Special technique in the Poland syndrome

10

10.1 Surgery of Poland's syndrome

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10.1.1 Principles of surgical correction

Planning of surgical correction of the chest wall deformity in Poland's syndrome depends primarily on the severity of the condition and the different types of tissues involved. This may include some or all of the following components: skin and subcutaneous tissues, breast, muscle(s), rib(s), and other skeletal deformities such as scoliosis. The treatment is therefore, tailored to the needs of the patient. The deformity in females has the added dimension of breast asymmetry that may require augmentation or total breast reconstruction. Surgical treatment may involve any or a combination of the following:

- Implant augmentation.
- Custom-made prosthesis.
- Tissue expansion.
- Latissimus dorsi (LD) muscle transposition.
- TRAM flap or other free tissue transfer.
- Lipomodeling, autologous fat graft, and liposuction.
- Rib cage reconstruction with autologous or alloplastic material.
- Nipple areola complex (NAC) reconstruction.
- Reduction, mastopexy or augmentation of contralateral breast.

Although most patients who present for treatment are young adults, increasingly children of the age of 10 years and in the early teens are seeking advice about treatment, but at a much earlier date parents seek advice about the deformity and indications and timing of surgery. Definitive treatment in young males is easier than in females due to the more dramatic changes in the size and shape of the female breast, as they grow older. Men with the deformity and approaching the middle age sometimes seek treatment due to a natural increase in the size of the normal breast and development of gynecomastia with age that leads to a more noticeable gross asymmetry of the chest (Fig. 1a). Mild rib cage deformity and/or partial absence of the anterior segment of one

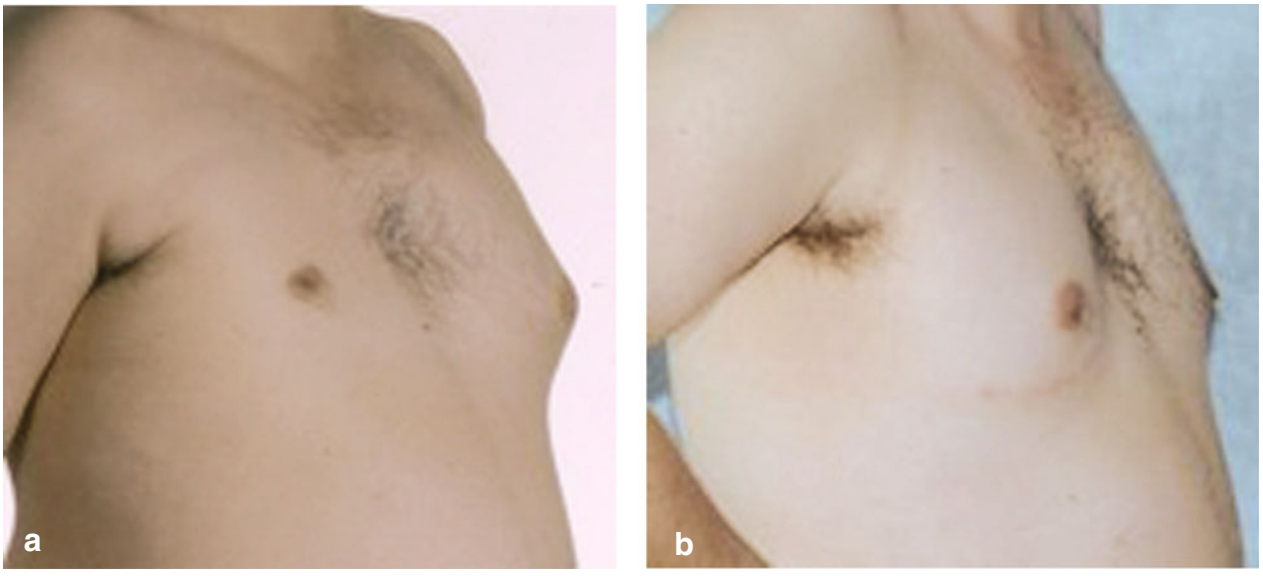

Fig. 1a and b. Correction of Poland's deformity in a 44-year-old male patient using a custom-made silicone prosthesis on the right side and liposuction of gynecomastia on the left side

A. H. Schwabegger (ed.), *Congenital Thoracic Wall Deformities*

or more ribs, commonly from second to fifth [27], that do not cause an obvious depression in the rib cage contour can be ignored during reconstruction but severe absence of multiple segments of ribs require chest wall reconstruction before the overlying soft tissue deformities can be corrected. Appropriate surgical treatment must be carried out on different age groups in males and females.
Personal experience include treating 32 patients between 1993 and 2007 with an age range of 11–44 years and using a variety of techniques either as single procedures or multistage and combined procedures, examples of which are demonstrated below.

10.1.2 Correction of male Poland's chest wall deformity

Although it has been mentioned that Poland's syndrome affects males more than females [21], in reality, because rarely there is a functional indications for surgery [5], more female patients seek treatment for aesthetic reasons than males do. But increasingly male patients who are self-conscious of the deformity seek surgical correction too.
The method of correction applied depends on the severity of the deformity. Insertion of custom-made silicone prosthesis in a subcutaneous plane can be very effective in camouflaging the deformity [12] (Fig. 1a, b). The consistency of the silicone prosthesis is dictated by the consistency of the tissues it replaces [5]. When the defect is more pronounced and reconstruction of the anterior axillary fold is required, LD muscle transfer can be considered. A custom-made prosthesis may also be required if the contour defect is too severe due to rib cage deformity [12, 15, 25]. However, the patient has to understand that this means sacrificing the posterior axillary fold and adding scars to the back and axilla for the purpose of tissue-addition to the chest. Preoperatively, it is important to clinically establish that the LD muscle on the affected side is equally developed like the contra-lateral normal side [3, 6]. If ipsilateral LD transposition is not available, free microvascular contralateral flap transplantation is an alternative (Chapters 10.2 and 10.3) and it is mandatory to establish the presence of suitable recipient vessels preoperatively as well as intra-operative assessment of the recipient vessels before embarking on the free tissue transfer [4, 20]. The area of muscle deficiency is outlined with the patient standing up and both hands tightly squeezing the waistline for comparison and the skin of the anterior chest wall is marked and extending onto the arm. Similar dimensions are drawn on the back skin overlying the LD muscle as a guide for the dimensions of the muscle harvest required for the reconstruction. Through an axillary dissection the adequacy of the thoraco-dorsal pedicle is ascertained first. The anterior chest dissection is carried out next through an inframammary incision and with the help of a set of lighted retractors. Further access is gained through the axillary incision that is used to identify the pedicle as part of raising the LD flap. Superiorly, in an attempt to reach as high as possible in correcting the deformity in the infraclavicular area, extreme care must be taken to avoid injury to the cephalic and/or subclavian vein particularly if the clavicular head of the LD muscle is absent or hypoplastic. Injury to the subclavian or cephalic vein can lead to disturbing hemorrhage and immediate action must be taken by gaining direct access to the bleeding vein to avoid heavy blood loss. The LD muscle can be mobilized through a relatively small transverse incision in the back, approximately 8–10 cm in length, level with inframammary fold or a vertical incision along the lateral border of the muscle [15] and a 5–6 cm incision in the axilla. A small ellipse of skin can be harvested with the flap and de-epithelialized to bury it under the NAC area to enhance the breast contour (Fig. 2). The muscle is completely islanded on its neurovascular pedicle by detaching the insertion from the intertubercular floor of the humerus and tunnelled through the axilla to the chest and then reinserted to the crest of the greater tuberosity of the humerus using the tendon of the clavicular head as a guide when it is present. Otherwise, in the complete absence of PM muscle, the tendon is sutured to the fibrous condensation of the periosteum of the crest above the deltoid insertion where the latter muscle fibers normally blend with the pectoralis major muscle insertion [15, 23]. This is carried out through the axillary incision and it requires strong retraction of the space between the deltoid and the two heads of biceps muscle. The periphery of the LD muscle is sutured to the chest wall along the lateral border of the sternum and to the lower border of the clavicular head of the PM muscle if it is present. The tendon is inserted to the humerus in a way to create sufficient resting tension in the muscle to continue acting as an effective functional unit and stand out in the anterior axillary fold (Fig. 2c). However, it is difficult to reproduce a fold of similar thickness to the normal side which is formed by rotational twisting of the normal pectoralis major muscle to form a rounded axillary fold before becoming tendinous and inserting to the humerus [23]. This however, can be compensated

