Versatility of the Pedicled Thoracodorsal Artery Perforator (TDAP) Flap in Soft Tissue Reconstruction

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Abstract: For the last decades, the latissimus dorsi skin-muscle flap has contributed to the efficient reconstruction of the loss of skin cover (especially in breast surgery) and in long-distance tissue defects. Unfortunately, the nonuse of such an important muscle as the latissimus dorsi for the patient, as well as the resulting thickness of the flap after reconstruction, has turned it into a second choice flap. However, this flap is still indicated in the reconstruction of areas which need a great amount of cutaneous and muscular tissue.

The appearance of the perforator flaps and, specifically, thoracodorsal artery perforator (TDAP) flap, has meant a radical change in relation to lower morbidity of the donor site, thus highly ranking the use of these flaps in the reconstruction for similar defects.

The aim of this publication is to present our experience with the pedicled TDAP flap in a series of 17 different cases. Of those, there were 14 cases of mammary reconstruction after sparing surgery, 2 cases of axillary reconstruction following severe recurrent hidradenitis, and a case of extensive substance loss in a patient’s upper arm following a severe crush injury.

Key Words: perforator flaps, pedicle flaps, soft tissue reconstruction, thoracodorsal vessels

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The use of the thoracodorsal artery perforator flap is a relatively new reconstructive procedure, and it has been shown to be the final stage in the progress initiated by the latissimus dorsi skin-muscle flap, but preserving the muscle. As with other types of perforator flaps, it can be raised with minimal preservation of structures of the donor site. Nevertheless, unlike other perforator flaps such as the superior gluteal flap (s-GAP) or the abdomen (deep inferior epigastric perforator, DIEP) flap, the thoracodorsal artery perforator (TDAP) flap provides a thinner and more manageable cutaneous paddle in most cases. Traditionally, the anterolateral thigh flap is used in reconstructive surgery where extensive and complex defects occur. However, due to the great adaptability of the TDAP flap, it also allows its use in extensive reconstructive surgery. Nevertheless, the use of TDAP flap has not gained sufficient acceptance since it first appeared due to its tedious and difficult dissection and its unpredictable results. Up to the present time, there are not sufficient articles published concerning the use of the TDAP flap in mammary reconstruction, only references of some clinical cases in axillary reconstructive surgery.

MATERIALS AND METHODS

In the time period from April 2002 to March 2006, the TDAP flap was used in 17 cases. In 14 of these cases, the TDAP flap was use in breast reconstructive surgery (8 cases of quadrantectomy/tumorectomy, 5 cases of simple mastectomy, and 1 case of exposed implant). In 1 case, this flap was used to reconstruct severe and extensive tissue loss secondary to burn in a patient’s upper limb. Furthermore, in 2 cases, the TDAP flap was used in axillary reconstruction surgery, needed following severe recurrent hidradenitis.

Anatomy

The thoracodorsal artery constitutes the latissimus dorsi muscle main pedicle. This artery originates in the subscapular axis. After forming the serratus muscle arterial branch, the thoracodorsal vessels divide in 2 more branches: the lateral or descendent branch and the horizontal or medial branch, diverging 45 degrees one from the other. Furthermore, the lateral branch, following a 2- to 3-cm intramuscular path, divides into 2 or 3 skin perforator arteries, perfectly defined in previous anatomic studies. The most proximal vessel reaches the subcutaneous tissue in a point located 2 or 3 cm posterior to the lateral edge of the muscle and 8 cm below the posterior axillary fold. This artery is orientated in the same direction as the subjacent thoracodorsal artery, making dissection easier. Each perforator vessel follows a 3- to 5-cm intramuscular path. The second perforator artery is located 2 to 4 cm below the previous one, usually smaller in diameter. Both perforator arteries have been identified in most dissections. The presence of a third perforator artery is not constantly found (50% of cases, depending on series). All these perforator arteries give off numerous muscular branches before penetrating the fascia to supply the overlying skin and subcutaneous fat layers.
Surgical Technique

