Indication and Technique of Reconstructive Lymph Vascular Surgery

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3.1 Indication and Prerequisites

Circumscribed impairment of the lymphatic system is the main indication for lymphatic grafting. In most cases, such a blockage results from surgical interventions such as lymphadenectomies in the axilla, groin, or pelvic area. Also dissections of lymphatic trunks in narrow parts of the lymphatic system, e.g., on the medial aspect of the knee, may lead to a lymphatic obstruction. In addition, infection or radiotherapy often damages the lymphatic pathways additionally and leads to the clinical manifestation of lymphedema.

A further indication exists for special forms of primary lymphedema with a regionally compromised lymphatic pathway, e.g., a unilateral lymphatic atresia at the groin and pelvis (Kinmonth 1982).

The following requirements have to be fulfilled prior to surgical treatment of secondary lymphedema (Table 3.1):

It is recommended to keep an interval of at least 6 months after the surgery or intervention, which has been followed by transitory swelling due to the interference with the lymphatic system. During that period of time, spontaneous normalization might occur, and lymphatic grafting may become superfluous. This time period should be used by complete decongestive therapy (CDT) which consists of manual lymph drainage, compression therapy, and exercises combined with skin protection.

After tumor therapy, an exact evaluation of the patient with respect to possible recurrence of the tumor is necessary.

In order to perform autologous lymphatic grafting, the harvest from the patient's thigh must be possible respecting residual lymphatic transport capacity after removal of the graft.

A preoperative lymphoscintigraphy permits evaluation of the lymphatic transport capacity in the donor region. If lymphatic flow is impaired in the donor region or there is swelling in the same region, lymphatic vessels should not be harvested.

The most important prerequisite is however the microsurgeon. He should have an extensive practice in microsurgery. Normally this deals however with vessels of more than 2 mm in diameter. Dealing with structures of less than 0.3 mm needs a considerable additional effort and therefore additional training.

The understanding and knowledge of lymphology is another prerequisite in order to avoid to be only a worker in a highly demanding manual field. The investigation of the patient, the appropriate indication, and the knowledge of managing complications and further possible treatment options need a profound expertise in the field of lymphatic diseases.

3.2 Equipment

The most advanced available microsurgical equipment should be used in order to facilitate the microsurgical demanding surgery on lymphatic vessels.

The microsurgeon should take advantage from the possible support to allow him just to move his hands and to get support for his forearms and elbows. Sometimes also breathing may be disturbing. It is advisable not to stop it with exertion, but to incorporate such periods within the workflow and repeat them more often instead of pausing for a longer time (Fig. 3.1).

The operating microscope is critical. It should allow high magnification of up to about 40-fold.

Improvements might be seen with addition of near-infrared light source allowing indocyanine green investigations during the surgery. However the visibility of lymphatic vessels is limited to the superficial area of the subcutaneous tissue. Therefore, the main lymphatic collectors which are located above the deep fascia may not be detected.

In order to manipulate the delicate lymphatic vessels, the finest microsurgical instruments available should be used. The tips of the pincers should measure not more than 0.1 mm.

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Table 3.1 Indication and prerequisites for lymphatic grafting

1. Circumscribed interruption or impediment of lymphatic flow
2. Undisturbed lymphatic system at least in one leg for harvesting
3. Lymphatic channels with a lumen at both sides of diseased area
4. Free of recurrence of malignant diseases
5. Capable for general anesthesia
6. Microsurgeon, experienced in microsurgery and lymphology as well

Fig. 3.1 Microsurgeon sitting in a chair with suspended forearms, operating microscope, ultrafine microinstruments

Also the suture material should be adapted to the size of the vessels to be anastomosed. In our personal experience in animals, we had the impression that reducing the foreign body reaction might be of advantage, looking at the histological findings showing large particles of the suture material next to the anastomoses. Since the production of polyglactin 910 (Vicryl®, Ethicon) with the size of 11-0 has been stopped, we use the remaining 10-0 (Baumeister et al. 1982).

However, nonabsorbable suture material, which is tinier than 12.0, might reduce the unfavorable correlation between vessel diameter and foreign body reaction.

Regarding the type of the needles, round needles are enough to penetrate the lymphatic vessel wall. For absorbable suture material, the smallest available needle size at the moment is BV 75-4.

To facilitate the suturing and handling the lymphatic vessels, a green plastic sheet is put underneath the vessels. Addition of some drops of Ringer's solution mixed with heparin helps to discriminate the front and back vessel walls by suspending the vessels.

3.3 Basic Technique

The basic technique follows the principles of vascular surgery and the adjustment to the special needs of lymphatic vessels. Elements were developed during the experimental phase of the reconstructive microsurgery of lymphatic vessels (Baumeister et al. 1981b, 1990, 2003).

3.3.1 Discriminating Lymphatic Vessels

Looking for lymphatic vessels is easy if they got stained. For staining, the dye has to get almost exclusively to the lymphatic system. This means that the molecular weight is relatively high in order to be ingested exclusively into the lymphatic capillaries. In Europe, Patent Blue V® is used for these purposes and fulfills these prerequisites (Fig. 3.2). The dye should be administered close to the subdermal lymphatic plexus. Thereafter it is quickly incorporated within the lymphatic system. Passive movements in anesthetized patients

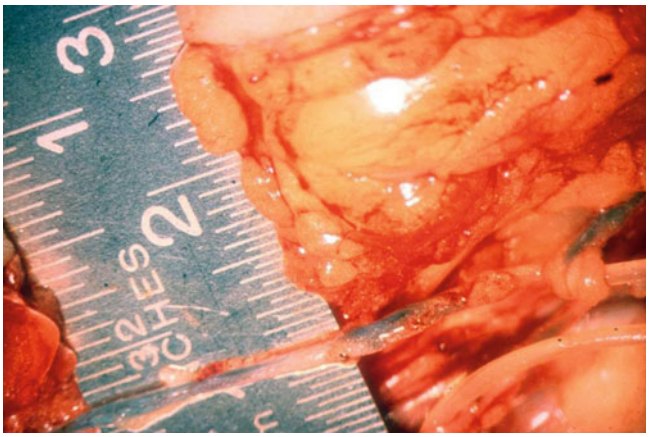

Fig. 3.2 Lymphatic collectors stained with Patent Blue V®

alleviate the transport to the base of the extremity within several minutes.