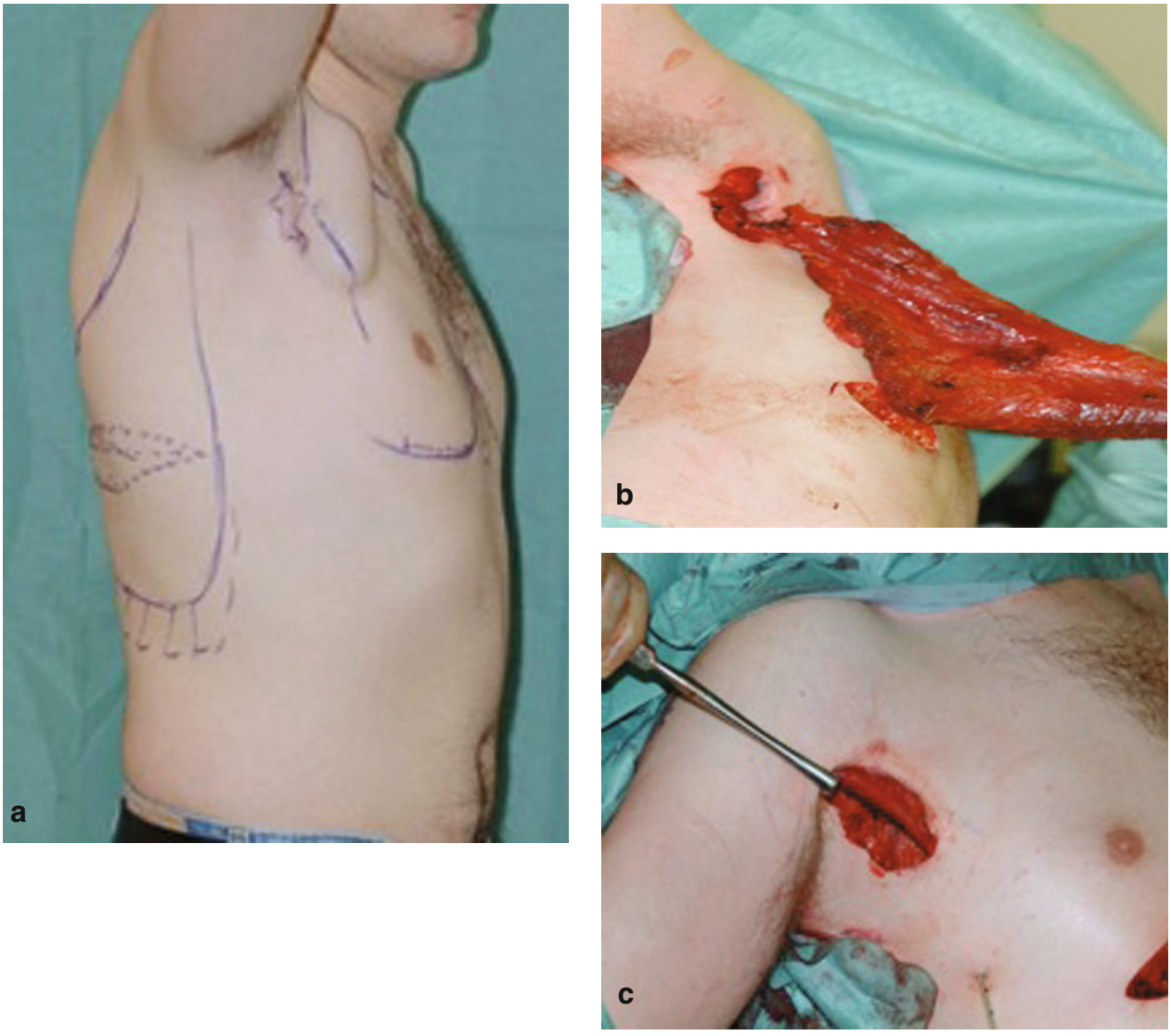

Fig. 2a. Planning of ipsilateral LD muscle transfer. This patient has had prior expansion of the anterior axillary fold skin, notice the –w– scar in the axilla to introduce the expander which is removed and the incision is reused for axillary approach and fixation of the LD tendon to the humerus. Also notice the outline of the dimensions of the muscle required both on the chest and the back including a small skin ellipse to de-epithelialize and use to enhance the breast contour. **b** The LD muscle completely islanded on the neurovascular bundle and ready to be inserted to replicate the PM muscle attachments. **c** LD muscle inserted in a way to reconstruct a functional anterior axillary fold

for with fat injection (Chapter 6.6.2) at a later date if the patient is still concerned. The remaining donor site skin flaps of the back are then quilted down the chest wall with absorbable sutures to prevent seroma formation [10, 24, 26]. In the absence of the ipsilateral LD muscle, the contra-lateral muscle [17] can be used as a free flap (Chapter 10.3). Targeted exercise in the postoperative period can help maintain and even increase the bulk of the muscle. When the skin in the region of the missing anterior axillary fold is unduly tight, tissue expansion can be carried out before the muscle transfer to facilitate the creation of the fold (Fig. 2a).

Lipomodeling is increasingly emerging as a very simple, safe, and effective way of correcting Poland's chest wall deformities, either as a primary method (Fig. 3a–d) or as a secondary procedure to compliment any of the above described techniques that often leave residual contour deficiency and rarely produce full symmetry [7–9, 22]. The procedure is minimally invasive, it does not leave visible scars

Fig. 3a and b. Preoperative views of basic Poland's deformity in a 23-year-old male patient treated with autologous fat injection. **c** 3 months after the first course of fat injection, 110 cc, notice the formation of a new axillary fold. **d** Final result several months after the second course of 80 cc fat injection and some liposuction of right breast with excellent lasting correction of the deformity

behind and it can be carried out as day case surgery. Furthermore, the reconstructed area feels entirely natural with no need for long-term maintenance work. However, the patient must have sufficient excess fat in the proposed donor sites such as abdomen, loins, hips, and thighs. Large amounts of fat may be required and must be injected methodically (Chapter 6.6.2) to correct the contour defect either in one or multiple sessions, using the Coleman system and technique of micro fat grafting to avoid fat necrosis. If there is a significantly tight skin with lack of subcutaneous tissues, staging the fat

injection allows the skin to relax after first injecting a relatively smaller amount of fat, 60–100 ml over a wide area, in preparation for further injections at a later dates. Lipomodeling may involve liposuction of the contra-lateral side to help achieve better symmetry (Fig. 1b).

