In this chapter we will describe the standard procedures of MTT in functional reconstruction. There will always be a patient that does not fit into this standard pattern. In these, the decisions on transfer must be made after careful examination, listing of all retained function and listing of the functions that are to be reconstructed (see Chap. 10). Thus, combinations and modifications of all possible transfers are to be considered.

We will present the transfers that aim to reconstruct special functions, not nerves. Therefore, the individual chapters will not always match the respective nerve lesions described in Chap. 2.

11.1 Scapula Muscles

Paralysis of the muscles of the scapula such as the trapezius, serratus anterior, levator scapulae and the rhomboid muscles make the scapula unstable and impair shoulder function. Additionally, their missing function may be responsible for a secondary scoliosis of the cervical and thoracic spine.

11.1.1 Shoulder Abduction (Accessory Nerve)

Depending on the level of nerve lesion, loss of function differs, especially because innervation is not as clear as always described. A proximal lesion involves paralysis of the sternocleidomastoid muscle. This weakens the ability to move the head away from the affected site. To our knowledge there is currently no indication to reconstruct this function by a transfer.

Involvement of the trapezius muscle, however, may lead to a general weakness in the affected shoulder girdle and arm, the inability to abduct the shoulder above 90°. The scapula rotates distally and laterally and flares slightly. Its inferior angle is closer to the midline than its superior angle. In abduction, this position is accentuated, while by moving the shoulder anteriorly the flaring disappears.

Rarely, if the functional loss has resulted in severe disability and nerve reconstruction has failed, reconstruction can be achieved by grafting fascial strips (for example taken from the fascia lata of the thigh) from the spine of the scapula to the distal cervical and proximal thoracic spinous processes. These static operations can be combined with a transfer of the levator scapulae muscle to the acromial part of the spine scapulae. However, if possible, the following dynamic operation is preferred, because its results are usually better.

Preferred Transfer. Dynamic reconstruction can be achieved by transferring the levator scapulae muscle laterally on the spine of the scapula to a point adjacent to the acromion. Other authors describe a lateral transposition of the rhomboid muscles under the infraspinatus muscle. The patient is positioned prone. Two incisions are made, one parallel to the lateral spine scapulae and one parallel to the medial scapular border. The trapezius muscle is dissected from the medial scapula, and the levator scapulae and the rhomboid muscles are identified. The muscles are detached from their origin with a small piece of bone, and dissected proximally, leaving the dorsal scapular nerve intact. Care must be taken not to injure the attachment of the serratus anterior and the subscapular muscle. The infraspinatus muscle is medially detached. The rhomboid muscles are then fixed with nonabsorbable sutures through drill holes (or anchors, e.g., corkscrew anchor systems) in the scapula as far lateral as possible. At this moment, the shoulder girdle is held dorsally, and the arm is abducted 90°. After reattachment of the infraspinatus muscle to its origin by nonabsorbable sutures, the lateral spine scapulae (as close to the acromion as possible) is freed from the trapezius muscle and the supraspinatus and deltoid muscles are carefully detached. Holes are drilled again or anchors are placed in the lateral spine scapulae (close to the acromion) and the levator scapulae muscle is tunneled through the paralyzed trapezius muscle and fixed to the drill.
holes or anchors with nonabsorbable sutures (Rudiger 1991).
Postoperatively, arm and shoulder are immobilized in a 90° abduction position with slight retroversion for 6 weeks. Mobilization starts with isometric contraction and then abduction.

11.1.2 Dorsal Scapular and Thoracodorsal Nerves

A dorsal scapular nerve lesion results in paralysis of rhomboid and levator scapulae muscles. Usually, an isolated paralysis (of levator scapulae muscle) is well compensated by the trapezius muscle. If the paralysis of the rhomboid muscles leads to functional problems, fascial grafts can be anchored between the medial border of the scapula and the distal cervical and proximal thoracic spinatus processes. Others describe a dynamic fixation of the inferior scapula angle with a strip from the cranial portion of the latissimus dorsi muscle (see Sect. 11.1.3).

The thoracodorsal nerve innervates the latissimus dorsi muscle, whose function is the internal rotation of the arm. The latissimus dorsi is dispensable and often used for reconstruction of other functions, as its function is compensated by pectoral, subscapular and teres major muscles.

11.1.3 Scapular Winging (Long Thoracic Nerve)

Winging the scapula is usually the result of a paralyzed long thoracic nerve. Abduction and anteversion of the arm accentuate the winging. Loss of the serratus anterior muscle results in an unstable scapula with an impaired abduction as the inferior angle cannot move ventrally. Many operative procedures have been described to restore scapula stability. None of these procedures were performed in large populations. Thus, the results are mainly based on case reports. The transfer of the sternal part of the greater pectoral muscle with or without a fascial strip, and the transfer of the minor pectoral muscle try to simulate the original serratus anterior muscle.

If intact, the transfer of the teres major muscle is preferred (Hass 1931). The teres major muscle (n. subscapularis) originates from the inferior angle of the scapula and attaches with the latissimus dorsi muscle at the crista tuberculii minoris. The internal rotation is well compensated by other muscles. The patient is placed on the healthy side, the arm is abducted 90°, but remains free for intraoperative movement. From an incision parallel to the ventral axillary fold, the serratus anterior muscle is exposed around the 5th and 6th rib. The teres major muscle is then dissected more dorsally, underneath the latissimus dorsi muscle and freed from its attachment at the humerus (leave tendon at the muscle). Care must be taken to avoid a lesion of the axillary nerve that runs through the lateral axilla space. The teres major can then be dissected very carefully (not to injure the supplying vessels) and is then pulled ventrally/caudally, where it can be periosteally sutured to the ribs and the remaining serratus anterior muscle.

Another popular method is the transfer of the contralateral latissimus dorsi muscle. However, there are still no long-term results available (Terzis and Papaconstantinou 2002). A static reconstruction is the connection of the injured scapula to the normally functioning scapula (at the level of the spinax) by fascia lata strips. Both scapulae are fixed with the medial border parallel to the spine.