To search lymphatic vessels, a superficial incision just of the skin and dermis is recommended. By that way superficial tiny lymphatic vessels will not be harmed. Middle-sized lymphatic vessels in the subcutaneous tissue are located just within the adipose tissue or adjacent to major veins. The biggest lymphatic collectors are found mostly close to the deep fascia.

Underneath the fascia bigger lymphatic vessels can be found between the main arteries and veins.

Within the subcutaneous tissue, gently spreading movements in an oblique fashion to the main direction of the lymphatic vessels with a bigger instrument—I am using the "Metzenbaum" scissors—allow access to the stained lymphatic vessels. At the start of searching, one should try to get an overview of the vessels present in the corresponding area, e.g., the ventromedial bundle at the thigh. The surrounding tissue is separated from the lymphatic vessels. These are not touched until their course became obvious. Only prior to the harvest, the fine preparation starts. Intact bigger lymphatic collectors are relatively resistant against longitudinal tension. They can be elevated by fine hooks or also gently elevated by wet fingers.

In the edematous tissue, the lymphatic vessels do not get stained like in an undisturbed lymphatic flow. Therefore, we do not attempt to perform a staining like we do during the harvesting process. Therefore it is difficult to discriminate between small veins, small nerves, fibrous bands, and the altered lymphatic collectors. Since the area of search is limited and is performed in oblique direction, only a limited number of structures have to be checked.

The lymphatic collectors are mostly somewhat hidden within the subcutaneous tissue. The biggest ones are located just above the deep fascia. Lymphatic collectors are gray shining and are often separated from the surrounding adipose tissue. Small nerves instead have a bright white appearance and show oblique silver-shining stripes. The final decision sometimes can only be made after transection of the structure. Veins deliver blood. Out of the nerves prolapses the axon. A lymphatic collector should show a lumen without blood, preferentially delivering clear fluid.

In the treatment of a lymphocele, staining of the incoming lymphatic vessels is mostly possible. Blunt dissection of the distal part of the lymphocele directs to the incoming vessels. If fibrous tissue hinders the dissection from the outside, the lymphocele can be opened. The holes in the wall at the distal area, together with extrusion of stained fluid, will clarify the source of the lymphocele.

3.3.2 End-to-End Anastomosis

The two lymphatic vessels should be situated next to each other.

The first stitch is the most difficult one since the wall is collapsed. It might be helpful to add a small amount of Ringer's solution mixed with heparin helping to lift the wall (Fig. 3.3). In very small lymphatic vessels with fibrosis around the lumen, it might be advisable to only fix the outer layer with the stitches. The content of the lumen of the vessel can then drain into the graft.

The back wall is just lifted when starting to anastomose. The first stitch is placed at the far end of the vessels.

The sutures are directed from outside to inside and back on the opposite wall.

The second corner stitch is placed in front of the surgeon.

The suture is finished with the closure of the front wall.

Care should always be taken to avoid tension to the lymphatic vessel wall in oblique direction.

In longitudinal direction the vessel as a whole is however remarkable resistant against tension.

The number of stitches is dependent on the size of the lymphatic and the condition of the vessel wall.

Very small lymphatic vessels may just be adapted by one single stitch.

Danese (1982) had shown experimentally that lymphatic collectors may perform anastomosis by themselves if they come close to each other. This is encouraging for the microsurgeon. He will learn to minimize the disturbance for the lymphatic vessel.

In middle-sized lymphatic vessels, three to four stitches are enough.

Leakage will not be a problem since the pressure is low (Fig. 3.4).

In big or enlarged lymphatic vessels, around 6 to 8 stitches can be applied.

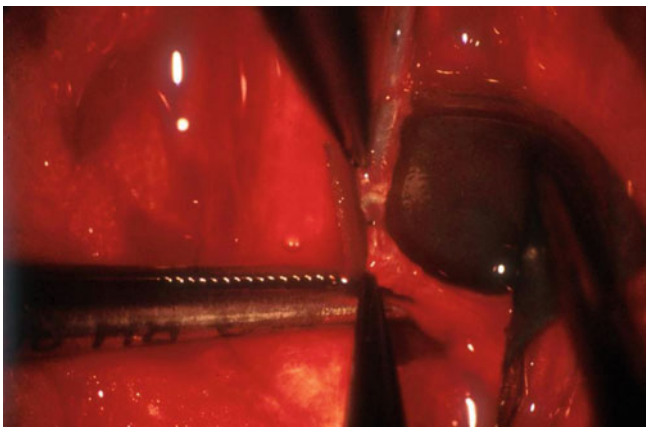

Fig. 3.3 End-to-end anastomosis, first corner stitch. Graft with translucent wall above, sclerosed lymphatic vessel of lymphedematous tissue with the lumen surrounded by fibrosed wall below (© Baumeister)

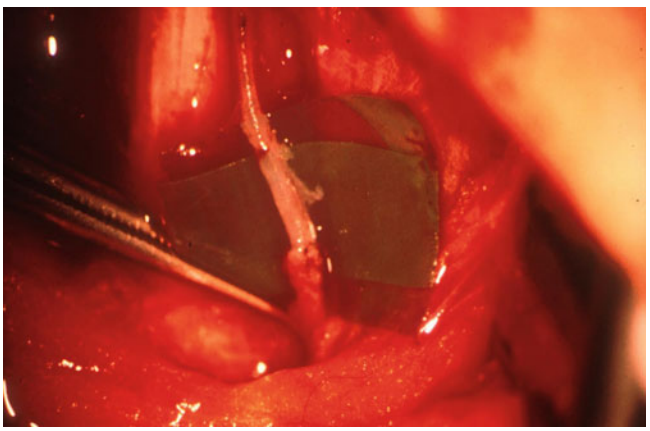

Fig. 3.4 End-to-end anastomosis completed. Graft filled with lymph (© Baumeister)