Prior to surgery, the perforator arteries are located using bidirectional echo Doppler (Fig. 1). The patient is placed in a lateral position, leaving the upper limb in neutral abduction, allowing good access within the donor and receiving sites, thus not needing to change the patient’s position throughout the entire operation. The reference points for the first perforator artery are pen marked. The flap’s central point should be located 8 cm below the posterior axillary fold and 2 cm behind the anterior border of the latissimus dorsi muscle. Then, the lateral border of the latissimus dorsi is pen marked as well. Other reference point is located 2 cm behind the anterior border of the muscle and 4 cm below the tip of the scapula. This reference point coincides with the thoracodorsal fork, where the lateral and medial perforators are formed. According to the estimation of the defect to reconstruct, the flap is designed including 1 or more of the located perforator arteries. In our study, none of the flaps width was greater than 9 cm, with the purpose of assuring the primary closing of the donor site. With the idea of facilitating the technique, the desepidermization of the skin area in relation to extension of the area to reconstruct was carried out prior to the raising of the flap. We began the dissection by the anterior side of the flap, cutting the fascia to carry out a subfascial manipulation of the perforator artery, facilitating its location. Once located and selected the perforator artery, we proceeded to perform the intramuscular dissection leading to the descending branch. The intramuscular dissection constitutes the most delicate part of the operation, having to be extremely cautious to preserve the numerous veins and muscular vessels which emerge form the perforator. This dissection implies the liberation of the nerve from the neurovascular bundle, this not usually being necessary since the rotation is facilitated sufficiently with the dissection of only this vertical branch. After the dissection, we proceeded to limit the amount of fascia up to 1 cm around the perforator. The cutaneous flap is tunneled in every case towards the defect. At this step, it is important to be careful not to damage the perforator and to avoid all tension or external pressure.

RESULTS

All the cases are included in Table 1. The largest dimensions of TDAP flap used were $21 \times 8$ cm. All the flaps were based on a single perforator artery, except in cases number 2, number 7, and number 12, in which 2 perforators from the same vertical branch of the thoracodorsal artery were isolated and used. Depending on the perforator diameter, the flap was based on 1 or 2 perforators only. In none of our cases was the latissimus dorsi muscle included. The nerve was spared in every case. The results in all cases were satisfactory, with complete viability of the transferred flaps, except in 2 cases where we
observed a hematoma underlying the injury. Both hematomas were drained, with satisfying results. Significant venous congestion was not observed in any of the cases. Only cases 1 and 3 presented discrete venous congestion in the distal tip of the flap, showing satisfactory evolution after desepidermization, thus not needing a correction surgery. None of the donor sites developed seromas. A serohematic collection was quite a frequent complication when using skin-muscle flaps. Nevertheless, when preserving the muscle, it is unusual to observe the appearance of seromas.

Clinical Cases

Case 1

A 41-year-old man, after suffering a crush industrial accident, presented with a third-degree burn on the posterior side of his left arm. After fascial debridement of the necrotic area and temporary coverage with biologic dressing (Biobrane), we proceeded to cover in a second time with a 21 × 8-cm perforator flap from the thoracodorsal artery tunneled to the defect (Fig. 2A, Fig. 2B). The first perforator artery was located by echo Doppler, showing sufficient diameter for a single-based perforator artery flap. The normalization of the defect was satisfactory. A small venous congestion at the tip of the flap did not compromise its viability. Neither major venous congestion complications nor serohematic collections were observed in the donor site. The resulting scar, in spite of its size, was approved by the patient (Fig. 2D).

Case 2

A 24-year-old male patient suffering from recurrent hidradenitis, in whom primary failure of covering with laminar skin graft occurred, was included in our study. We performed then a TDAP flap of 18 × 8 cm. A semilunar design was chosen to fit better to the outline of the axilla, which would follow the route of the vertical branch of the thoracodorsal pedicle. This area was chosen because it is practically hairless in men. A single-based perforator artery flap was raised and tunneled to the defect. We observed a good blood supply in the postoperative days, with satisfactory evolution (Fig. 3).

Case 7

A 37-year-old female patient suffering from an in situ breast carcinoma over her left breast underwent quadrantectomy. She was included in our series for reconstructive surgery using a TDAP flap. A perforator flap was designed using an area of skin to fit in the outline of the receiving site, and a larger area without skin was left to replace the glandular volume taken away by the previous resection. Underlying the flap, a bidimensional implant of 225 mL was placed. The patient presented localized bleeding within the first day postoperative. The hematoma was drained, without vascular compromise of the skin in the perforator flap. The evolution of the flap was satisfactory, the esthetic results of both the reconstructed site and the donor site being accepted by the patient (Fig. 4).

