

The Role of Tissue Expansion for Head and Neck Reconstruction at Ramathibodi Hospital

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Abstract

The technique of tissue expansion especially for head and neck reconstruction has been successfully used at Ramathibodi Hospital. During 1987-1999, there were 28 patients, 10 males and 18 females. Ages ranged from 7-43 years. New expanders were used in 8 patients, reused expanders by autoclaving sterilization were used in 18 patients, and two patients underwent tissue expansion by using Foley's catheter. Five patients underwent reexpansion while two patients underwent immediately reexpansion procedures and three procedures were carried out few weeks later. The most common tissue expanders used were rectangular shape of different sizes. There were minor complications including two minor wound infections which responded well to antibiotic therapy, two partial wound disruptions with exposure without extrusion of the expanders, one partial erosion of skin over the reservoir, one perforation of the expander by a needle during saline instillation, and one partial skin flap necrosis. Only the 25-gauge needles were used for instillation of saline through the ports and there was no port (reservoir) failure. Despite those minor complications, the overall post operative results were satisfactory. The skin or scalp defect can be replaced with skin flap or scalp flap respectively of identical color, texture, and appendages including hair growth.

The concept of using tissue expansion in Plastic and Reconstructive Surgery was first reported by Neumann¹ in 1957 when he reconstructed a partial traumatic ear amputation by expansion of postauricular skin for coverage of a cartilage graft by progressive distention with air of a subcutaneously placed rubber balloon. Despite his success, the technique was ignored for two decades until Radovan,² in January 1976, successfully expanded an arm skin using a temporary expandable silicone saline-filled implant. The

expanded skin flap was used to resurface an adjacent defect of the arm following removal of a decorative tattoo. This concept of tissue expansion has significantly added to Plastic and Reconstructive Surgery a technique that could offerenable the surgeon to improve cosmesis in the skin defect with minimal morbidity of the donor site. Since then a number of scientific articles³⁻¹³ have described the techniques of tissue expansion for reconstruction of a variety of defects throughout the body. As a matter of fact, the

technique of tissue expansion has been used for centuries by various cultures to enhance their concept of beautification. The hill tribed women called "Paduang" who live in the border of the north of Thailand and Myanmar wear metal rings around their necks for decoration and to enhance linear growth (Figure 1). The simplest example of tissue expansion one can realize is the natural expansion of the abdominal wall of a pregnant woman in response to a growing uterus and later after delivery loose skin develops (Figure 2).

In 1987, we started using tissue expansion at Ramathibodi Hospital for reconstruction of defects from different area of the body.¹⁴ We have found that tissue expansion is particularly suitable for reconstruction of the head and neck defect because this

region of the body has a very good blood supply and its complication rate is low.

Tissue Expander

The prototype tissue expander is a silicone gel envelope with a silicone tube leading to a separate port (reservoir) through which saline solution can be injected into the silicone envelope and thereby expand it. They are commercially available in the market by many manufacturers abroad in many different sizes and shapes such as rectangular, round, sausage, crescent, horse shoe-shaped, and elliptical. They also are made in various volumes ranging from a few cubic centimeters to several thousand cubic centimeters. There are two types of tissue expanders available in our country. One is a remote valve system in which the injection port that receives the needle during injection of saline is attached by a small silicone tube of varying lengths to the tissue expander. The second type has an indwelling port in which the injection port and tissue expander are in a single unit without a silicone tube. The indwelling port usually incorporates a magnet and can be located with the use of a small device provided by the manufacturer. This type of expander has been used in breast reconstruction but its disadvantage is the higher risk of inadvertent perforation of tissue expander by accident during saline injection. The advantage of the former type of tissue expander that we normally use at Ramathibodi Hospital is the lower risk of perforating the expander since the injection port is placed under the skin at a distance from the tissue expander or externally, especially when used in children, to avoid pain from percutaneous saline injection.