Injectable alloplastic hydrophilic gel materials such as Bio-Alcamid™ (Polymekon, Italy) have been advocated as a simple method for correction of various contour defects including the chest wall and in Poland's deformity [18]. However, the highly viscous material is not easy to inject, particularly when very large volumes are needed to correct such deformities. Furthermore, one has to weigh the relative simplicity of the technique against possible long-term problems that may arise from injecting large amounts of alloplastic material such as infection and granulomatous reactions. Autogenous tissues are always preferable and should be the first choice of treatment whenever applicable.

Asymmetry of position of NAC is more difficult to correct in male patients, however significant asymmetry of size can be corrected with tattooing.

10.1.3 Correction of female Poland's chest wall deformity

The female deformity is more complicated due to the added breast deformity and asymmetry that also involves the NAC. In patients with partial absence of PM muscle and mild to moderate degree of breast asymmetry, unilateral breast augmentation or bilateral differential breast augmentation may be sufficient to achieve an acceptable level of correction. However, implant

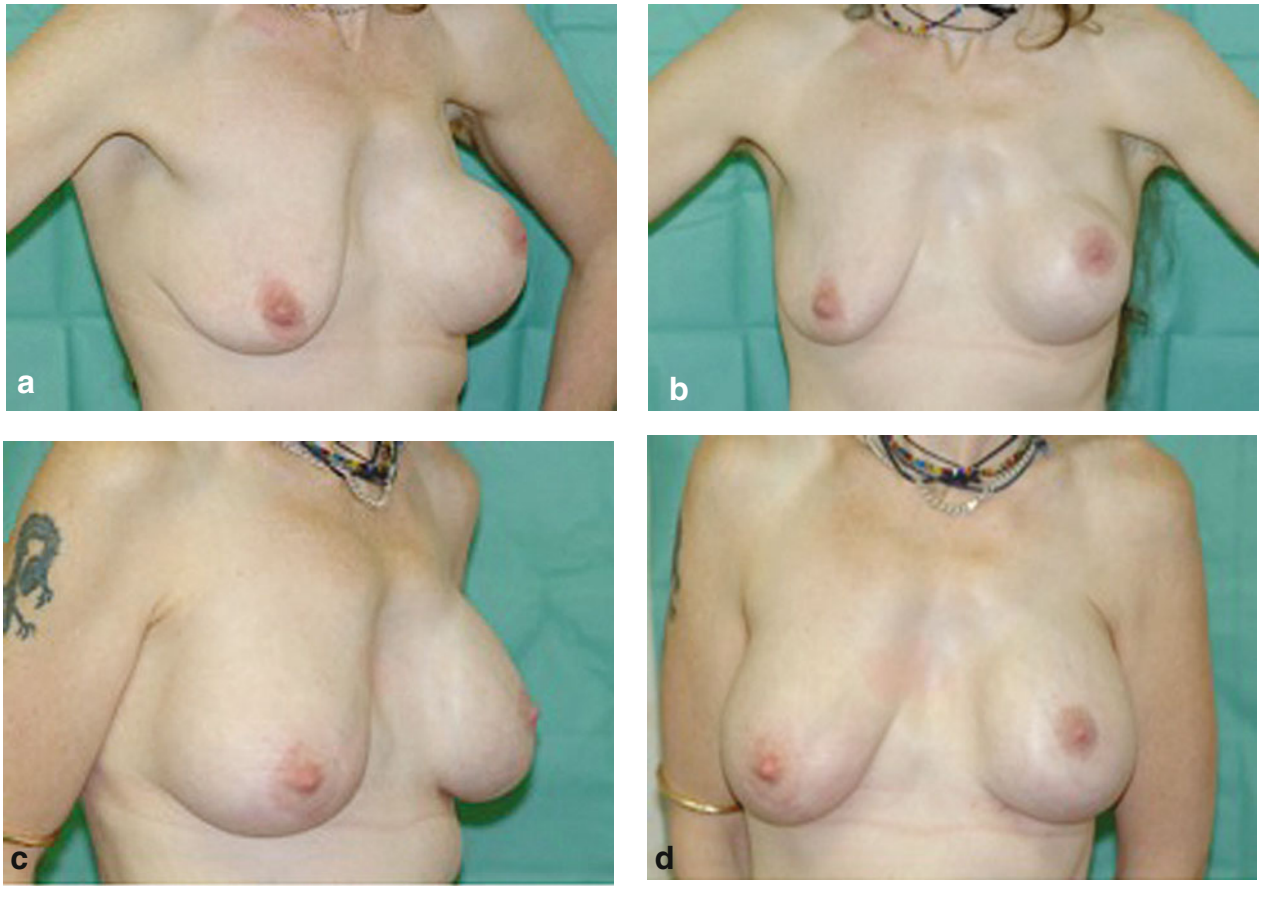

Fig. 4a and b. Unsatisfactory result from attempted correction of Poland's deformity in a female patient using round silicone breast implant. Notice the appearance of an accentuated upper pole deformity and gross asymmetry with her naturally ptotic right breast. **c** and **d** Significant improvement after replacing the old implant with a full height and full projection anatomically shaped (Inamed® BioDimentional) breast implant and mastopexy + augmentation of the normal right breast using a medium height and medium projection of a similar breast implant