Case 12

A 39-year-old woman suffering from an in situ breast carcinoma underwent mastectomy with no radiotherapy and was later included in our series for TDAP flap reconstructive surgery. Having to be precise in terms of symmetry with her other breast and considering the amount of skin to do so, we decided to design an island based on 2 perforators from the vertical branch of the thoracodorsal artery. A bidimensional implant of 295 mL underlying the flap helped to obtain the symmetry expected, all at the same surgical time. The results were accepted and satisfactory for the patient (Fig. 5).

DISCUSSION

The latissimus dorsi muscle flap, in its pediculated form, has played a decisive role in the reconstruction of
defects placed in the upper limb, chest, and the reconstruction of head and neck. Also, this pediculated flap has constituted a fundamental tool in breast reconstruction. Nevertheless, its thickness and the consequences in the donor site (esthetic and functionally) have led to a decrease in its use and indications. To reduce the thickness of the flap, several authors have described longitudinal slimming, as well as the use of minimal muscle tablets. These new approaches have contributed to diminish functional defects.

The introduction of the perforator flaps has allowed us to do so without the use of the muscle as a vehicle for the vascularization for any skin flap. An axial vessel directly nourishes a skin island through 1 or more direct or indirect perforators, which provides vascularization of tissue of smaller thickness and preserves the function of the muscle in the donor site.

Since the Angrigiani et al initial descriptions, the possibility of raising a flap island without the muscle, based on some of its perforators, has reduced the great disadvantages of this type of flap. The preservation of the muscle diminishes its functional loss, and in addition, it is less painful postoperatively. This technique can also eliminate third spaces within the wound, thus avoiding the formation of seromas and maintaining the outline and symmetry of the back without alterations. The muscle flaps frequently need thinning in a second surgical time, whereas the TDAP flap is sufficiently thin to adapt perfectly to defects that require thinner tissue in the reconstruction.

Nevertheless, the TDAP flap has not been used generally by plastic surgeons when compared with other perforator flaps for different reasons. First, the number of latissimus dorsi perforators’ branches is limited (3 at the most). Other perforator flaps, such as DIEP, the s-GAP, or the ALT (anterolateral), showed a greater diversity of perforators. Second, the distribution of these perforators has only been researched in a few anatomic studies. Although the measures and the constant presence of 2 more proximal perforators have been published, their location and distribution have not been described sufficiently. Third, the dissection of these perforators has been described as tedious due to their small diameter, long intramuscular track, and close proximity to the thoracodorsal nerve branches.
Changing from a perforator flap to a skin muscle flap with a small island of muscle should be considered for those cases in which the perforators are too small or tissue blood perfusion is not present macroscopically.8 It was not necessary to use in any of the cases of muscular atmosphere. In the fourth place, the venous drainage of the TDAP flap has been described as poor and insufficient (low-output flap). Due to this reason, a venous anastomosis has been recommended in much of the literature. In our series, serious venous congestion was not observed; thus, venous anastomosis was not considered. The presence of other flaps in the proximity such as the parascapular and scapular, which show less morbidity in the donor site, makes the choice of the TDAP flap controversial on numerous occasions. In the described clinical cases, most scars developed in the donor site were in a vertical disposition, with the end of the flap directed towards the scapula, matching posterior axillary folds. This makes these scars less visible by being partially hidden, not only by bra wearing in women but also by the arm itself. The area of the flap is found within the limits described by Taylor20 for this angiosoma. In our series, it is observed that the length of the pedicle of the TDAP is enough to tunnel and transfer the flap to the breast, arm, or axilla. Taking into account that the tunnel was thought to be for a cutaneous island of a larger size than the perforator, the latter should not be endangered later in its definitive situation, and always in the absence of hematomas that exert an unfavorable external pressure.

The reliability of the vascular pedicle of the TDAP flap, the size of the skin island that can be used (10 × 25 cm),1,21 along with the wide angle of rotation, make this perforator flap a good candidate to consider when reconstructive surgery of the face, thorax, axilla, and upper limb9 is required.