Regardless of the type of tissue expander selected, it must be of sufficient size to provide adequate expanded skin expansion desired for reconstruction in one two-staged procedure. A custom-made tissue expander calculated and designed by the surgeon can be provided by the manufacturer. This type of tissue expander will expand the skin to fit the unusual defect sizes and shapes in one procedure. However, it is not practical in our country as it is more expensive and may delay the procedure because of manufacturers concerned. We have to use the imported tissue expanders of different sizes and shapes that only are commercially available in our country. The patient has to pay at least 13,000 Baht for one new tissue



Fig. 1 Paduang children and women who live in the border of Northern Thailand and Myanmar wear metal rings around their necks, forearms and legs for decoration.



Fig. 2 Loose skin and striae gravidarum of the anterior abdominal wall following delivery.

expander which is designed by the manufacturer for a single use and then must be discarded. For a larger defect, 1-3 tissue expanders may be required instead of a custom-made one to fulfill the reconstruction need. Reexpansion can be immediately or later performed, that is the adjacent tissue can be reexpanded a second or third time if necessary, to completely achieve the final goals in reconstruction. Since some patients cannot afford to buy new tissue expanders, we have to solve their economic problems by reusing the tissue expanders.^{14,15}

Based on the process of tissue expansion, nerve integrity is preserved so that a flap of relatively normal sensitivity can be created. By inducing an increased blood supply by a process similar to delay, the safety of a random or extended axial flap can be significantly increased. If overlying muscle is expanded during the process of tissue expansion, a functional motor unit can be created for specific needs, such as in the brow. The expanded skin flap can simply be transposed, rotated or advanced into the primary defect for primary closure leaving no secondary defect to be reconstructed.

PATIENTS AND TECHNIQUES

During 1987-1999, there were 28 patients who underwent head and neck reconstruction by using the technique of tissue expansion. There were 10 males and 18 females, age ranged from 7-43 years. We also used tissue expanders for reconstruction of other parts of the body as well as the head and neck region.¹⁴ During our early experience, we had to use new tissue expanders. In those cases, the patients chose the plan of management themselves and they had to pay for the expanders if they preferred the technique of tissue expansion. Many patients chose other techniques though they knew that tissue expansion, a new and better technique, was available but they could not afford to buy a new expander. Few years later, we collected some tissue expanders removed from the patients kept in the operating room. We saved the patients' money by reusing those expanders (Figure 3) again and again, as long as they were not ruptured. They were sterilized by gas or autoclaving sterilization.¹⁴ After reusing the expanders for a period of time, we have found that autoclaving sterilization a few days before the operation was preferred as we encountered

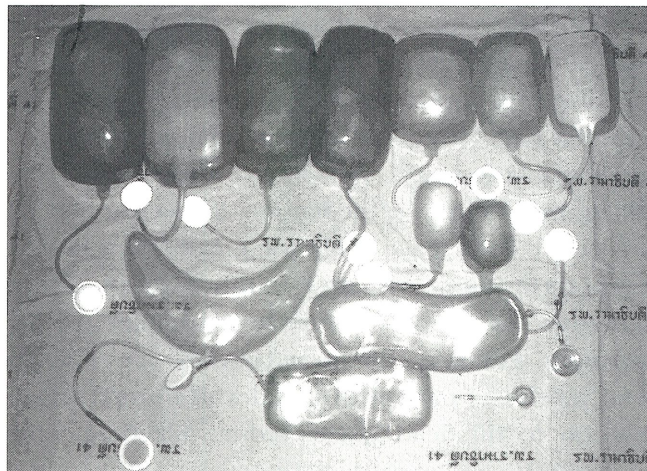


Fig. 3 Various sizes and shapes of some tissue expanders with remote ports that were reused at Ramathibodi Hospital.

