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Compartmentalization of the Latissimus Dorsi Muscle

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ABSTRACT

This anatomical study provides a detailed description of the thoraco-dorsal artery, vein and nerve systems within the latissimus dorsi muscle. The nerve and vascular relationships in ten fresh cadaveric latissimus dorsi muscle specimens, were analysed. Radio-opaque material was injected into the thoraco-dorsal artery, while the thoraco-dorsal nerve and its main branches were dissected and labeled with fine wire. These dissections were accomplished microscopically following which all the specimens were X-rayed for further analysis. The results of these investigations are presented and suggestions are made regarding the subdivision of the muscle into independent neurovascular functional units. The study demonstrated that the latissimus dorsi muscle is composed of two neurovascular units and that splitting of the muscle into independent units is a reliable surgical maneuver. This technique increases the utility of the muscle for local or distant transfer and minimizes donor site morbidity.

INTRODUCTION

The latissimus dorsi myocutaneous flap was first described for breast reconstruction by Tansini in 1896 and in 1906 [1,2], but the technique was lost for several years. Following the recent rebirth of the myocutaneous flap and the advances in microsurgery which made free tissue transfer reliable, the latissimus dorsi myocutaneous (or muscle flap) became the most widely used flap in reconstructive surgery [3].

There are some cosmetic and functional problems associated with the latissimus dorsi muscle harvest such as contour defect, moderate shoulder weakness, decrease in shoulder range of motion and change in hand dominance [3]. These side effects in the donor site have stimulated many studies to develop techniques which may spare some function of this muscle.

The compartmentalization of the latissimus dorsi muscle into individually functional units, where each unit has its own neurovascular supply, would allow the harvest of only that portion of the muscle which is necessary for reconstruction. Sufficient innervated muscle segment then remains to minimize donor site morbidity. The objective of this study was to investigate the neurovascular distribution within the latissimus dorsi muscle in order to develop defined functional units based on independent neurovascular supply.

MATERIAL AND METHODS

The study involved dissection and radiography of ten latissimus dorsi muscles in five fresh cadavers. The work was done in four phases:

1- *Injection:*

The thoraco-dorsal artery was approached through a small axillary incision where it was isolated and cannulated. Ten ml of Microphille was then injected under constant pressure into the artery to infuse the latissimus dorsi muscle (Fig. 1).

2- *Dissection:*

The skin overlying the latissimus muscle (from the scapular spine cephalad to the iliac crest caudad and from the midline to the mid-axillary line), was raised from lateral to medial with labeling of the myocutaneous perforators using medium size hemoclips. The latissimus dorsi muscle was then raised with careful preservation of its neurovascular pedicle (Fig. 2).

3- *Labeling the nerve:*

The thoraco-dorsal nerve was meticulously dissected under microscope magnification and the intramuscular branches of the nerve were traced down to the individual muscle bundles. The nerves were labeled using a computer link cable which was fixed along the nerve with multiple 5/0 sutures. This labeling technique with malleable and multifilament cable allowed easy splitting of the cable at the appropriate branching points of the nerve.

4- *X-ray:*

Each muscle specimen and its overlying skin was X-rayed for analysis (Fig. 3).

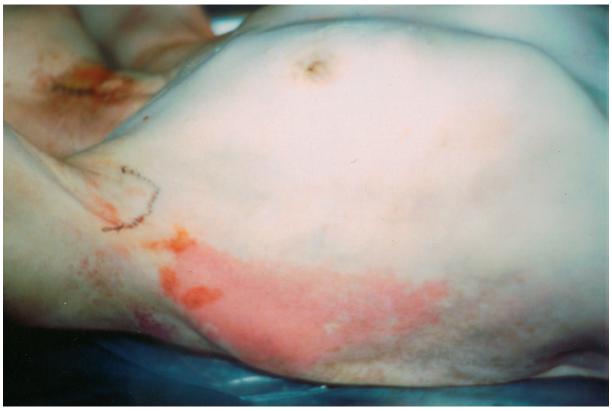

Fig. (1): The latissimus dorsi muscle with its overlying skin territory (Stain Microphille).

Fig. (2): X-ray showing the branching system started by two main branches (Stain Microphille).

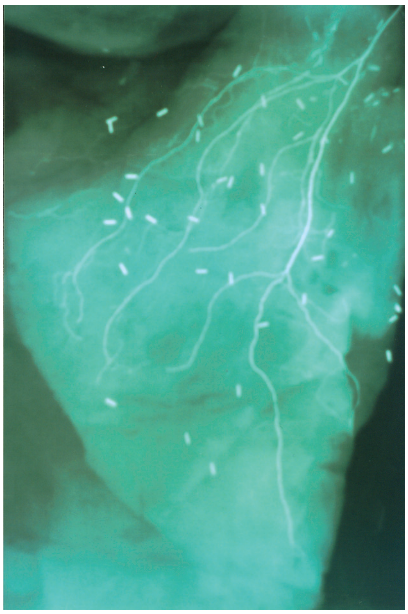

Fig. (3): X-ray showing the distribution of the myocutaneous perforators and that the upper lateral quadrant has the highest density of perforators (Stain Microphille).

RESULTS

The neurovascular system follows the intramuscular connective tissue framework to reach the muscle bundles. The branches of the thoraco-dorsal nerve and vessels within the muscle always follow a parallel relationship with the muscle fibers.

