be slightly above minimum normal values for the patient’s age and height (FEV$_{1,0}$ = 2.25 lt, FVC = 2.60 lt, referring respectively to forced expired volume and forced vital capacity). The patient underwent staged reconstruction of the lateral abdominal wall. After removal of the contracted scars, the full-thickness cutaneous deficit was reconstructed by Integra in two stages (Figs. 2a,b,c): first the anterior abdominal wall was reconstructed and then, 12 months later, the lower lateral abdominal walls cm$^2$. At four-week intervals in each reconstructive stage the outer silicone layer was removed and the template was covered with thin autologous skin graft.

The third patient presented with a giant congenital naevus of the forearm (15 x 12 cm). His main concern was the aesthetic outcome after its removal. After excision of the lesion, the full-thickness cutaneous deficit was also reconstructed by skin regeneration template in two stages (Figs. 3a,b,c), as described above.

**Results**

Recovery was uneventful in all three patients, who were given instructions about daily skin care with aloe vera cream after autologous skin grafting and removal of sutures.

Seventeen months after reconstruction the first patient presented with symmetrical breasts, stable breast contour with adequate projection of the reconstructed breast, and a natural inframammary fold. No recurrent contractures occurred. Expansion of artificial dermis was achieved with the use of a tissue expander over a period of three weeks,
followed by a silicone implant, resulting in normal breast shape, size, and volume. The outcome was evaluated by the patient as very satisfactory.

The second patient, at her six-month follow-up, had a new spirometry that suggested improved breathing (FEV$_1$ = 2.98 lt, FVC = 3.10 lt). The umbilico-symphysial distance increased by 12 cm. One year post-operatively the patient was reviewed and found to be three months pregnant. The abdominal skin and the template were naturally and evenly expanded and the patient was followed up every month thereafter until delivery. The artificial dermis was naturally expanded within a period of nine months (Fig. 2c) and the patient had the opportunity to experience an uncomplicated full-term pregnancy. No stretch marks developed on the patient’s abdominal skin during pregnancy. After delivery the patient’s abdominal skin quality was similar to that of the surrounding skin.

The third patient presented at the yearly follow-up (Fig. 3b) with restored skin elasticity without any re-contracture appearing. At three years the recipient site maintains its elasticity, colour, and contour, resembling those of the surrounding normal skin. Expansion of the artificial dermis was achieved within a few years as the patient grew up.

**Discussion**

Management of full-thickness defects due to excision of lesions and post-burn contractures includes the use of skin grafts, flaps, and tissue expanders. These methods are often associated with donor site morbidity or are not accepted by patients as satisfactory treatment options owing to related aesthetic problems. Integra regeneration template has been successfully used to cover large burned surfaces of the trunk and upper limb full-thickness cutaneous deficits due to as been successfully used to cover large burn surfaces of the trunk and upper limb full-thickness cutaneous deficits due to excision of extensive lesions. It has been also been documented as being successfully expanded and used in combination with tissue expanders and implants in post-burn breast reconstruction.

Tissue expansion of the post-burn breast is a well-recognized modality of reconstruction since it has been suggested that expansion of the scarred chest wall soft tissues causes softening of the scars, which is beneficial for the final reconstruction. It has been shown that mechanical force enhances keratinocyte growth and protein synthesis and alters cell morphology by stimulating signal transduction pathways, thus triggering cascades that lead to skin surface enhancement. However, most plastic surgeons prefer tissue expansion after the release of scars.

In the patient presented here, release of the contractures preceded expansion of the artificial skin, as the limited skin envelope would have restricted the tissue expander.

The major problems caused by extensive post-burn scars on the chest and abdominal walls are breathing difficulties and discomfort. In female patients the perspective of normal abdominal skin stretching during full-term pregnancy is remote. Abdominal discomfort, pain, uterine displacement and scar breakdown may seriously complicate pregnancy during the last trimester. Even after scar excision and autologous skin grafting, breathing may be impaired by residual fibrosis and/or late graft contracture. Thin split-thickness skin grafts have a significantly higher tendency to secondary contraction than thicker skin grafts; the latter however, increase donor site morbidity. Transpositional flaps and expanded reverse abdominoplasty have been suggested as alternative treatment modalities to skin grafting. However, the increased morbidity of these techniques compared to grafting is not to be ignored. In the patient described here, reconstruction with the use of artificial dermis and autologous skin graft improved breathing capacity, eliminated discomfort and disfigurement pregnancy.

For the third patient the psychological impact was of great importance, as the patient declined the use of a tissue expander though it had been proposed to him as an appropriate form of treatment. The necessity of repeated infiltrations and the look of the tissue expander on his forearm discouraged the patient from selecting this reconstructive method, while the result of the use of artificial dermis and thin skin grafting was rated by the patient as being very pleasing.

**Conclusion**

In conclusion, reconstruction with expanded artificial dermis provides elasticity and compliance of the reconstructed body surface and permits extensive expansion over various periods of time, improving the patients’ overall quality of life. Expansion of artificial dermis should be considered a reliable and safe alternative reconstructive method, particularly in areas where tissue expansion is an absolute necessity for good functional and aesthetic results.
BIBLIOGRAPHY


Mots-clés: expansion du derme artificiel, reconstruction des brûlures, grossesse, sein

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