ered not a single postoperative wound infection in so doing.¹⁵

The procedure was mostly performed under general anesthesia with prophylactic antibiotics. In addition, local infiltration with anesthetic solution with adrenaline was employed to reduce bleeding during dissection. The technique was divided at least into two stages. In the first stage, 1-3 reused tissue expanders were selected depending on the size and shape of the defect. The reused expanders were tested before temporary implantation to make sure that there were neither puncture holes nor system leakage. We preferred inserting the expander(s) under the skin within the subcutaneous fat over the preparotid fascia, cheek, above the platysma muscle of the neck; under the galea aponeurotica of the scalp; and under the frontalis muscle of the forehead. The incision for placement of the expander was carefully planned so that it did not compromise alternatives in flap reconstruction. Usually the incision was adjacent to, but not over, the area of expansion; or one edge of the flap which would be advanced, transposed or rotated was used as incision site through which the implant (expander) was placed. The incision was made as short as possible, the longer the incision was the chance of wound dehiscence and exposure of the expander. The dissected pocket was 1-2 centimeters larger than the width and the length of the expander to permit the expander to lie comfortably in a flattened

position. When multiple expanders were required, we created a single pocket for all expanders to prevent pseudosheath septae formation among them. The injection port was tunneled away from the expander and the incision site. A vacuum suction drain was always used to prevent hematoma formation and to reduce the dead space. Following meticulous hemostasis, pure saline irrigation without antibiotic or antiseptic was employed before placement of the expander. Following the wound closure, the expander(s) was(were) partially instilled with normal saline solution to fill dead space, reduce bleeding, and maintain the pocket size without tension at the suture line. Removal of all sutures was done in two weeks time, then serial injection with sterile normal saline solution was begun. The instillation process was carried out under sterile condition and patience of the surgeon during injection was critical because only a 25-gauge needle was used for injection to avoid subsequent leakage of the reservoir. Care should be taken not to puncture the expander so that it could be reused again and again. The volume of normal saline injected slowly at each session depended on the skin perfusion color of the expanded area and patient discomfort. If the expanded area appeared pale with no capillary refill at all after waiting for 15-30 minutes, some volume of normal saline solution was withdrawn until capillary refill had returned. Usually the inflation proceeded regularly 2-3 times a week until adequate volume of expansion was achieved usually within 6 to 10 weeks. The total volume of expansion could be 40 per cent more than the volume of the tissue expander without causing rupture of the expander.

In the second stage, intraoperatively more expansion of the expander(s) would be done to stretch more skin flap, the expander(s) was(were) later removed and the expanded skin flap or scalp flap was rotated, transposed, advanced, or dissected as an island flap to cover the defect. In addition, limited capsulotomy of the pseudosheath had been helpful to unfurl the expanded flap. It should be noted that the incisions during capsulotomy must not be too deep to avoid disturbing or compromising the blood supply of the expanded flap. Apart from that, capsulotomy of the surrounding fibrous septae was essential, for instance, to smoothen the skull surface. However, reexpansion with the same expander(s) was (were) immediately or later performed if the defect was too large and the

expanded skin flap or scalp flap was insufficient to completely cover the whole defect in one procedure.

RESULTS

There were eighteen patients who underwent surgery employing the reused tissue expanders, eight were with new tissue expansion and two had Foley catheters for tissue expansion. Two or three reused expanders were together implanted in most cases. Five patients underwent reexpansion procedures due to larger defects which could not be corrected in one procedure. Two reexpansion procedures were carried out immediately after the first procedure and three were carried out few weeks later. The most common tissue expanders reused were rectangular shape of different sizes. There was a definite learning curve in the technique of tissue expansion at Ramathibodi Hospital. There were minor complications which included two minor wound infections which responded well to antibiotic therapy, two partial wound disruptions with exposure but without extrusion of the expanders, one perforation of the expander by a needle during saline instillation, one partial skin erosion over the reservoir, and one partial skin flap necrosis. There was no port failure. Despite those minor complications, the overall postoperative results were satisfactory.