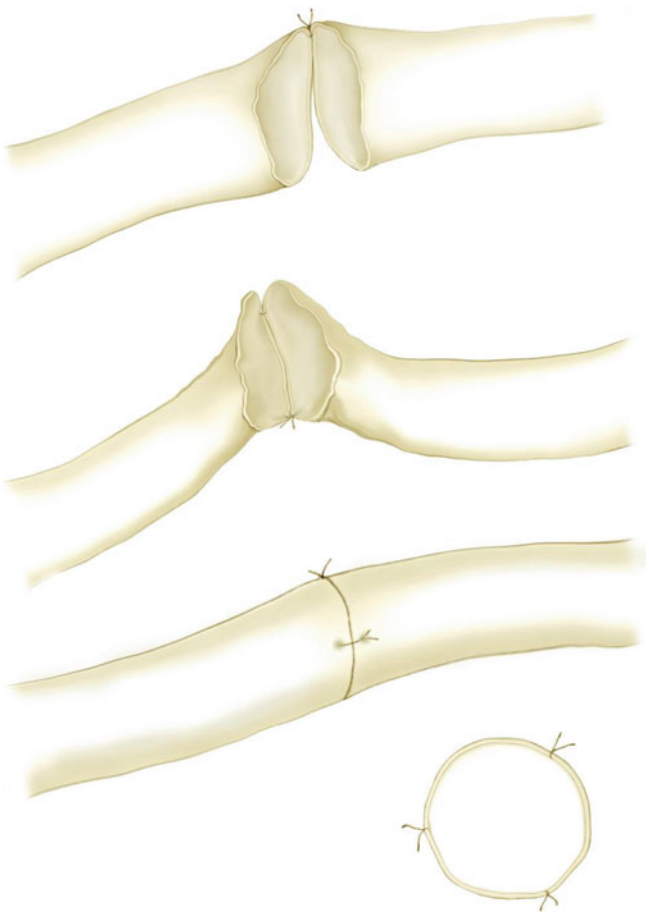

Fig. 3.5 End-to-end anastomosis with three stitches (© Baumeister)

The graft is filled with lymph at the end of the anastomosis also when the wall of the lymphatic vessel within the edematous tissue shows fibrosis (Fig. 3.5).

Different reason may contribute to this phenomenon.

A lumen can be seen also in lymphatic collectors in severe and long-standing lymphedemas.

Reconstruction within the lymphatic system does not need a pressure to work against another system like in lympho-venous anastomoses.

Lymphatic vessels are known for the active transport of the lymph. Lymphatic vessels continue pumping also in nutrient solution.

We saw recovery of activity along the lymphatic channels which was not present prior to the grafting in lymphedema patients in follow-up lymphoscintigraphies.

Therefore, a suction force produced by the lymphatic grafts can be postulated which helps to empty lymphatic vessels, also when they are not able to pump themselves.

The histological findings in lymphatic collectors, which have been chosen for anastomosis, underline the usefulness to perform reconstructive lymphatic surgery also in long-standing lymphedemas (Frick et al. 1990, 1992).

The example of a 50-year-old patient, 10 years after mastectomy and subsequent lymphedema of the arm, is shown in Fig. 3.6. The lumen is somewhat enlarged; endothelial cells are prominent.

3.3.3 End-to-Side Anastomosis

End-to-side anastomoses may be advisable if a lymphatic channel should not be transected, either to spare the normal flux or to give additional influx into a graft.

An oval excision into the wall is created. The stitches start either at the lowest part or at a point opposite to the surgeon in order to get a full view to the anastomosis until the last stitch. Collapsing of the wall can also be a problem. Therefore it might be helpful to fix the wall with one stitch first and to open the wall thereafter just next to it.

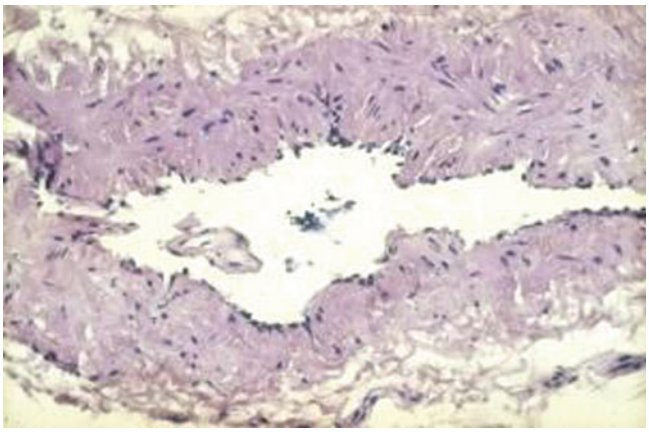

Fig. 3.6 Transection of an open lymphatic collector at the upper arm, selected for anastomosing, 10 years after mastectomy, somewhat distended lumen, prominent endothelial cell (H-E)

3.3.4 Harvesting of Grafts

At the thigh, there exists the ventromedial bundle which contains up to 16 lymphatic collectors (Kubik 1975, 1989). They spread out between the bottlenecks of the lymphatic system at the knee and the groin region. In between these two endangered regions, lymphatic vessels can be used for grafting. Even if one removes 2–3 vessels, more than three quarters of the vessels within the bundle remain untouched. Branches at the distal end allow additional anastomoses. Figure 3.7 shows two long free lymphatic grafts with branches at the distal end. The central endings are ligated. The threads have long endings which allow pulling at the grafts later on during the procedure.

Since often the grafts show also ramification prior to the entrance into the inguinal lymph nodes, also on both ends, additional anastomoses may be possible.

