Egypt, J. Plast. Reconstr. Surg., Vol. 49, No. 1, January: 81-89, 2025

Thoracodorsal Artery Perforator Flap, A Workhorse Flap

MOHAMED ABDALLAH EL NAHAS, M.D.; FOUAD MOHAMED GHAREEB, M.D. and MOHAMED SALAH ABO EL HODA, M.Sc.

The Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Menoufia University

Abstract

Background: Improvements in our knowledge of the vascular anatomy have enabled the design of a new type of fascio-cutaneous flaps, which are based on perforating vessels only. Thus, donor site morbidity is markedly reduced.

Objective: The aim of our study was to ease flap harvest, shorten operation time, minimize donor site morbidity, maximize esthetic outcome, decrease complication rates and post-operative recovery time and therefore TDAP flap is considered as a work horse flap.

Methods: The authors describe their experience about the role of TDAP flap in reconstruction of different complex tissue defects. Representative cases are presented for illustration.

Results: We conducted a study involving 24 patients who underwent TDAP flap reconstructions from January 2022 to April 2024. The patients aged 4 to 49 years. Flaps ranged in size from 12cm × 6cm to 26cm × 15cm. In 12 cases, one perforator was identified: In 9 cases, two perforators and in 3 cases, three perforators. Free TDAP flaps were used in 17 cases, while pedicled flaps were used in 7 cases. The donor site was primarily closed in all cases without any movement restrictions. There was one case of partial flap loss, but no cases of total flap loss occurred.

Conclusions: TDAP flap provides a reliable and versatile option for plastic surgeons in reconstruction of complex soft tissue defects with limited donor site morbidity and excellent functional and esthetic results.

Key Words: *Thoracodorsal – Free – Flap – Pedicled.*

Disclosure: No disclosure.

Introduction

It has been found difficult to reconstruct complex wounds involving multiple tissue losses and three-dimensional tissue defects. Such wounds can be accompanied with extensive soft tissue defects and dead spaces of variable location and magnitude. To achieve successful wound healing and prevent postoperative complications, their reconstruction requires not only coverage of surface defects but also obliteration of dead space **[1]**.

When it comes to reconstructive surgery, one of the most dependable living tissues is the latissimus dorsi musculocutaneous flap **[1]**. Nonetheless, a sizable muscular section of the flap causes a major functional impairment **[2,3]**. Furthermore, this flap's thickness makes it unsuitable for resurfacing a distal limb's shallow defect **[4]**.

Perforator based flaps from the back can be made thin for functional and aesthetic refinement. They are also helpful for resurfacing defects **[4,5]**. Particularly for contouring or covering shallow defects resulting from crushing or degloving injuries, the release of contracted burn scars, and extensive resections of skin cancer, the requirement for thin flap coverage has increased **[5]**.

Ever since Angrigiani **[15]** introduced the idea of the thoracodorsal artery perforator (TDAP) flap, the latissimus dorsi musculocutaneous flap harvesting technique has been altered to remove the muscle portion and obtain only the cutaneous part, which is supplied by a single thoracodorsal artery perforator. Subsequently, a number of additional reports about the application of this flap were released **[4]**.

The thoracodorsal artery perforator flap has attracted great interest because its unique advantages including long donor vessel that can reach a recipient vessel far from traumatized or irradiated defects, provides a flap of suitable thickness for resurfacing the shallow defect of a distal limb, the function in the latissimus dorsi muscle is preserved, and the donor region is concealed well in clothes. The primary drawback of the TDAP flap is particularly problematic since blood vessels vary in diameter and locations, necessitating lengthy operation **[1,4,6,7]**.

In many and different reconstructive applications of this flap, the precise pattern, size, and po-

Correspondence to: Dr. Mohamed Abo El Hoda,
E-Mail: mohamed.mohamed9@med.menofia.edu.eg

sition of the perforating vessels are significant. A safe and quick dissection is made possible by the pedicle and lateral branch perforators, which are typically found along the muscle's lateral border and are more reliably located [7].

Following the description of perforator-based flaps, these flaps have taken the place of a number of myocutaneous flaps in the resurfacing of shallow distal limb defects [5]. The key factors for selecting a free TDAP flap are:

- Preserving muscle (the flap contains only the skin and subcutaneous adipose tissue).
- Constant thickness.
- Large flap dimensions.
- Long vascular pedicle.

The primary drawback of the thoracodorsal artery perforator flap is the time-consuming dissection of perforators with different dimensions and positions, necessitating extended operation. Nonetheless, experience and training could help with this [7].