CASE REPORTS

Case 1

A 24-year-old woman presented with capillary hemangioma at medial aspect of right cheek, medial canthal region and medial half of left upper eyelid. The decision was made to use tissue expander for correction of this vascular lesion. A 400 ml rectangular shape expander was used and placed subcutaneously under the right cheek skin and above the platysma of the neck skin. The expander was slowly filled with saline solution twice a week over the ensuing 7 weeks. The patient then underwent second operation. The expander was removed and partial capsulotomy to unfurl the expanded skin flap was done before being transposed to cover the defect. The lesion was excised after the flap had been developed. However, the defect of left upper eyelid was reconstructed with postauricular Wolfe graft. The patient required few



Fig. 4 A, B A 24-year-old lady had a capillary hemangioma at right face as shown in the pictures. A rectangular shape, 400 cc tissue expander, was placed subcutaneously beneath the cheek skin and above the platysma of the neck skin.
 C Intraoperative picture following removal of the tissue expander. The arrows demonstrated the pseudohemorrhage formation around the expander.
 D, E Two years after operations.

procedures for revision of the scars. The postoperative result was excellent (Figure 4).

Case 2

A 32-year-old woman sustained acid burn to her scalp and face. There was traumatic alopecia about 40 per cent of the scalp involving the vertex and frontal hairline. She was advised to have tissue expansion technique to correct the whole defect. Three rectangular shape tissue expanders following autoclaving sterilization were reused. They were placed around the defect and under the hair bearing galea. A single pocket was created for three expanders. Six weeks

later the second operation was performed. The expanders were removed, the expanded scalp flaps were rotated and advanced to cover the defect and a temporoparietal island flap from each side of the expanded scalp was carefully dissected and used for reconstruction of the frontal hairline. To make the most benefit of the expansion, capsulectomy of the fibrous septae formation between the expanders and partial capsulotomy of the expanded scalp flap were carried out before flap coverage. However, there was still an alopecia defect measuring 6×12 cm. Reexpansion was performed 6 weeks later when three rectangular tissue expanders were reused for correction



Fig. 5 Photograph of Case 2 who sustained acid burn to her scalp and face with a traumatic alopecia of about 40 per cent of the scalp.

A Front view.

B Top view.

C Three rectangular shape expanders were placed for reconstruction.

D Postoperative photograph after first tissue expansion procedure. The frontal hair line was reconstructed with two island flaps from both temporo-parietal expanded scalp flap. There was still a remaining defect at the vertex measuring 6 x 12 cm which needed further reconstruction.

E Photograph demonstrated three tissue expanders being inserted adjacent to the alopecia defect 6 weeks later for second expansion procedure.

F Final appearance following reexpansion procedure.



Fig. 6 A, B Photographs of Case 3 who suffered from neurofibroma at right fronto-temporo-parietal region measuring 13 x 15 cm
 C Two rectangular shape tissue expanders were used for reconstruction. One for expansion of the forehead skin and another one for expansion of the scalp.
 D The expanders were removed. The forehead flap and the scalp flap were advanced and rotated to cover the whole defect respectively.
 E, F Three months after the operation.

of the residual defect. Unfortunately, one tissue expander was accidentally perforated by a needle puncture during serial saline instillation. The other two expanders worked well and provided enough scalp flap to cover the remaining defect. She was very satisfied with the postoperative result (Figure 5).

Case 3

A 43-year-old lady had been suffering from neurofibroma at right fronto-temporo-parietal region since birth. Two rectangular tissue expanders were reused for reconstruction. One 200 ml expander was placed under the frontalis muscle. Another one 400

ml expander was placed under the galea of the scalp. Serial instillation of the saline solution was carefully performed 2-3 times a week. Six weeks later the patient underwent second operation. The whole scalp lesion measuring 13 x 15 cm was completely excised. After the expanders had been removed, the forehead flap was laterally advanced to reconstruct the frontal defect and the scalp flap was rotated to correct the temporoparietal defect. The dog ear was excised and revision of scars was carried out few weeks later under local anesthesia. The postoperative result was excellent. The disease was cured and the frontalis muscle function was restored (Figure 6).