The sparing surgery of the breast in many occasions resorts to tumorectomy and/or quadrantectomies to conserve as much of the breast as possible. This is supported by patients themselves, who agree with the conservation of most of the breast, then reducing the impression of mutilation. In addition,

### TABLE 1. Patient Characteristics and Clinical Indications for Flap Reconstruction

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex</th>
<th>Age</th>
<th>Defect Situation</th>
<th>Flap Size, cm</th>
<th>Defect Origin</th>
<th>Complications</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>41</td>
<td>Arm</td>
<td>21 × 8</td>
<td>Burn</td>
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</tr>
<tr>
<td>2</td>
<td>F</td>
<td>26</td>
<td>Axilla</td>
<td>18 × 8</td>
<td>Hidradenitis</td>
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</tr>
<tr>
<td>3</td>
<td>F</td>
<td>24</td>
<td>Axilla</td>
<td>12 × 6</td>
<td>Hidradenitis</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>38</td>
<td>Breast (UEQ)</td>
<td>13 × 7</td>
<td>Quadrantectomy</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>61</td>
<td>Breast (UEQ)</td>
<td>11 × 6</td>
<td>Quadrantectomy</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>54</td>
<td>Breast (UEQ)</td>
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<td>No</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>39</td>
<td>Breast</td>
<td>12 × 8</td>
<td>Mastectomy</td>
<td>Hematoma</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>38</td>
<td>Breast</td>
<td>13 × 7</td>
<td>Exposed implant</td>
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</tr>
<tr>
<td>9</td>
<td>F</td>
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<td>Mastectomy</td>
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<td>Mastectomy</td>
<td>No</td>
</tr>
<tr>
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<td>34</td>
<td>Breast (UEQ)</td>
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<td>Quadrantectomy</td>
<td>Hematoma</td>
</tr>
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<td>F</td>
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<td>16 × 7</td>
<td>Quadrantectomy</td>
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<tr>
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<td>F</td>
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<td>Breast</td>
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<td>Mastectomy</td>
<td>No</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
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<td>Breast (UEQ)</td>
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<td>Quadrantectomy</td>
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<td>16</td>
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<td>49</td>
<td>Breast (UEQ)</td>
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<td>Quadrantectomy</td>
<td>No</td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>38</td>
<td>Breast (UEQ)</td>
<td>14 × 8</td>
<td>Mastectomy</td>
<td>No</td>
</tr>
</tbody>
</table>

F, female; M, male; UEQ, upper external quadrant.

### FIGURE 5. A, B, Design of the TDAP flap in patient with simple mastectomy. C, Thoracodorsal perforator flap dissection with the skin paddle. E, An adequate breast contour was achieved.
sparing surgery associates a smaller tumor exeresis, allowing greater reconstruction techniques.

Having said this, from the plastic surgeon’s point of view, this type of surgery is not his/her preference, as it is known that the results with the traditional procedures are esthetically not very well accepted. In many cases, a complete mastectomy is offered to patients because better results can be achieved with reconstructive surgery. Research in relation to the use of pedicled perforator flaps in mammary reconstruction is in the early stages. Hamdi et al.8 presented a series of 28 patients with mammary defects following quadrantectomies, reconstructed through perforator flaps of thoracodorsal artery or intercostal artery perforator (ICAP). An algorithm protocol for the election of these flaps was used, depending on the type of defect in the breast. In all the cases presented for mammary reconstruction, the use of skin-muscle flap, an underlying implant to obtain a sufficient mammary volume, and the presence of a scar on the patient’s back were considered disadvantages.

Recently, satisfying results have appeared in literature concerning the use of the pedicled TDAP in chronic hidradenitis with scarring complications and shoulder defects. Covering defects located at the axilla and arm requires thin flaps that at the same time allow functional and esthetic recovery in a single surgical time. In addition, the reconstruction of defects in the axilla following severe recurrent hidradenitis is useful with this flap, especially if hairless skin is used.

When using TDAP flaps, the donor site shows similar complications to those which appear when using latissimus dorsi muscle flaps. It is recommended not to take more than an 8-cm width for the flap. The sparing of the muscle may add more tension when primary closing is intended. On the other hand, the scar direction and the axillary fold may conceal the scar itself.

CONCLUSIONS

The TDAP flap is a new tool for mammary reconstruction following sparing surgery, for axillary defects after exeresis of severe chronic hidradenitis, and for large defects of the upper limb. In addition to the functional benefit for the latissimus dorsi muscle, it also presents advantages as far as pliability to the defect. In spite of the references concerning the tediousness of the perforator flap dissection, mainly because of the different size and location of the perforators, we believe that its use does not show greater difficulty when compared with other types of perforator flaps. Therefore, we consider the TDAP flap as a valid alternative for defects such as those in our series of cases.

REFERENCES


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