Staining of the vessel is important to facilitate the preparation and to identify functioning lymphatic vessels which will remain untouched. If however only two or three stained lymphatic vessels become visible, harvesting should not take place. For staining we use Patent Blue V ®. It is injected into the subdermis at the first and second web spaces. Passive movement of the joints leads to a quick transport toward the groin, which means that after about 15 min, the lymphatic vessels become stained with a blue-green color. Signs of dermal backflow, indicating deficiency in lymphatic transport, would be a contraindication for harvesting. For safety reasons, we perform a lymphoscintigraphy at the lower extremity in all patients who ask for lymphatic vessel transplantation, in order not to oversee an occult lymphatic transport problem.

The incision is started below the groin medial to the palpable femoral artery. We search for stained, bigger lymph collectors which are found above the deep fascia. We normally do not use stained lymphatic collectors adjacent to the greater saphenous vein since they are variable and not straight enough. From the starting point, we elongate the incision toward the knee, but we always stop above this area. Since the direction of the incision is adjacent to the direction of the lymphatic vessels, the incision is mostly somewhat curved toward the dorsal aspect of the thigh. The harvest is terminated proximal to the knee. Below that, connecting vessels are remained ensuring the undisturbed lymphatic flow (Fig. 3.8).

Fig. 3.7 Two lymphatic grafts with two additional peripheral branches, proximal ligatures with long threads to allow pulling (© Baumeister)

Since harvesting of lymphatic vessels is a crucial point, we recently also checked the lymphatic flow at the harvesting site performing lymphoscintigraphy. It was shown within a group of 19 consecutively investigated patients that there was an unchanged normal outflow after the harvest. The mean follow-up period was 4 years (Weiss et al. 2015).

In selected cases, where only moderate amounts of fat were present, we harvested the grafts in a minimally invasive way. We used two short incisions and dissected the

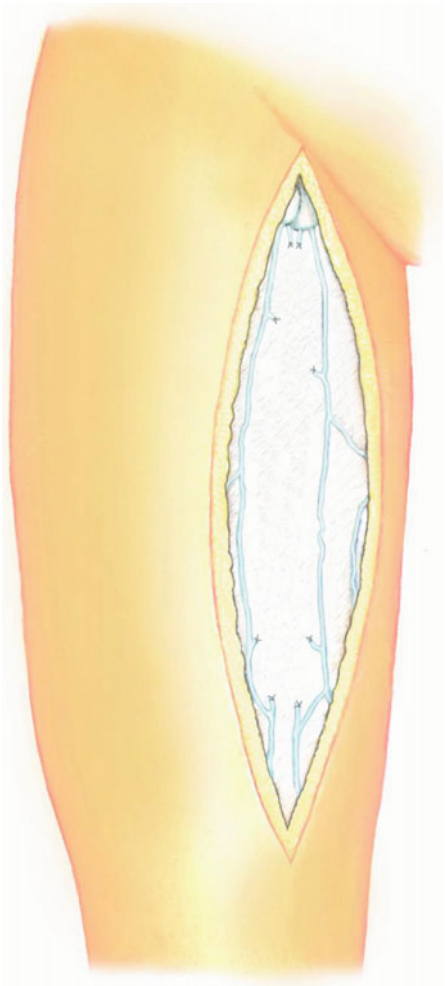

Fig. 3.8 Grafts have been harvested from the ventromedial bundle; peripheral connections to neighboring lymphatic vessels are remained (© Baumeister)

lymphatic vessels with the help of an endoscope. Through the endoscope the stained vessels could be seen clearly; however the overview about the bundle is limited (Baumeister et al. 2000).

3.3.5 Lymphatic Vessel to Lymph Node Anastomosis

Especially at the neck, it might be of advantage to connect the grafts directly to a lymph node.

Opening just the capsule of the node gives access to the marginal sinus. Bleeding should be avoided by careful preparation. The grafts are now adapted to the capsule with about four single stitches. Figure 3.9 shows a lymph node with two lymphatic grafts (above, one completely and one partly sutured) connected to the lymph node in the same way as two original lymphatic vessels (below, lateral).

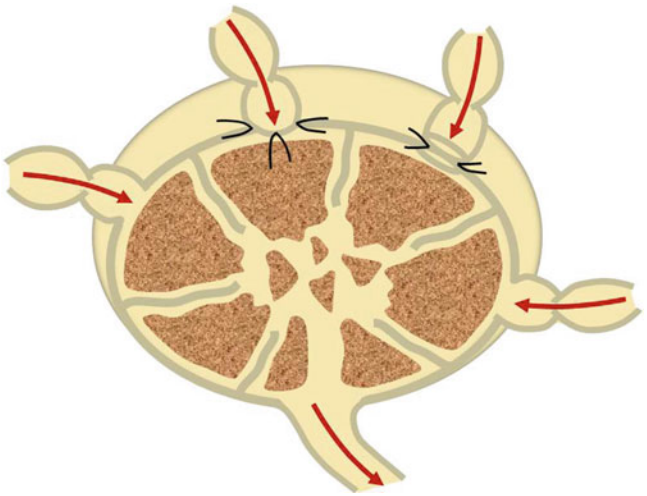

Fig. 3.9 Scheme of lymphatic vessel to lymph node anastomosis: two anastomoses, one partly finished (*right*), one completely finished (*left*) at the upper part of the node, connected to the marginal sinus like normal afferent lymphatic vessels (lateral on both sides)

3.4 Treating Edemas of the Upper Limbs

Most of edemas of the upper extremities are caused by an obstacle of the lymphatic system in the axillary region. In these cases this region has to be bypassed.

In all patients we perform a lymphoscintigraphy to verify the lymphatic transport deficiency.

In primary lymphedema, additionally an indirect lymphography, or nowadays a MRI lymphography, has to be performed since different defects besides a local interruption might be present and a treatment with lymphatic grafts therefore may not be advisable.