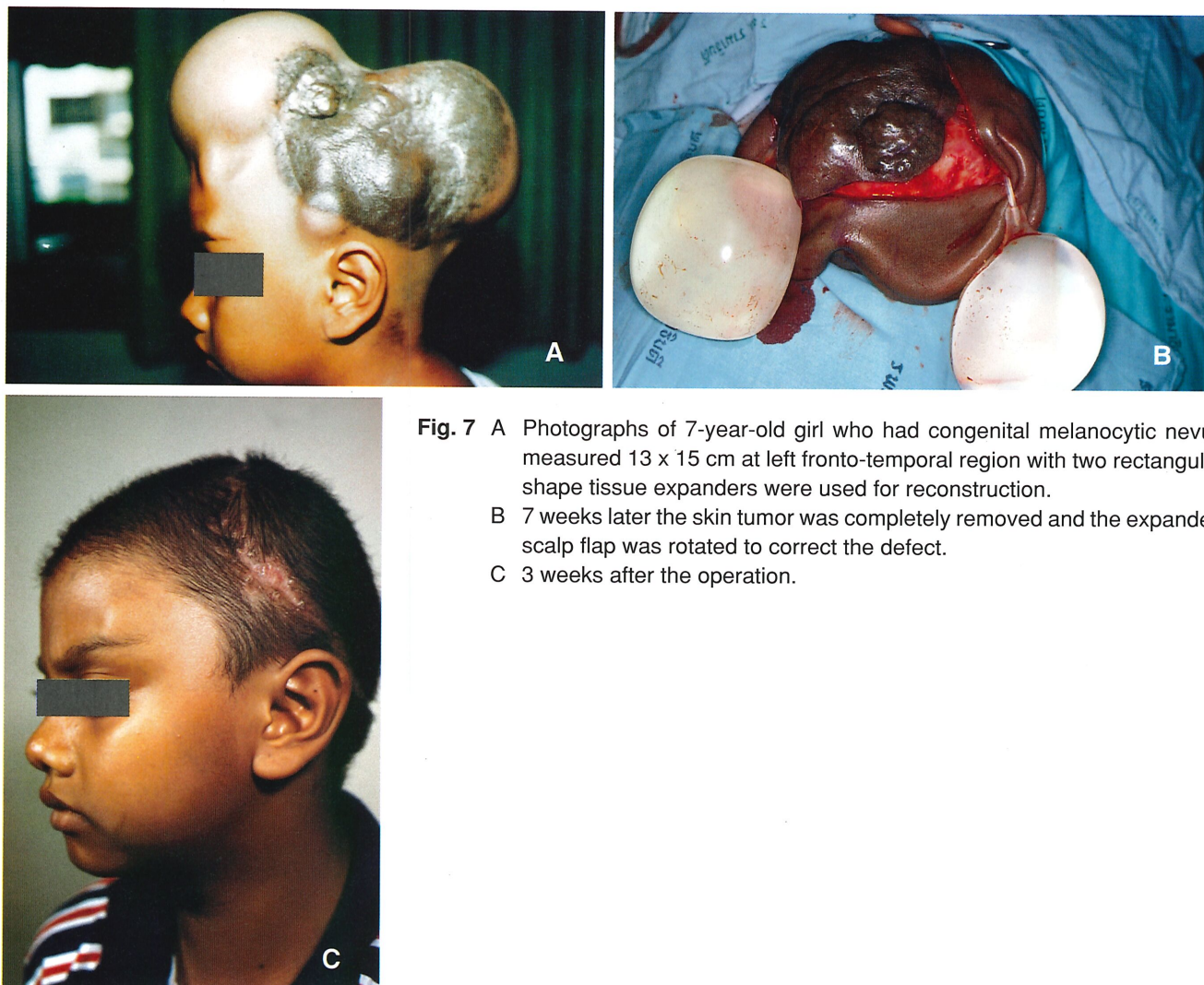


Fig. 7 A Photographs of 7-year-old girl who had congenital melanocytic nevus measured 13 x 15 cm at left fronto-temporal region with two rectangular shape tissue expanders were used for reconstruction.
 B 7 weeks later the skin tumor was completely removed and the expanded scalp flap was rotated to correct the defect.
 C 3 weeks after the operation.

Case 4

A 7-year-old girl had a congenital melanocytic nevus measured 13 x 15 cm at left temporoparietal region. Prophylactic and cosmetic purposes were indicated for surgery. Two rectangular tissue expanders were reused for expansion of the normal scalp. The patient was well cooperative during serial instillation of saline solution. Eight weeks later she underwent second operation. The melanocytic nevus was completely removed and sent for histopathological studies. The defect was completely covered with the expanded scalp flaps. The postoperative result was excellent (Figure 7).

DISCUSSION

A cardinal rule of reconstructive surgery is to prevent distortion and maintain the aesthetic and functional norm. Occasionally, these goals are difficult to satisfy completely, and priorities must be assigned. If necessary, function and avoidance of distortion must take precedence over aesthetics. To prevent disturbances of function and form, flaps and grafts that violate cosmetic principles are sometimes required. As far as head and neck reconstruction is concerned, the advent of tissue expansion has provided a useful tool for plastic surgeon because the expanded skin flap or scalp flap can serve well for correction of the skin loss

or surgical defect. With careful design and good techniques, tissue expansion can provide excellent functional and aesthetic results of not only the head and neck reconstruction but also reconstruction of other parts of the body, with minimal donor site morbidity.¹⁴

Tissue expansion offers many advantages. Most notably it enables the surgeon to reconstruct the defect and primary closure of the donor site. Less wound tension at the time of closure may prevent widened scars and distortion of important anatomical structures. Expanded skin flap with similar color, texture, adnexal structures as well as excellent vascularity enables rotation, transposition, advancement of large flaps that may be useful in the head and neck region.