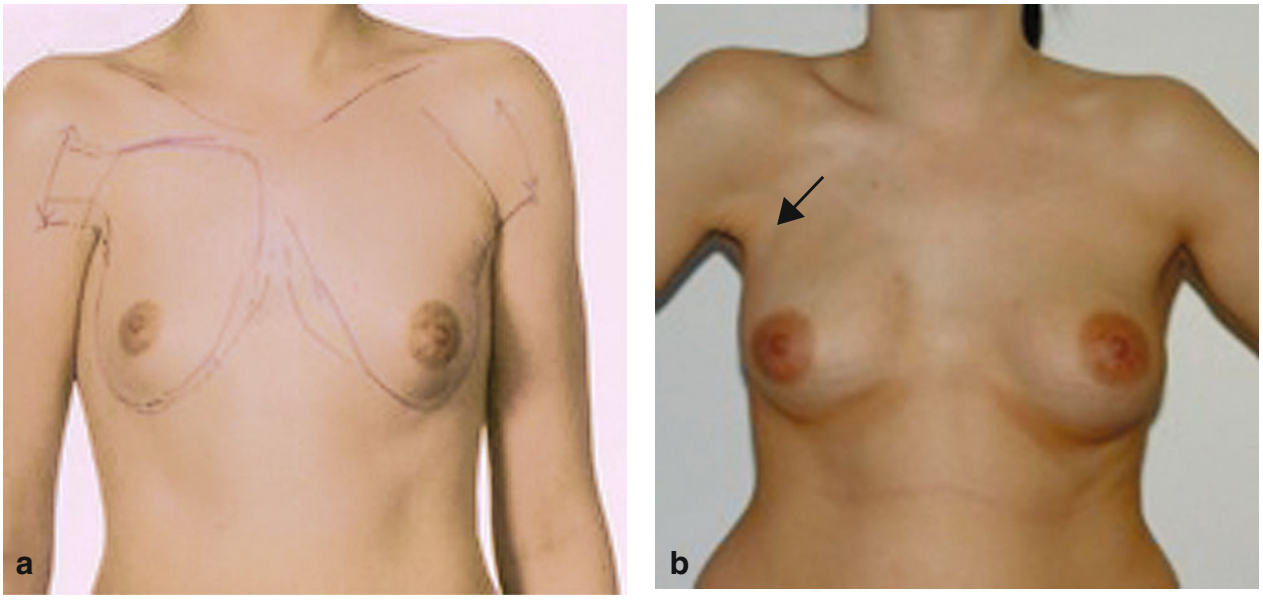

Fig. 5a. 17-year-old female patient with complete absence of right PM muscle and moderate breast asymmetry; planning for a combination of bilateral differential breast augmentation and right LD muscle transfer to reconstruct the anterior axillary fold and reduce the contour deficiency in the infra-clavicular region. **b** Notice a fully functional LD muscle in the right anterior axillary fold indicated by the arrow. Further correction of any residual contour deficiencies can be improved with fat injection

alone does not correct the defects in the infra-clavicular and anterior axillary fold areas. A full height anatomical implant is preferable to help correct some of the upper pole contour deficiency (Fig. 4a–d) [16], which demonstrated a complex reconstruction of the chest wall and breast deformity in a female patient using customized composite silicone prosthesis. Before dissection of the pocket is started it is necessary to establish the integrity of the ribs, as missing ribs also signify missing intercostal muscles (Figs. 1 and 2 in Chapter 10.3), therefore, extreme caution is required during dissection of the pocket to avoid injury to the pleura and the lung. This is highly relevant if one is revising an old implant with capsulectomy and change of prosthesis; the posterior wall of the capsule may effectively be adhered to the parietal pleura. This principle applies to male patients as well if they undergo prosthetic reconstruction.

Breast augmentation can be supplemented by fat injection in the upper pole, the infra-clavicular region and the area of the anterior axillary fold to further correct the contour deficiencies in these areas that cannot be addressed by implant alone [22]. Total correction of significant deformities in females with Lipomodeling, i.e., fat injection alone is possible in selected patients [8, 9].

When breast hypoplasia is combined with tight skin and in cases of breast aplasia, tissue expansion is necessary to create a skin envelope for the new breast [2]. Depending on the circumstances of the case, the expander is either replaced with an implant, or autologous tissue transfer is required either alone or

Fig. 6a. Significant left chest wall deformity in a 19-year old thin patient with a relatively large and fully developed right breast requiring multi-staged procedures. **b** Stage one involved making a cast of the rib cage defect to manufacture a custom-made semi-solid textured silicone prosthesis to create a platform for the breast reconstruction. The prosthesis is introduced in a subcutaneous pocket (see arrow) that was very carefully dissected because of the missing ribs; the dissection was made safer by creating a tumescent field. The prosthesis was fixed with few sutures at the periphery of the rib defects through holes made during the manufacturing of the prosthesis. **c** Stage two involved a bipedicled muscle preserving TRAM flap to harvest a flap with maximum possible dimensions to help introduce some soft tissue in the subcutaneous plane covering the area from below the clavicle to the inframammary fold and from the lateral border of the sternum to the anterior axillary fold. The soft tissue mound is significantly small and further measures needed to create a breast. **d** Stage three, a Style 150 adjustable breast implant was inserted in a pocket dissected between the TRAM flap and the custom-made silicone prosthesis preserving its covering capsule. The implant was inflated to its capacity over a period of several weeks and in a stage four, nipple reconstruction was carried out and later followed by tattooing of the NAC. The whole process took approximately a year to complete and as a final touch the patient went and had a decorative tattoo designed by a professional


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b


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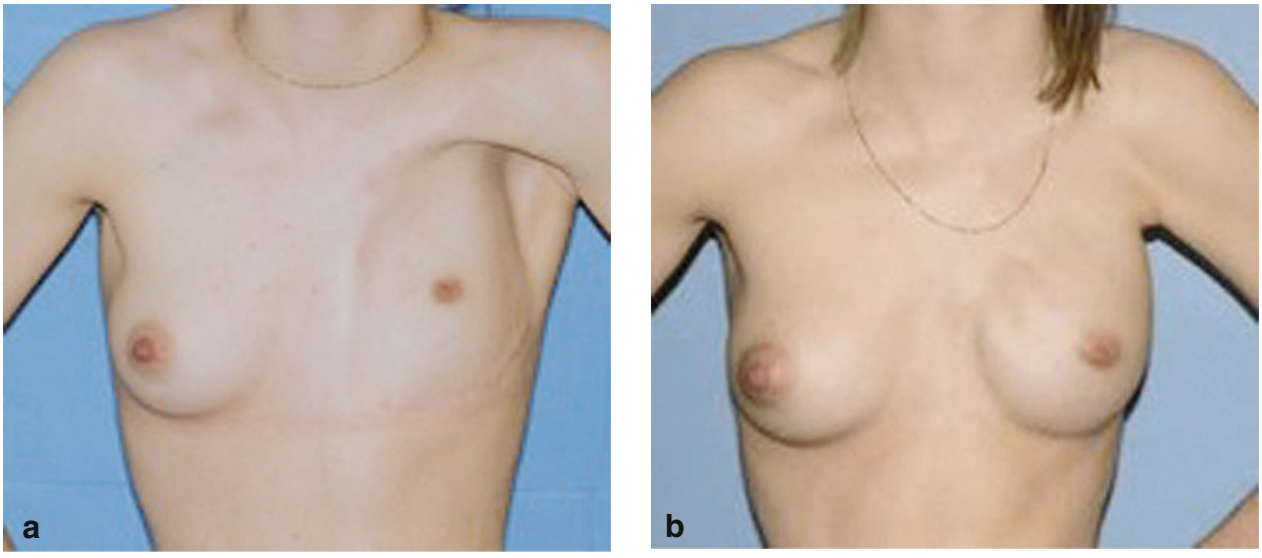