First, lymphatic collectors are searched below the axilla. Care has to be taken to keep away from irradiation fields. Depending on the length of the graft, the collectors are searched more distally to the axilla. Dependent also from the lymphoscintigraphic findings, collectors are searched more laterally, if the lymphedema is predominant in the draining area of the long cephalic pathway.

An oblique incision is performed transecting just the cutis. Underneath, the subcutaneous tissue is opened by blunt preparation. Since the biggest collectors are found just above the fascia, the searched is intensified there. Because in lymphedema a dye is transported mainly along the cutaneous lymphatic network and the transport is disturbed along the extremity, a dye is not applied at the edematous limb.

In order to facilitate the preparation and to save the lymphatic vessels, the search is performed under the microscope using a medium magnification.

In early stages of lymphedema, the lymphatic vessels have a gray, shiny appearance, and the lumen can be seen clearly after transection. As the lymphatic vessels undergo fibrosis in

later stages of lymphedema, it becomes more difficult to discriminate between small nerves and fibrous cords. In this case, the final decision regarding their potential use for grafting can be made only after transection of the structure.

The nearest undamaged lymphatic system away from the upper arm is found at the neck region. The distance between the upper arm incision and the neck region is mostly equivalent or even less, compared to the length of the thigh and the distance between the groin region and the knee region. Lymphatic grafts can be used therefore in sufficient length.

The incision at the neck is performed about 2–3 cm above the clavicle at the dorsal border of the sternocleidomastoid muscle. It can be performed in one of the natural folds and will be hidden thereafter.

The sternocleidomastoid muscle is shifted medially or transected at the lateral border. Underneath, within the fat, lymphatic vessels and lymph nodes can be found.

The walls of the lymphatic vessels at the neck however are thinner than at the arms or the legs. Injection of dye subdermally behind the ear may facilitate the search for appropriate vessels. If the lymphatic vessels become stained appropriately, recognition is easy.

Suturing in this is area is often difficult because of the collapsing thin-walled vessels. Before transecting, it may be helpful to differentiate between the front and back walls by fixing the front wall with a suture.

A less demanding way exists in anastomosing the grafts with the lymph nodes. A superficial, oval incision is made in the capsule of the node, giving access to the marginal sinus. The graft is then connected with approximately four to six interrupted sutures.

To position the grafts between the two anastomosing sites, tubing from a drain is placed in the subcutaneous tissue between the incisions in the upper arm and the neck. Subsequently, the grafts are pulled through the wet drain gently and without friction. After removal of the tube, the grafts remain in the subcutaneous tissue free of tension. Care has to be taken that the grafts are pulled in the right direction according to the direction of the lymphatic flow (Figs. 3.10 and 3.11).

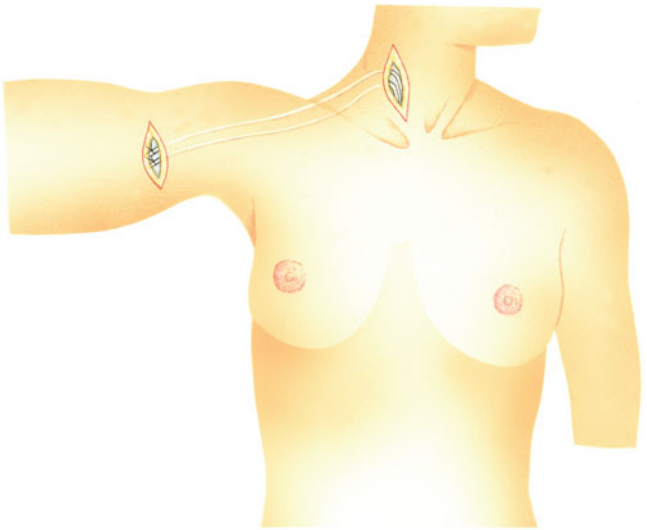

Fig. 3.10 Reconstruction of a lymphatic interruption in the axilla connecting lymphatic collectors at the upper arm and lymphatic vessels or lymph nodes at the neck by lymphatic autografts (© Baumeister)

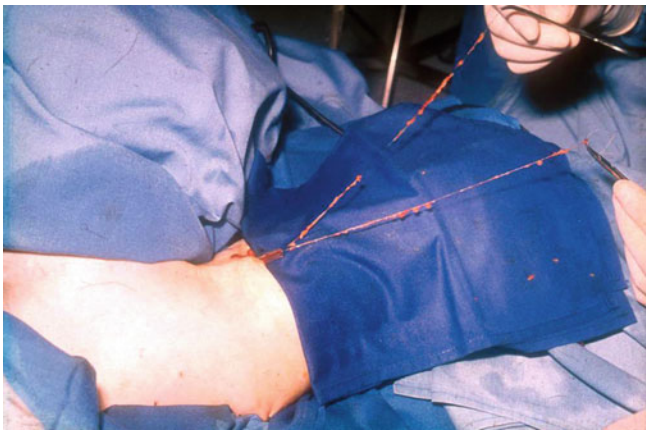

Fig. 3.11 Lymphatic vascular grafts ready for pulling them into a silicon tube which connects the incision at the upper arm with the incision at the neck (© Baumeister)

3.5 Treating Edemas of the Lower Limbs

Reconstruction of the lymphatic vascular system needs for harvesting one lower extremity which is not compromised at all regarding the lymphatic transport (Baumeister et al. 1981a). Additionally, an undisturbed lymphatic vascular system close to the area of obstruction should be present to take in the additional lymphatic fluid.

Treatment of edemas of lower limbs is therefore restricted to unilateral ones. The contralateral leg serves for harvesting. The undisturbed inguinal and pelvic lymphatic systems are then able to receive the lymph from the edematous side.

In all patients we perform a lymphoscintigraphy to verify the lymphatic transport deficiency.

In primary lymphedema, additionally an indirect lymphography, or nowadays a MRI lymphography, has to be performed since different defects besides a local interruption might be present and a treatment with lymphatic grafts therefore may not be advisable.

