Selective transposition of the pectoralis major myocutaneous flap: an electromyographic evaluation

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Abstract. Although it has been postulated that the segmental anatomy of the pectoralis major muscle should allow intact motor function to be preserved at the donor site after a myocutaneous island flap has been transposed, the functional outcome of this “selective” harvesting technique has not been previously investigated. In this study the degree of innervation of the residual pectoralis major muscle on the chest after traditional (10 patients) and “selective” (10 patients) pectoralis major myocutaneous flap transposition has been evaluated using postoperative electromyography. According to the data obtained, while an intact innervation of the external segment is maintained utilizing both techniques, it is impossible to preserve functional innervation of the remaining sternocostal strip medial to the donor site during a pectoralis major myocutaneous flap transposition, even after its “selective” harvesting.

Key words: Pectoralis major myocutaneous flap – Selective transposition – Electromyography

Transposition of a myocutaneous flap necessarily creates a secondary morphological and functional defect at the donor site. In order to overcome this problem different authors [3-8] have described “modified techniques” that are intended to include a limited portion of the muscular belly in the flap, while leaving the most part undisturbed with its motor innervation intact. Since 1991, we have routinely used a selective technique for pectoralis major myocutaneous flap transfer. Some undesired side effects of the traditional operation: a pulling sensation in the neck due to contraction of the muscle if it maintains innervation, a hollow appearance of the anterior chest, and serious impairment of abduction and free motion of the shoulder when the trapezius muscle has been denervated during a previous neck dissection, should be avoided by this technique.

Some doubts, however, still exist about the functional effectiveness of this “selective” technique since the complex and variable course of the nerve fibers to the muscle [2] can represent a major obstacle to their preservation during surgical dissection of the flap.

In a recent study which used electromyography to study the function of the residual strip of rectus abdominis muscle after its selective transposition in a series of TRAM flap breast reconstructions there was a high percentage of cases with maintained innervation [1]. In this study, electromyography has proved to be an extremely accurate investigational tool in order to evaluate the fate of the residual muscular strips. In fact, since normal muscle is usually electrically silent at rest (except for insertional activity secondary to needle stimulation and occasional fasciculation or normal myokymia), while frequent fibrillation potentials (spontaneous discharges of single muscle fibre occurring in the absence of voluntary muscle contraction) and group polyphasic potentials (muscle action potentials with more than four phases, occurring as groups) are features of denervation, it is possible, by means of electromyography, to measure the degree of surgical denervation at the donor site after a myocutaneous flap transposition. The important components to be interpreted include amplitude, frequency, and duration of the summed action potentials on a sample of a population of muscle fibers.

The aim of the present paper is to investigate the soundness and reliability of the pectoralis major selective transposition technique, evaluating the degree of innervation of the residual pectoralis major muscle on the chest by means of postoperative electromyography.

The selective pectoralis major myocutaneous flap transfer: neurovascular anatomical basis

The pectoralis major muscle may be considered to consist of three subunits: a clavicular, a sternocostal and an
external segment. As described by Morain [3] and Tobin [7], segmental portions can be converted into islands based on the major vascular pedicle; they can be transferred separately.