Fig. 7a. Rib cage deformity corrected in the cardiothoracic department using methylmetacrylate cast introduced through an incision near the inframammary fold region and the patient referred for breast reconstruction. **b** Breast reconstruction with a combination of LD muscle transfer and Style 150 full height anatomical implant resting on a platform of methylmetacrylate prosthesis. Notice the functional LD muscle in the anterior axillary fold

combined with an implant. LD muscle transfer is ideal for this purpose with the implant inserted behind it. The muscle contributes to the correction of the upper pole and the anterior axillary fold contour deficiencies as well as providing added soft tissue cover for the implant (Fig. 5a, b). Alternatively, Lower abdominal excess tissues can be transferred either as a pedicled TRAM, free TRAM, DIEP or SIEA or other free perforator flaps [11, 13, 20]. In the presence of severe absence of multiple rib segments with obvious chest wall defect and severe breast hypoplasia or aplasia (Fig. 6a), appropriate reconstruction of the skeletal defect is necessary before the breast and other soft tissue defects can be rectified. The reconstruction becomes more challenging when the patient is thin and has a well-developed contralateral breast (Fig. 6a). Preference should be for the least invasive technique with the minimum visible scars and complications. Custom-made silicone prosthesis is preferable and serves this purpose well. Alternatively, methylmetacrylate cast made at the time of the exploration can be used (Fig 7a). In a second stage soft tissue transfer is carried out. If LD muscle is used, an adjustable expander/implant can be inserted under the muscle at the same time to be expanded at a later date (Fig. 8b). However, if TRAM or other autologous free tissue transplantation is carried out, the flap is de-epithelialized and inserted under the skin with attention paid to correcting the upper pole and anterior axillary defects which takes a significant volume of the flap to achieve. Insertion of the expander/implant under the transferred tissues is deferred to a later date to prevent problems with flap survival due to pressure (Fig. 6b–d). A narrow strip of skin from the flap can be left and inset in the skin incision made in the future inframammary fold to monitor circulation in the flap that could be removed at a later date. This technique avoids insertion of a skin paddle from the flap as in delayed breast reconstruction in order to create natural ptosis. If the patient has a high NAC on the affected side, a strip of skin from the flap can be inserted above the NAC to lower its level. Further procedures to reconstruct NAC and make final adjustments of shape and size may be necessary.

10.1.4 Correction of Poland's chest wall deformity in children

Children between the ages of 8 months and 16 years have been treated for chest wall deformity including the use of LD muscle transfer, ipsilateral as well as contralateral micro-neurovascular transfer, rib grafts, and synthetic mesh. So far, no evidence of long-term adverse effect on the musculo-skeletal development is reported [1, 14, 17, 19]. However, one must consider the fact that the procedure is primarily carried out for

Fig. 8a. 11-year-old girl had insertion of Style 150 implant after becoming very self-conscious of her relatively minor breast asymmetry and absent pectoral head of PM muscle when she was 12 years old. At this stage the augmented breast is larger and no saline insertion was needed for another 2 years. **b** Same patient at the age of 18 requiring change of implant. **c** Now the patient is aged 21 and notice the change in her weight, she requested change of her implant in the right breast for a bigger one

aesthetic rather than functional reasons [5] and perhaps unless there is a compelling reason for operating earlier in life [1], one should allow the child to grow to an age when they can demonstrate signs of self-consciousness and willingness to undergo surgery. Young girls with minor form of the deformity commonly become more aware of it once they begin to develop a normal breast on the contra-lateral side which can happen as early as the age of 10–11 years. Many of them are happy to postpone treatment until they have matured further and some until they have fully grown. If they wish to have early treatment, it is reasonable to use a suitable adjustable breast implant with potential to increase the volume as the contra-lateral breast grows larger (Fig. 7a–c) until such time when a more definitive treatment can be carried out with the patients' full informed consent. The

earlier surgery is carried out the more likely that revisions will be required, as the patient grows older, particularly in female patients.

In conclusion, Poland's chest wall deformity includes a wide range of visible deformity and asymmetry, from simple to complex, depending on the severity and the extent of the different tissues involved. Rarely treatment of the chest wall deformity is required for functional reasons. A variety of treatment options are available, ranging from simple to very complex and multistage procedures. There is no age or sex limitation on surgery as such, but judgment must be exercised in each patient on an individual basis, taking the patients' specific circumstances into consideration including the presence of other associated deformities.

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10.2 Special microvascular flap for the Poland syndrome, the TMG-flap

Thomas Schoeller

10.2.1 Introduction

The Poland syndrome deformity is characterized by the missing lower part of the pectoralis major muscle and therefore the missing anterior axillary fold (Fig. 1). Additionally hypoplasia of the breast gland can be associated in various forms. Severe other deformities of the upper limb can be also seen and are described in a different chapter (Chapter 2.3.4). The idea of correcting a missing pectoralis major muscle by a free functional transverse myocutaneous gracilis (TMG)-flap is a relatively new approach to this particular problem. In former times the most common surgical correction was the transposition of the latissimus dorsi flap, if this muscle was not effected by the Poland syndrome [1–4]. In some centers lipofilling is used as a primary method of correction [5]. In our hands the lipofilling procedure is more used as an ancillary procedure for minor volume corrections (see Chapter 6.6.2). The TMG-flap gives the opportunity to create a dynamic and functional anterior axillary fold by inserting the gracilis muscle in the direction of the missing pectoralis major muscle followed by a nerve coaptation. Additionally the attached skin can be used to build up the missing soft tissue volume in the infraclavicular region and if necessary also to add further volume to the missing breast.

10.2.2 Surgical technique

The operation is performed in two teams, one is preparing the recipient pocket (Fig. 2) for the gracilis-flap in the pectoral region of the affected side, the second team simultaneously harvests the TMG-flap at the contralateral thigh (Figs. 3–5). The skin is undermined from the thoracic skeleton and the recipient vessels, preferably the thoracodorsal vessels, if available, as well as a recipient motor branch from muscles in the vicinity (Fig. 6). Due to the characteristics of the Poland syndrome a high variability of unexpected anatomy occurs with sometimes, apart from the absent pectoralis muscle and breast gland, hypoplastic or even missing further anatomical structures [6].

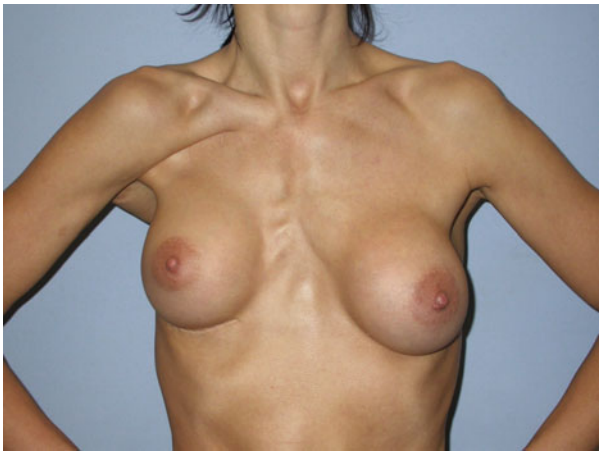

Fig. 1. Missing anterior axillary fold due to hypoplastic pectoralis major muscle (PMM). Only the clavicular portion of the PMM is visible during forced contraction. This patient already received subglandular breast implants in a former operation

Fig. 2. Marking of the recipient pocket in a subcutaneous plane to host the transplanted microneurovascular flap. The orientation of the pocket simulating the direction of the lacking portion of the PMM

Fig. 3. Marking of the gracilis muscle along the thigh, with a transverse skin island along the groin and the anterior gluteal fold, in order to keep the resulting scar in a hidden region

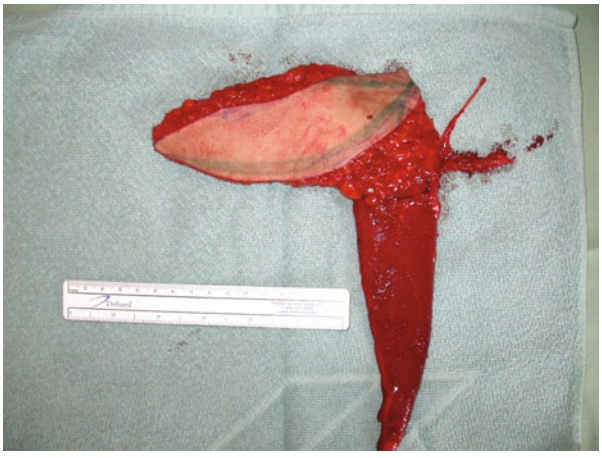

Fig. 5. Harvested free transverse myocutaneous graciilis (TMG)-flap with the vascular pedicle (right) and nerve (45° angle to vessels)