For unilateral edema of the lower limb, the grafts remain attached to the inguinal lymph nodes (Fig. 3.12). The endings of the grafts distally are closed with sutures with long endings. For transposing to the opposite side the grafts they are used for pulling.

Above the symphysis, a tunnel is created to connect the harvesting side and the area of anastomosing at the affected limb. A silicon tube is inserted temporarily to facilitate the transposing of the graft (Fig. 3.13).

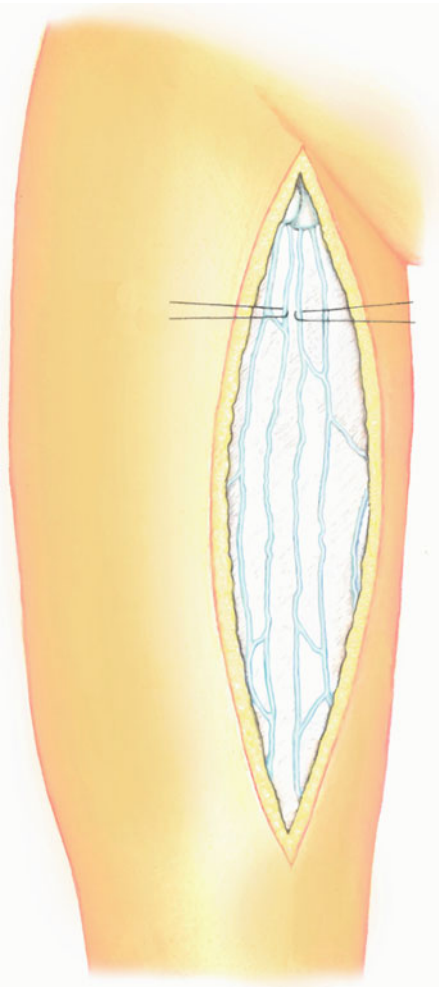

Fig. 3.12 Choosing two lymphatic collectors remaining attached at the lymph nodes for transposition in case of unilateral leg lymphedema (© Baumeister)

Fig. 3.13 Insertion of a tube between the incisions on the side of harvest and the affected limb for pulling the grafts without friction; tube is removed thereafter (© Baumeister)

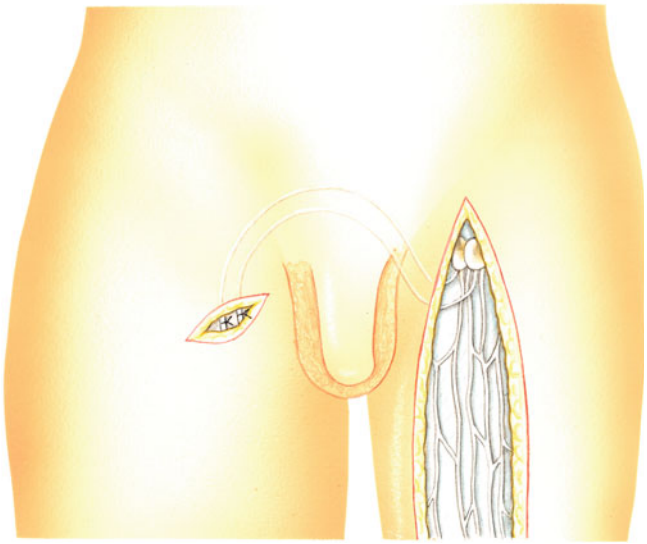

Fig. 3.14 Transposition of the grafts form healthy side to the affected limb, lymphatic anastomoses with ascending main lymphatic collectors (© Baumeister)

The distal ends of the grafts can easily be directed with prolonged threads of the suture. They get connected to one end of a bigger thread which has been inserted into the tubing of the drain before. The distal ends of the grafts are pulled into the tube and thus transposed to the opposite thigh. After removal of the tube and anastomosing the distal endings of the grafts with lymphatic vessels at the edematous side, the lymph flows in the correct direction. Lymph flows from the affected limb via the grafts to the lymph nodes of the healthy side. The lymph continues than the normal way, up to the thoracic duct and the left venous angulation (Fig. 3.14).

Exceptionally lymphatic grafting may also take place if both lower extremities are affected. This is the case when the area of obstruction is well defined and located at the distal part of the pelvis.

In one patient with resection of lymph nodes distally at the pelvis and proximally at the groin, lymphatic grafts have been harvested from the affected side and anastomosed to the distal inguinal lymph nodes and got attached to the central pelvic lymphatic tissue. By that way risk of additional swelling is restricted to the already edematous side. The patient improved clearly at the edematous side also at a follow-up period of more than 6 months.

3.6 Treating of Lymphoceles

Following surgical treatment, sometimes a lymphocele is remained, mostly located at the root of an extremity. This is a result of damage to the lymphatic vascular system. Transected lymphatic vessels fill the cystic structure. In cases with limited influx into the lymphocyst, they may be treated successfully

by conservative means. Injection of small amounts of glucose with a concentration of 40–50 % after emptying the lymphocele, followed by continuous slight compression, may induce gluing of the walls. If the overall lymphatic outflow of the limb however is persistently disturbed, the lymphocele may persist and lymphedema may occur. Especially in these cases, simple resection of the lymphocele and ligature of the lymphatic vessels which fill the lymphocele will not be sufficient. Reconstructive lymph vascular surgery has to search for the incoming vessels and connect them with grafts in these cases. By that way, the influx into the lymphocele is stopped, and the lymphocele may be resected with no risk of recurrency. Furthermore the graft can transport the arriving lymph into an undamaged lymphatic system which means that the reason for the edema is eliminated.

Examination prior to the surgery helps for an exact planning. Several methods are helpful.

With the onset of 3 T MRI lymphography, it became possible to show the exact entrance of the lymphatic vessels into the lymphocele (Notohamiprodjo et al. 2009).

With the combined help of lymphoscintigraphy and MRI lymphography, it is possible to show the connection between the way of lymphatic fluid and the filling of the cele (Notohamiprodjo et al. 2012).