The thoracodorsal artery runs on the deep surface of the muscle and splits into a medial and lateral branch. According to several authors the bifurcation on the deep surface of the latissimus dorsi muscle approximately 4cm distal to the tip of the scapula and 2.5cm medial to the lateral free border of the muscle [8,9,10].

Nonetheless, the bifurcation was primarily located 1.7cm from the muscle's lateral border and 2 cm distal to the scapula's tip. The bifurcation of the thoracodorsal artery was also found to be 5.0±1.5 cm (range: 2.0-9.0cm) from the axilla's dome; this structure has not been documented before. Prior to dissection, this measurement will be useful in planning how to acquire the TDAP flap [11].

Patients and Methods

This is a study of 24 cases of thoracodorsal artery perforator flaps done from January 2022 to April 2024 for patients with complex soft tissue defects. There were 8 females and 16 males. The age group ranges from 4 to 49 years with a mean age of 27 years. Free TDAP was done in 17 cases while pedicled flap was done in 7 cases. Follow -up ranged from 3 months to 1 year. The flap design was based on thoracodorsal perforator located 6-8cm from apex of axilla within 2cm from anterior border of latissimus dorsi muscle. One or more perforators of 1.5 to 4cm interval were found. All the data about the vascular system anatomy, the length of the pedicle, donor site morbidity, and the flap outcomes regarding the functional and the aesthetic outcomes were recorded.

Surgical procedure:

All patients were given general anesthesia, put in a lateral decubitus position with ipsilateral arm scrubbed and included in surgical field with well padding of pressure sites and genitals. Intraoperative marking of the flap was done. The flap's longitudinal axis is oriented from the axilla's apex and extends downward within two centimeters of the LD muscle's anterior border. Using an intraoperative Doppler device, the perforators' location was found to be 6–8 cm from the axilla's apex and 2cm from the anterior border of the LD muscle (Fig. 1).

Fig. (1): Showing pre-operative markings. Identification of perforator/s using handheld Doppler 2cm from anterior border of LD, 8cm from apex of axilla.

The size of the flap is determined according to the defect. Using a 3.5 X magnifying loupe, incision of anterior border is carried out first deep to superficial fascia overlying the LD muscle, dissection continued till site of pre-located perforator is reached. In this area, dissection is carried out until one or more suitable perforators is detected and marked using vessel loop. Flap harvesting continued with incision of inferior and posterior borders above level of superficial fascia of LD and a strip of muscle from LD 2cm wide was harvested starting from below and around perforator/s and extending up towards thoracodorsal pedicle to avoid intramuscular dissection and skeletonization of vessels and significant reduction of operation time, on the same hand, visualization of descending branch of thoracodorsal artery is crucial (Fig. 2).

The pedicle is dissected until the desired length is obtained. If extra length is needed, the transverse branch of thoracodorsal artery is ligated and divided, and dissection continues until subscapular trunk is reached.

Identification of vascular pedicle to serratus anterior muscle plays significant role in flap harvesting as a lifeboat for supercharging, turbocharging and flow through flap harvesting. In all cases of free TDAP flap, only one vein is present in thoracodorsal pedicle, in such case vascular pedicle to serratus anterior provides excellent door to additional flap drainage. A flow through flap was done on anterior tibial artery where main thoracodorsal artery anastomosed on proximal end of vessel and serratus branch was anastomosed on distal end of vessel. The same principle was applied on venous drainage as well as different recipient vessels (Fig. 3).

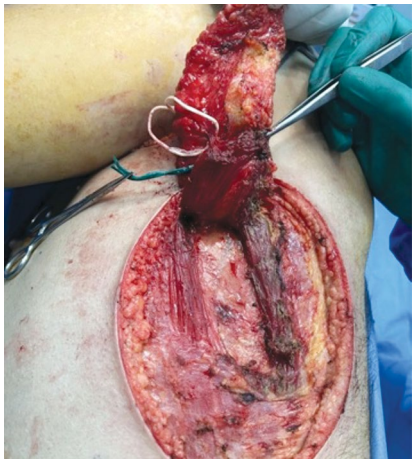

Fig. (2): Showing LD muscle strip instead of intra-muscular dissection or muscle cuff around perforators.