Fig. 4. The flap already dissected, notice absence of any scar at the thigh. The gracilis muscle was dissected via the skin incision, that circumcised the skin island

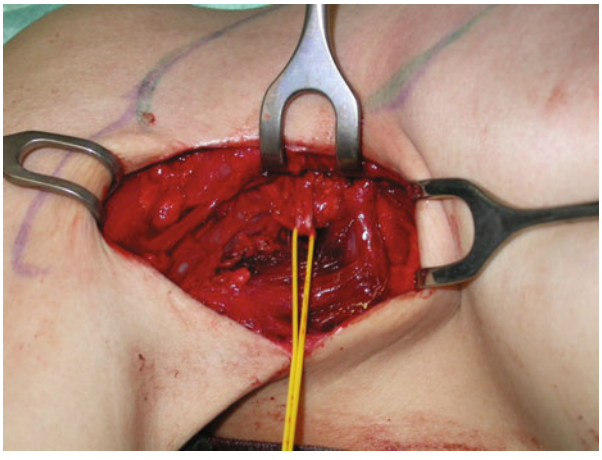

Fig. 6. Thoracodorsal nerve marked with a rubber loop, to which the anterior branch of the obturator nerve supplying the gracilis muscle will be coapted end to side

10.2.3 Harvesting of the TMG-flap

The patient lays in supine-position, the thigh is slightly abducted and the calf mobile, trapped with sterile stockings. The skin island of the flap is featured by its landmarks which are: the upper border is the natural crease of the groin in extension to the infragluteal fold (Fig. 3). The anterior border is the palpable tendon of the adductor longus muscle, the posterior endpoint is the posterior midline and the lower boarder of the skin island is defined by the laxity of the skin which will be tested preoperatively in a standing position. The skin is pinched and approximated to the upper line where tension free closure is still possible. Usually a width of the skin island of 8–12 cm can be harvested. The skin island is elevated including the fascia of the thigh, posterior and anterior of the attachment of the gracilis muscle. The skin island after harvesting remains attached to the gracilis muscle only. In the next step the plane underneath the facia and above the gracilis muscle is mobilized along the whole length of the inner thigh. Attention is paid to the secondary minor pedicle of

the gracilis muscle. In many cases direct clipping of this pedicle can be achieved, but if this pedicle arises very distal only a blunt dissection with a slowly overextension and subsequent rupture of the pedicle may cease bleeding therefrom. As soon as the conjunction between tendon and muscle is felt, the tendon is dissected with long scissors, but transected as far distally as possible. The origin of the muscle will be released from the pubic bone and the nerve motor branch and the vascular pedicle are prepared up to the length requested. The motor branch (anterior branch of obturator nerve) should be followed as proximally as possible (up to 10 cm is rather feasible). The motor branch enters the muscle about 2 cm above the hilus of the vascular pedicle (Fig. 5). The nourishing vascular side branches into the adductor longus and abductor magnus muscle have to be clipped off and the pedicle is further developed until it originates from the profunda femoris artery and vein. The closure of the donor side resembles a typical medial thigh lift. Skin closure by resorbable sutures is recommended since stitch removable in that region is very uncomfortable for the patient. Postoperative compression stockings to the thigh is necessary for the first 10 days.

10.2.4 Preparation of the donor side

Preoperative markings are defining the submammary fold and a symmetrical approach to the new anterior axillary fold (Fig. 2). Just posterior to the new anterior axillary fold a lazy-S skin incision is made and the skin at the anterior thoracic skeleton is undermined together with the breast tissue, if present. Special care has to be taken by that step because sometimes ribs are missing [6] and perforation of the thinned thoracic wall may cause pneumothorax (Chapter 10.3). As soon as the whole area is undermined the volume filling flap is inserted (Fig. 7). Prior to flap insertion the skin island needs to be deepithelialized entirely. The subcutaneous part is used to fill up the missing volume either at the infraclavicular region or may serve to add further volume to an underdeveloped breast in women. Fixation of the flap to the deep tissue layers especially toward the midline is facilitated by special hooks equipped with cold light. Then the anterior axillary fold is created by suturing the tendon of the gracilis muscle to the humerus bone or the upper arm fascia with particular attention not to damage any crossing nerves. The origin of the gracilis muscle then is sutured to the rib periosteum and intercostal muscles to the same position as the contralateral pectoralis major muscle presents itself (Fig. 8). Care has to be taken to maintain the correct resting tension, which preferably should be marked with a suture into the muscle before release of the tendon during flap harvest. As soon as the whole flap is sutured and secured, the vascular pedicle will be hooked up by microsurgical anastomoses. End-to-end-anastomoses to the thoracodorsal vascular bundle are preferred. An epineural window to the thoracodorsal nerve is cut, followed by an end-to-side neurorrhaphy secured with a drop of fibrin glue. At the recipient side no compression should be applied after wound closure.

Fig. 7. The free flap is transferred to the site of reconstruction, depicting the volume that is available with this flap, necessary to fill up the missing tissue and occasionally depressed thoracic wall

Fig. 8. The situation immediately after wound closure. An oxygene probe serves for flap perfusion surveillance. The plastic pads secure transcutaneous fixation sutures to keep the muscle and skin flap at the position desired

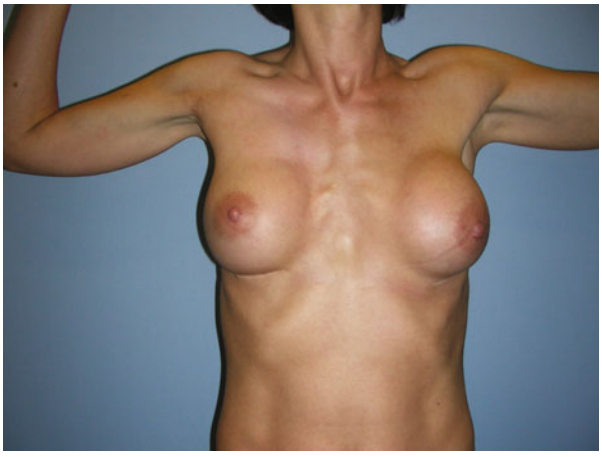

Fig. 9. The situation one year after flap transfer. Notice the sufficient volume bulk at the upper implant margin and the recreated anteror axillar fold at the right side. The reconstructed side resembles even more aesthetic than the contralateral side with a lateralized breast implant due to slight capsular contracture

10.2.5 Discussion

The TMG-flap reconstruction for a Poland syndrome associated thoracic wall deformity is a new and dynamic approach to this difficult problem. It has to fulfill two tasks: first the restoration of the anterior axillary fold and second a volume replacement (Fig. 9). The idea behind the nerve coaptation and the functional transfer is not to provide strength as an adjunct to an underdeveloped pectoralis major muscle, but should create a natural looking and contracting muscle bulk at the anterior axillary fold. Usually half a year thereafter EMG-records show first positive signs of muscle flap reinnervation. Therefore it is of paramount importance to maintain the normal resting tension during surgery, otherwise the muscle fibers cannot contract properly. Depending on the discrepancy of the breast volume and the available tissue at the medial thigh and buttock, the skin paddle can be sufficient to restore a missing breast volume also. Optionally an additional silicone breast implant may be necessary just to adapt the breast volume to symmetry. A second TMG-flap for the missing volume can be inserted if a pure autologous reconstruction is intended and silicone implants are refused. If only a small volume discrepancy has to be corrected, lipofilling would be the method of choice for refinement ([5] or Chapter 2.3.4).