The disadvantages of tissue expander include the added time for reconstruction. The procedure does require at least two operations and multiple visits to the surgeon are also required during the expansion period. A compliant patient is essential to a successful tissue expansion. The patient needs to be well-informed, motivated, and fully understands the whole process of the procedure. Tissue expansion may necessitate time away from work or school depending in part how well the patient tolerates the cosmetic deformity and body image distortion that occurs during the interim period of the procedure. However, these problems are usually tolerated well by the Thai patients. The most important problem that happens to them is that the tissue expander is quite expensive and financial problem makes them refuse the use of tissue expansion technique. We have solved this problem by reusing the expander despite the direction mentioned by the manufacturing company is "single use only". We have found that once there is no leakage of the expander system and it can be readily sterilized, it can be temporarily implanted and reused again and again. Autoclaving sterilization is recommended as it is simple and readily possible in the operating room of our country. The 25-gauge needle which is used for instillation of saline through the port is recommended to prevent port failure during high back pressure of the saline in the expander through the port. The reused expander is applicable for reconstruction of not only head and neck region but also to all areas of the body.^{14,15} Satisfactory results following reconstruction with tissue expanders have been achieved in our experience.

CONCLUSION

When local tissue of similar quality is insufficient to reconstruct a cutaneous defect of the head and neck, tissue expansion provides a valuable reconstructive option because it enables the plastic surgeon to adequately expand and replace like tissue with like tissue with preservation of sensation and adnexal structures. Thus, the missing skin and scalp defect can be satisfactorily replaced with skin flap and scalp flap respectively of identical color, texture, and appendages including hair growth.

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