Before starting the surgery, Patent Blue V ® should be injected subdermally at the periphery of the extremity. The incoming lymphatic vessels will become stained and can be identified and isolated (Fig. 3.15). If this does not work, the lymphocele should be opened and the entrances of vessels may be recognized from inside.

In cases showing a lymphocele close to the groin, lymphatic vessels can be transposed from the contralateral healthy side and drain the lymph to the healthy side (Fig. 3.16a, b).

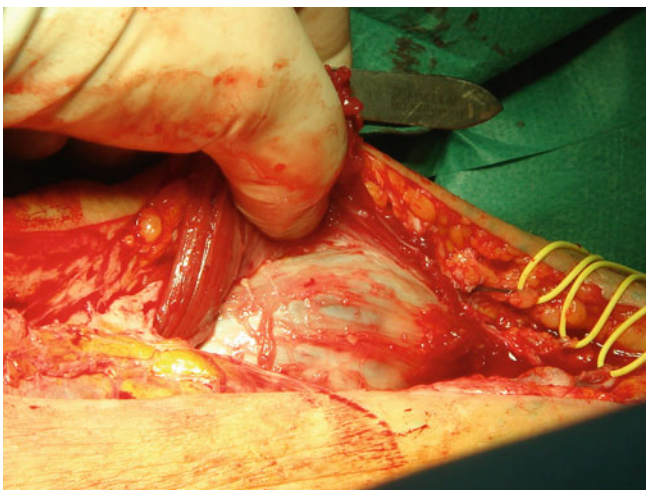

Fig. 3.15 Intraoperative view on the lymphocele and incoming stained lymphatic vessels, fixed with vessel loops (© Baumeister)

In lymphoceles close to the axilla, free lymphatic grafts taken from the thigh may connect the incoming lymphatic vessels to the healthy lymphatic system at the neck area like in cases suffering from lymphedema after axillary dissection.

If the use of a graft or transposing to undamaged lymphatic collectors nearby is impossible, lympho-venous anastomoses may be performed.

3.7 Treating of Lymphatic Fistulas

As one of a possible sequel of an injury to the lymphatic vessels, a lymphatic fistula may occur. This is the case when neighboring lymphatic vessels are not able to master the lymphatic load. The continuous elevated pressure leads to the persistence of the fistula. If with time the adjacent lymphatic vessels get adapted and are able to transport the lymphatic fluid, the fistula will dry up. Therefore first a conservative approach may be advisable.

If however the fistula persists, the feeding lymphatic collector should be identified first by MRI lymphography and lymphatic scintiscan (see also Fig. 5.29) (Notohamiprodjo et al 2009, Weiss et al. 2014) and finally during surgery with the help of intraoperative staining of the lymphatic vessels using Patent Blue V®. If possible, a reconstruction should be attempted, either by using a transposed lymphatic vessel from the opposite leg in case of a fistula close to the groin area (Fig. 3.17a, b), a free transplant for a fistula close to the axilla, or short free grafts in cases of a fistula in the periphery of an extremity. If reconstruction seems not to be possible, either a direct occlusion of the incoming lymphatic vessels or a deviation into an adjacent vein can be attempted.

3.8 Treating of Special Cases

Bottlenecks of the lymphatic system, like the medial aspect of the knee region or at the main lymphatic bundles at the lower leg, are endangered if surgical interventions or trauma interrupts lymphatic vessels to a greater extent.

This is a pattern of a localized blockade too. Lymphatic vessels in front and behind the interruption are in these cases able to bridge the gap (Fig. 3.18).

Edema of the penis and the scrotum may be also caused by a localized blockade of draining lymphatic vessels or lymph nodes, e.g., the medial ones at the groin. Under the condition of an undisturbed lymphatic outflow in at least one leg and open lymphatic vessels at the basis of the penis or scrotum, reconstruction is possible. Short lymphatic grafts terminating in the lateral inguinal lymph nodes are transposed to the penile and scrotal areas. There, anastomoses are performed with the lymphatics in the edematous area (Fig. 3.19).

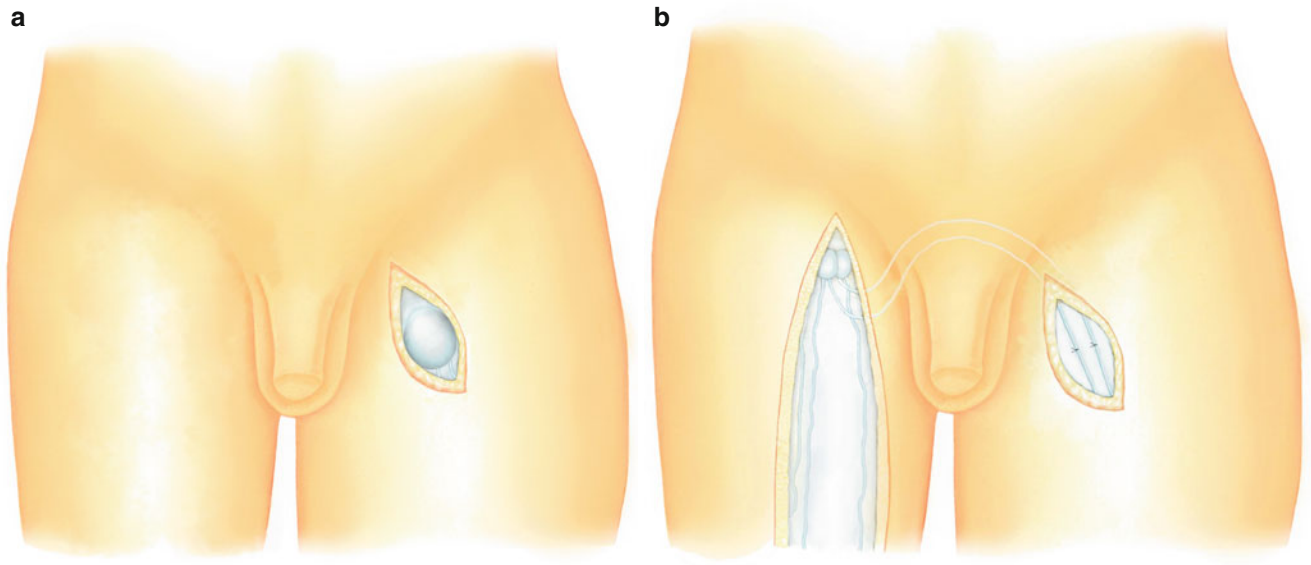

Fig. 3.16 (**a**) Lymphocele at the groin region filled by two incoming lymphatic collectors. (**b**) Lymphocele resected, incoming lymphatic collectors anastomosed to transposed lymphatic vessels from the healthy contralateral leg (© Baumeister)