10.2.5.1 Advantages

The major advantage of that procedure consists in the relatively inconspicuous donor site at the thigh which can be placed in a concealed natural body fold. The loss of the gracilis muscle function is totally compensated by the remaining adductor muscles and therefore not really noticeable for the patient [7, 8]. The three-dimensional shape and volume of the TMG-flap allows a lot of freedom for the surgeon to insert the flap depending on the individual requirements of the deformity. The TMG-flap provides with the potential for a dynamic and functional reconstruction and all the benefits of an autologous tissue reconstruction [9–11].

10.2.5.2 Disadvantages

Since the TMG-flap transfer is a microvascular procedure all the risks associated with microanastomoses have to be taken into consideration. Therefore patients with a general contraindication for microvascular procedures should be excluded from that procedure. It bears the risk of a total failure in case of an anastomosis problem. If not trained routinely for other indications, it may become a very long and tedious procedure. Regarding the donor site sometimes sensory branches from the posterior thigh nerve cross very superficial into the skin island and have to be dissected during incision along the skin island in the posterior part of the TMG-flap. This might result in a numb area on the posterior aspect of the thigh. However, and in contrast to the harvest of an infragluteal flap, it will not result in a disturbing neuroma, which has to be mentioned to the patient in the informed consent preoperatively.

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10.3 Special microvascular flap for the Poland syndrome, the latissimus dorsi-flap

Anton H. Schwabegger

10.3.1 Introduction

As an element for the reconstruction of the anterior axillary fold in the Poland Syndrome with partially or completely missing M. pectoralis major, the ipsilateral latissimus dorsi as a muscle (LDM)-flap or eventually as myocutaneous-flap offers itself as a transposed-flap ([1–3] and Chapter 10.1). In some cases however, at the ipsilateral side an associated deformity with hypoplastic or even missing components of the thoracic wall, namely of ribs, intercostal muscles and also of the Latissimus dorsi muscle [2, 4] may be found (Figs. 1 and 2). Apart from such muscle and skeletal anomalies, also the probability exists that moreover yet vascular anomalies in the sense of hypoplasia or aplasia of the thoracodorsal vessels, which are necessarily important for a transposition, are present. As already described by Beer in 1996, prior to a planned transposition of the LDM it is absolutely necessary above all to perform a detailed functional test and suitable imaging (e.g., angio-MRI) of the latissimus- and skeletal thorax region in regard to the vascular situation of the concerned side [4]. If significant anomalies should exist, which indicate lack of sufficient circulation, other alternatives like autologous tissue transplantation or lipofilling ([5] and Chapter 6.6.2) must be taken into consideration for smaller corrections, or microvascular transplanted flaps (Chapter 10.2) for major defect reconstruction. But also in planned microvascular transplantation of autologous tissue, an exact clarification of vascular anatomy must take place in order to test the situation of the recipient vessels whether namely as nourishing vessels they show sufficient diameters and course length for anastomosis of a muscle or myocutaneous-flap or if they are present at all. Furthermore a three-dimensional-CT imaging (Figs. 1 and 2) is extremely helpful in order to be able

Fig. 1. Three-dimensional volume rendering CT scans reveal hypoplastic and fused ribs I–IV. The intercostal spaces are narrowed, as a sign of lesser function due to hypoplasia. The internal thoracic artery of the affected side seems of much lesser caliber than contralaterally. Conjoined with the underdeveloped skeletal morphology this means an indirect sign, that also the thoracodorsal vessels might be hypoplastic at that side

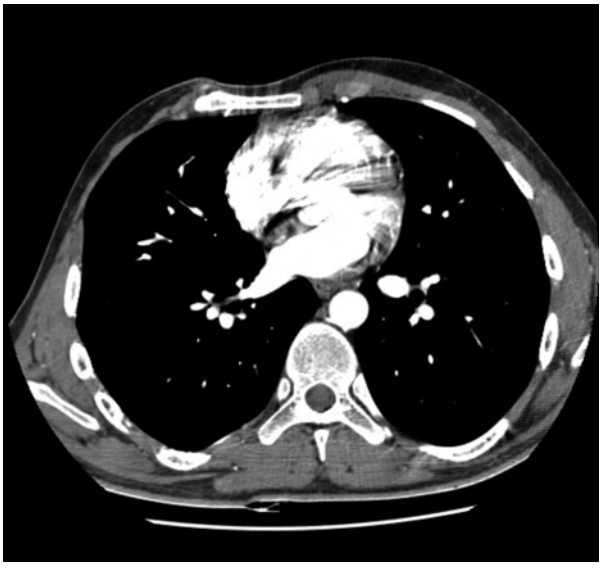

Fig. 2. Conventional CT scan reveals absent pectoralis major muscle, absent ribs and extremely thinned soft tissue separating skin and pleural cavity at the right side

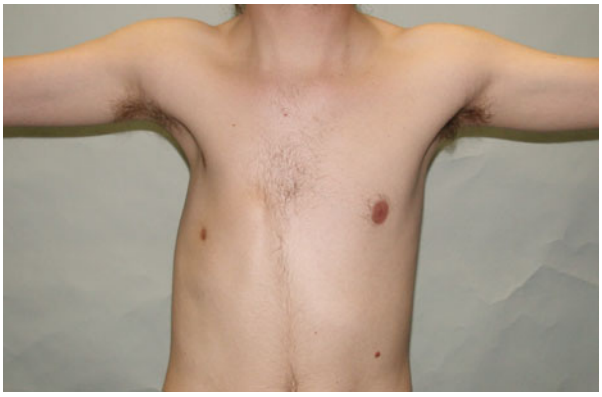

Fig. 3. A 25-year-old male with Poland syndrome, normal anatomy of the left upper extremity but partially absent pectoralis major muscle at the right side