The pectoral branch of the thoracoacromial artery, the dominant pedicle of the pectoralis major muscle, for most of its course does not run within the muscle but instead in a fatty areolar sling deep to it and easily separable from it. It is this anatomic finding on which the technique of selective transposition of the sternocostal portion of the pectoralis major as a true island myocutaneous flap is based [3, 5, 7]. The nerve supply to the pectoralis major muscle is comprised of the medial and lateral pectoral nerves. Anatomy texts usually name these nerves on the basis of their origin from the brachial plexus; this is not correlated with their actual position as found by the surgeon at operation. The branches of the lateral pectoral nerve are all positioned medial to those of the medial pectoral nerve in their peripheral distribution. Thus, for clarity and for practical purposes, we prefer to reverse this classical “anatomical” description: the medial and lateral pectoral nerves will herein be named according to their anatomic peripheral relationship to the pectoral muscles. Following this classification, the medial pectoral nerve arises from the lateral cord of the brachial plexus from C5, C6 and C7 and is accordingly distributed to the upper portion of the muscle [3, 5, 7], while the lateral pectoral nerve arises from the medial cord of the plexus (C8 and T1) and is distributed to the inferior portion. In this way, all branches of the medial pectoral nerve lie medial to those of the lateral pectoral nerve in their peripheral distribution. As described by Moosman [2], the medial pectoral nerve runs medial to the pectoralis minor muscle and usually divides into two to four branches that course medially and downward to supply the clavicular and the upper two-thirds of the sternocostal portion of the pectoralis major muscle. The nerve passes through the costocoracoid foramen with the thoracoacromial vessels, enters the interpectoral space, and intermingles with their vascular tributaries to the muscle. Conversely, the lateral pectoral nerve arises medial or behind the pectoralis minor, sends twigs to this muscle, and descends on its dorsal side; then the nerve enters the interpectoral space and supplies the external and the lower third of the sternocostal segments of the pectoralis major muscle. In its course, it is related to the pectoralis minor muscle in one of the following ways: (a) it descends as a single branch around the lateral border of the lower half of the muscle (38% of cases); (b) it divides into two branches with one passing through the muscle and the other around its lateral margin (32%); (c) it descends as a single branch that passes through the muscle (22%); (d) it descends as two or three branches of variable size, all of which pass through the muscle, often at different levels (8%).

Surgical technique

An adequate size skin paddle is designed on the sternocostal portion of the pectoralis after evaluation of the defect to be resurfaced. A fasciocutaneous “random” extension is never included, thus the skin lies entirely over the muscle. The skin paddle is circumferentially incised down to the fascia and at its lowest aspect to the retropectoral space. Traction is exerted on it from below then the skin island is everted and its deep aspect is exposed, this allows the surgeon to identify the pedicle of the flap, the pedicle is protected while dividing the full-thickness of the muscle above it and around the island. Dissection proceeds upward, progressively separating the vascular bundle from the overlying muscular belly. Great care is taken not to damage the peripheral branches of the lateral and the medial pectoral nerves. A true myocutaneous island flap is therefore obtained and skeletonization is carefully carried out until the clavicular muscle segment is reached. At this point, a large “buttonhole” is fashioned between the fibers of the clavicular muscle segment and the overlying clavicular fascia to allow passage of the myocutaneous island and its pedicle up into the neck, through an almost intact upper pectoralis. Muscle suturing is performed in order to reattach the fibers around the harvested area, allowing the primary closure of the donor defect under not more than moderate tension.

Patients and methods

From 1991 to 1994, 20 patients underwent selective harvesting of the pectoralis major myocutaneous flap while 42 patients underwent traditional muscle-splitting pectoralis major myocutaneous flap transposition.

No difference in flap viability was observed. Postoperative complications were limited and similar. From an aesthetic point of view, the donor site defect was much less significant in the “selective” group. Scarring and nipple distortion were similar in the two groups, but the patients of the “selective” group showed a better contour of the infraclavicular region with a natural-looking anterior or axillary fold. The prominent bulge over the clavicle that is seen with the traditional technique was always avoided.

Ten patients operated with the “selective” technique and ten patients operated with the traditional technique were used to study. A needle electromyography of the lateral and medial aspects of the pectoralis major muscle was performed in all patients, using concentric standard needle electrodes, three months after the operation of flap transposition. The needles were positioned along the medial and lateral borders of the operated pectoralis muscle; single motor unit potentials were elicited and interpreted.

Results

In all patients of both groups, needle electromyography of the external segment of the pectoralis major muscle demonstrated an interference pattern at maximum voluntary effort (Fig. 1), normal parameters of motor unit potentials (Fig. 2), and no pathological spontaneous activity, while study of the sternocostal segment showed no voluntary activity (Fig. 3), and presence of positive sharp waves and fibrillations. These results indicate a normal function of the lateral part of the muscle and a denervation of the medial part. In only one case (Fig. 4) (patient operated with the “selective” technique), an increased amplitude of muscle potential of the medial aspect – an increase in electrical activity, recorded from the muscle fibers of a motor unit due to reinnervation of muscle fibers by the sprouting of uninvolved nerve cell processes – was observed.

Furthermore, while in the “selective” group the innervation and the function of the clavicular segment of the muscle...