The main branches of the nerve are always in a more lateral and superficial plane than the vessels (i.e. more toward skin), but some small nerve branches pass deeper than the vessels to innervate the deeper muscle bundles. The branches of the thoraco-dorsal artery are the deepest structure (i.e. more toward the chest) and the veins usually lie between the arteries and the nerves. The branches of the vessels are always found following the branches of the nerves. These nerve branches always course in a straight line. The vessels usually follow a tortious course deeper to the nerves.

In all cases, there were main medial and lateral branches for both the nerves and the vessels, then each main branch gave off its own branches. The lateral branch of the nerve and the vascular pedicle was always bigger than the medial one, with this lateral branch coursing more or less parallel to the lateral muscle border. The angle between the larger lateral branches and the medial smaller branch is variable from case to case.

The distributions of the secondary branches of the main medial and lateral branches have no fixed pattern. At the proximal site of early branching there are interdigitations between the nerves and the vessels of each main branch. In our study of the distribution of the myocutaneous perforators, we found these differ ences from case to case, but in all cases, the upper lateral quadrant of the muscle includes the larger number of these perforators.

DISCUSSION

The latissimus dorsi muscle is one of the most frequently used flaps in reconstructive surgery. It can be used either as a muscle alone or with its overlying large skin island. Its large surface area coupled with its reliable long neurovascular pedicle has facilitated the use of this flap either as a local rotational or as a free flap transfer. The previous clinical reports have suggested that the latissimus dorsi muscle is organized into independently innervated segments. However, the anatomical documentation of these suggestions has been insufficient [4].

Because the functional consequences of both the used and the remaining muscle segments must depend in part on the neurovascular organization within the muscle, some previous investigators have tried to analyze the neurovascular supply of the latissimus dorsi muscle. Tobin et al., reported the results of their investigation on the location of the neurovascular hilus of the latissimus dorsi muscle. They also reported on the different patterns of the neurovascular bifurcation **[5]**. Taylor et al., in their recent work, analyzed the neurovascular relationships in the skin and the underlying muscles. They also presented a classification of the muscles based on their nerve supply. According to this classification, the latissimus dorsi muscle is type 1 muscle, because it is supplied by a single motor nerve which divides after entering the muscle **[6]**.

The author considers this study a continuation of the previously mentioned investigations, as it includes a detailed description of the neurovascular anatomy within the muscle substance that has not before been sufficiently elucidated. Also in this study, we have noted different findings when compared with the previous reports.

Tobin et al. **[5]** reported that the lateral branch of the thoracodorsal neurovascular pedicle is larger than the medial one. Our observations support this statement. In all our specimens, we found the course of the lateral branch of the thoracodorsal neurovascular pedicle is more or less parallel to the lateral muscle border. We do not however agree with Tobin's report on the position of the medial branch. The latissimus dorsi muscle has almost a triangular shape. The upper border of the muscle is horizontal at the level of the scapular lower end, while its lateral border is almost vertical and forms the posterior axillary line. The angle between the upper and the lateral borders of the muscle is nearly 90 degrees. Tobin et al. **[5]**, also mentioned in their report that the lateral branch of the thoracodorsal neurovascular pedicle was parallel to the lateral border of the muscle, while the medial branch was always parallel to the upper border of the muscle and the angle between the medial and the lateral branches were 45 degrees in all cases. Our findings do not support his results, as the angle between the two branches must be more than 45 degrees if the medial branch of the pedicle is found parallel to the upper muscle border. In our observations, the angle between the two branches was always different from one case to another and the medial branch was not parallel to the upper border of the latissimus dorsi muscle in most of our cases.

They also had reported that in 6% of their dissections, the neurovascular tree arborized into three or four major branches which took courses parallel to each other **[5]**. In our study, we did not observe this pattern of branching. In all our cases, branching was started by two major branches and each of them gave off its own smaller secondary branches.

Neither Taylor et al. **[6]** nor Tobin et al. **[5]** reported on the distribution of the musculocutaneous perforators of the thoraco-dorsal vessels. In our study, we find that the upper lateral quadrant of the latissimus dorsi muscle has the majority of perforators. The medial side of the muscle is mainly supplied by the paramedian perforators. Therefore, the skin of the upper-lateral territory is the most reliable when transferred with the muscle based on the thoracodorsal vessels. On the other hand, none of the previous investigations described the relationships between the nerves, veins and arteries. Our study found that the nerves were usually located in a more superficial and lateral position than the vessels. The veins are always located between the nerves and the arteries, the arteries assuming deeper position in the branching system.

The findings of this study show that the anatomy of the thoracodorsal neurovascular supply allows splitting of the muscle into two large, independent innervated, vascularized motor units. Although there are different branching patterns of the secondary branches, in all cases the branching starts with a proximal bifurcation of only two main branches. Each branch then gives up its own secondary branches which always assume a parallel relationship with muscle fibers.

Splitting of the muscle surgically will be easy if the dissection starts distally where the branches take a parallel relationship with the muscle fibers. More proximally toward the main pedicle, more careful dissection is required because of the interdigitation of the neurovascular main branches. The complexity of the branching system and the interdigitation between the nerves, arteries and veins at the area of early branching, makes dissection even more difficult and the surgeon must be careful to avoid sacrificing some of these branches, especially the tortuous vessels.

The previously mentioned features of the thoracodorsal neurovascular distribution within the latissimus dorsi muscle, makes splitting of the muscle into two independent motor units technically uncomplicated and adds versatility to its reconstructive applications as a local rotational or as a free flap.

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