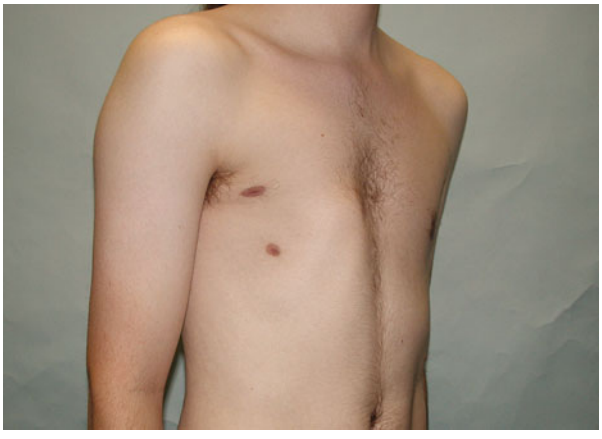

Fig. 4. Additionally a parasternal asymmetric keel chest deformity at the affected right side is clearly visible from an oblique aspect, extending from ribs IV to VII

to detect any possible hypoplasia at the lateral thoracic wall itself. Such anomalies can cause a keel (Figs. 3–5) or funnel chest deformity wall at their variants, however there can also exist merged, hypoplastic, or several missing ribs. In this particular situation, i.e., if no further tissue sheet is present between subcutaneous tissue and pleura, the danger of damage to the pleura and lungs thoroughly exists during the surgical preparation of a tissue pocket as a recipient bed for the flap to be transplanted. The danger of such pleura damage is relatively high also along a Lipofilling procedure, because herewith the fatty tissue is injected with more or less sharpened cannula and in multiple layers into the subcutis (Chapter 6.6.2). This danger of unintended perforation is imminent when muscles and ribs are absent, and also because during anesthesiologic ma-

Fig. 5. Associated displacement of a hypoplastic nipple-areola complex (NAC) into the axilla, even accessory and minor NAC is present therefrom caudally

chine respiration the intrathoracal pressure is raised thus keeps the pleural layers very closely to the adjacent thin skin.

The microvascular transplantation of a Latissimus dorsi muscle was mentioned by Hester already in 1982 and by Beer in 1996, the microneurovascular, i.e., with nerve coaptation was described by Kelly [6] as a case report in 1999. While in females the transverse myocutaneous gracilis (TMG)-flap as described in Chapter 10.2 very well suits not only for a recreation of the anterior axillary fold but furthermore also for augmentation of a hypoplastic or even missing breast, the LDM as a pure muscle-flap ideally can serve as replacement for a missing PM (pectoralis major) muscle because of its similar fan-shaped anatomy. Dependent upon the desires, requirements and possible other concerns with regard to function loss and scar development, the contralateral LDM may be transplanted as a microneurovascular flap, when an ipsilateral LDM-flap is not existing, hypoplastic, or with uncertain blood supply.

10.3.2 Surgical technique

The technique concerning recipient site and flap harvesting differs from that in the TMG-flap procedure. Simultaneous tissue pocket preparation and flap harvesting is not possible, because the patient has to be positioned left or right sided alternately. As already mentioned in the previous chapter, unexpected anatomy, if not properly investigated prior to surgery may

cause severe problems concerning revascularization of the transplanted flap and may lead to complications like unintended perforation into the pleural space [6].

10.3.3 Harvesting of the LDM-flap and preparation of the donor side

This technique of flap harvesting is only shortly described here and not in detail, as it is a common and standard procedure in reconstructive surgery worldwide. First the recipient side is prepared in lateral position. Even if in the preoperative imaging the anatomical situation appears clear with sufficient vessel calibers, it is very advisable, first to prepare the recipient site, in order to anticipate any possible anatomical variants and in order to have sufficient time at disposal for possible intricate or time consuming preparations. The preparation of the tissue pocket is sufficiently described already in Chapter 10.2. First if the anatomical situation is assured and the recipient tissue pocket is prepared, the patient can be turned onto contralateral side for the purpose of harvesting of the LDM-flap. It is of paramount importance to maintain ischemia time of the muscle-flap to be transplanted very short, especially if the muscle-flap will be transplanted as a functioning microneurovascular flap, i.e., with coaptation of the thoracodorsal nerve to nerves at the recipient side. An ischemia time up to 2 h is well tolerable, after 4 h already half of the muscle fibers will develop necrosis and after 6 h of ischemia, complete necrosis of all muscle fibers and therewith fatty degeneration will take place without possibility of any reinnervation and therewith total loss of contractile muscle function. The longer ischemia time lasts, the more edema will develop within the transplanted muscle. In the reconstruction with the LDM solely as a muscle-flap within a subcutaneous tissue pocket, in whose preparation the overlying skin must be stretched, an edematous swelling muscle would choke its own blood supply, in the sense of a compartment syndrome. In addition to the probabilities of prolonged problems during performance of the vascular anastomoses at the site of reconstruction, it is therefore imperative, that ischemia time between flap raising/harvesting and revascularization must be held as short as possible. Under certain circumstances, e.g., with slim patients, raising and harvesting of the LDM may easily succeed with the patient laying at his back, the shoulder elevated and the thorax slightly turned utilizing suspension pads [7].

Fig. 6. Postoperative aspect after correction of the keel chest deformity and microneurovascular LDM transplantation from the contralateral side and nerve coaptation to the intercostal nerve III

Fig. 7. Good result of parasternal contour after correction of the keel chest deformity through a parasternal incision according to the Ravitch technique and postoperative keel chest device compression. This operation was performed one year prior to the LDM transplantation

After carrying out flap harvesting a partial or on demand eventually complete relocation of the patient takes place, so that insertion of the flap with microsurgical anastomoses and nerve coaptation is comfortably possible. According to the anatomical situation, the thoracodorsal nerve will be coapted to Intercostal nerves, to pectoral muscle branches or other available motor nerves in an end-to-end or end or end-to-side fashion. As already mentioned, particular care has to be taken into account to maintain the correct resting tension, which preferably should be marked with a suture at the muscle surface before release of the tendon and/or muscle origin during flap harvest [8].

Fig. 8. The NAC from the axilla was transplanted and extended to a symmetrical size to match the contralateral side; the accessory NAC was excised

Such a maintained resting tension then supports an aesthetically pleasant result of the axillary fold as well as an occasional function of a replaced pectoralis major muscle (Figs. 6–8).

10.3.4 Discussion

A microneurovascular autologous transplantation succeeds with functional acceptable results all the more sooner the earlier it is carried out in the youth of the patients [6]. Not only the reinnervation in the pediatric population is significantly better, also the distensibility of the skin in children generally is superior to adults.

10.3.4.1 Advantages

The particular advantage of the LDM (the healthy, contralateral side) exists in its constant and very well-known anatomy as well as in a vast experience with this tissue-flap in reconstructive surgery in general. Moreover it substantially shows larger calibers and a longer vascular pedicle in contrast to most other flaps available or suitable for the actual purpose. In analogy and additionally also the thoracodorsal nerve, which is a requisite for the purpose of a reinnervation of a functioning muscle, provides with constant anatomy and usually sufficient length. For the case that additional tissue volume is required, it can be lifted also as a myocutaneous-flap with a correspondingly large skin island [9], with or without deepithelialization. The more fan-shaped structure and muscle fibers anatomy correspond that of the missing pecoralis major muscle (PMM), so that out of this aspect the LDM appears ideally suited as replacement or recreation of the PMM.

10.3.4.2 Disadvantages

In analogy to all other microvascular procedures also here the risk of circulation problems with partial or entire flap loss exists, however substantially much lesser compared to other flaps due to its constant anatomy and extensive overall experience. Harvesting of the contralateral muscle-flap on the one hand can lead to weakening of retroversion of the arm, but on the other can reduce the prominence of the posterior axillary fold and therefore can create shape symmetry, assimilating to the usually hypoplastic anatomy of the side concerned by the Poland syndrome. The donor site scar at the back is well visible while in males preferably it is supposed to be put laterally onto the thoracic wall. It is more eye-catching in females and not that easily concealable, as the donor site region of a TMG-flap at the groin and thigh region.

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