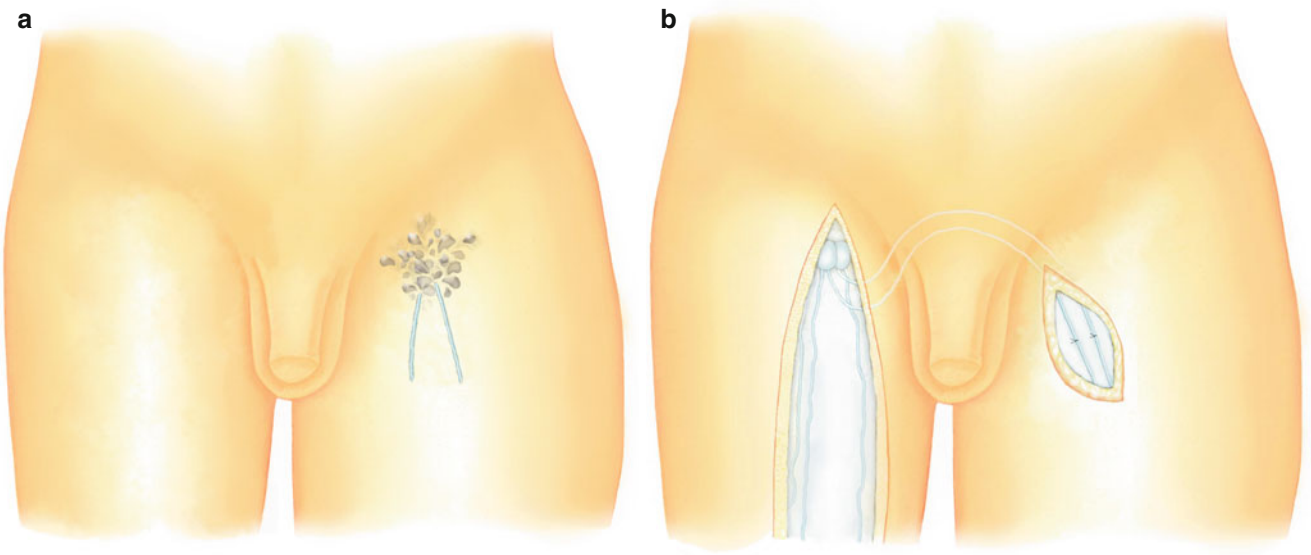

Fig. 3.17 (**a**) Lymphatic fistula at the groin with two open lymphatic collectors. (**b**) Lymphatic fistula resected two open lymphatic collectors anastomosed to two lymphatic vessels from the opposite leg (© Baumeister)

In primary lymphedemas too, localized atresia or agenesis of the lymphatic system may be the cause of lymphedema. Kinmonth (1982) described in his book: The Lymphatics a type of lymphedema which is due to a localized and unilateral atresia of the lymphatic system at the groin or the pelvic region. The distal lymphatic system was normal in the direct lymphography. In these special cases of primary lymphedemas also transposing of healthy lymphatic vessels from the opposite thigh is possible. Beneath the absent or diminished lymphatic nodes, the lymphatic collectors are anastomosed with the transposed lymphatic vessels. The lymph may flow thereafter to the contralateral lymphatic nodes and further on toward the pelvic chains at the not affected side like in unilateral secondary lymphedemas.

Fig. 3.18 Reconstruction of an interrupted lymphatic pathway at the knee (© Baumeister)

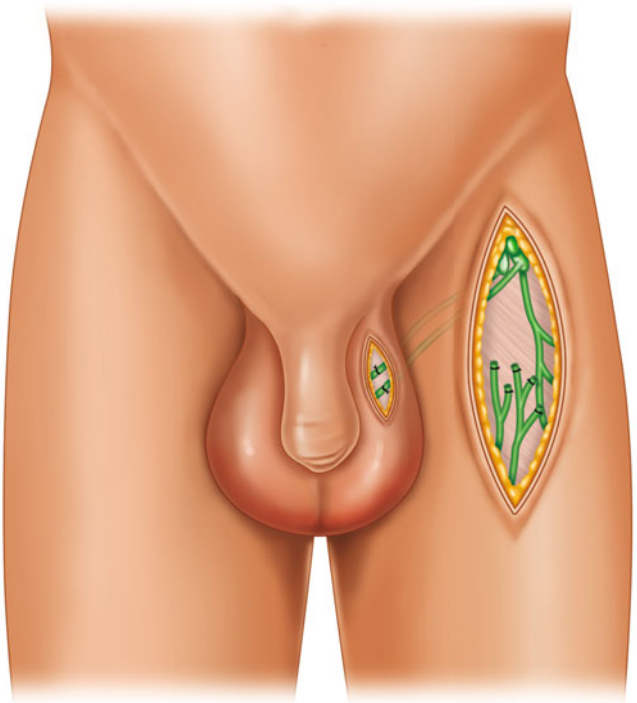

Fig. 3.19 Transposition of lymphatic grafts, connected to the lateral lymph nodes at the groin in penile and scrotal lymphedemas

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