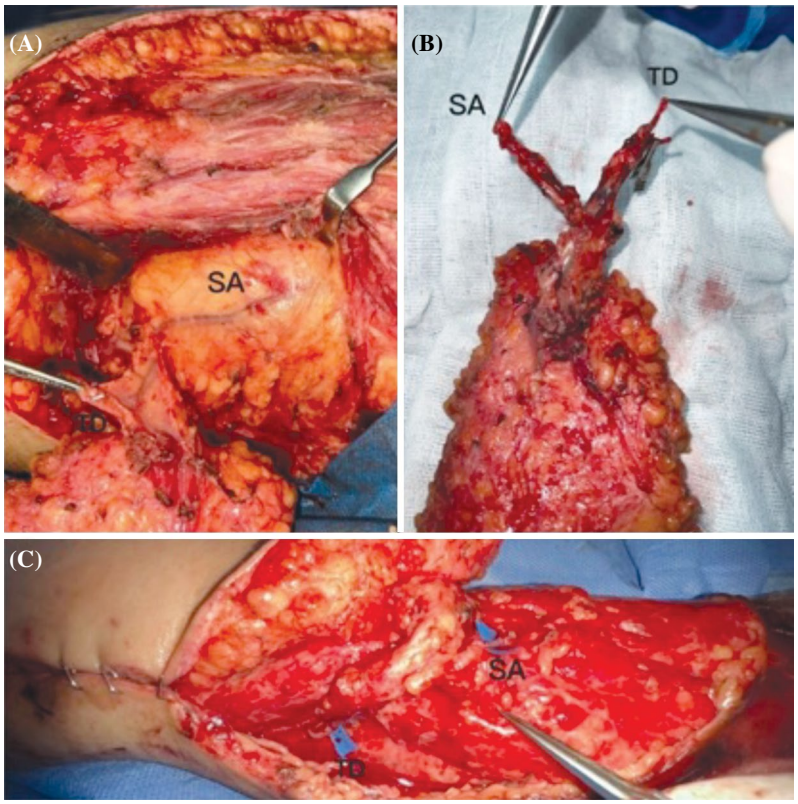

Fig. (3): Showing both main thoracodorsal pedicle, descending branch of thoracodorsal and serratus pedicle.
(A): Serratus ant pedicle running on lateral chest wall below LD muscle.
(B): Flap harvest and identification of both pedicles.
(C): Microvascular anastomosis of thoracodorsal vein on one of veina comitant of radial artery and anastomosis of serratus vein on cephalic vein for supercharging.

If a sensate flap is needed, the posterior cutaneous branches of the lateral intercostal nerves must be preserved together with the long thoracic and nerve to LD. Prior to the complete detachment of the skin paddle and the cutting of the descending branch of the thoracodorsal artery, dermal bleeding and satisfactory capillary filling are verified.

Closure of donor site after meticulous hemostasis and suction drain 18G insertion, two layered closures using vicryl 2/0 and polyproline 3/0 followed by post operative binder for 10 to 14 days minimize post operative seroma rates.

Microsurgical anastomosis was done using 12.5X Zeiss microscope. Artery was done first then vein using 8/0 or 9/0 polypropylene, while nerve was done using 10/0 polypropylene.

Tunneling under skin bridge was done in axillary or partial breast reconstruction.

Results

From January 2022 to April 2024, 24 patients have been reconstructed with TDAP. Four cases of axillary reconstruction, three cases of breast reconstruction (pedicled TDAP) and free TDAP was done in 17 cases of complex soft tissue defects (Table 1). The patients were between 4 and 49 year old. Sixteen patients were male (66.6%), and 8 patients were female (33.3%). Reconstruction after trauma occurred in 15 patients (62.5%) followed by post burn release and reconstruction in 8 patients (33%) and reconstruction after Hidradenitis suppurativa excision defect in one patient (4%). (Table 1: defect data).

The size of the flaps ranged from 6 to 15cm in width and 12 to 26cm in length. One perforator was found in 12 cases, two perforators in 9 cases and three perforators in 3 cases. Primary closure of the donor site has been done in all cases with no reported movement restriction. partial flap loss occurred in one case with no total flap loss encountered. (Table 2: flap data).

Table (1): Defect data.

Defect data	
Etiology:	
Post traumatic	15 (62.5%)
Post burn	8 (33%)
Hidradenitis suppurativa	1 (4%)
Sex:	
Male	16 (66.6%)
Female	8 (33.3%)
Site:	
Axilla	4 (16.6%)
Breast	3 (12.5%)
Head and neck	3 (12.5%)
Upper limb	5 (20.8%)
Lower limb	9 (37.5%)
Defect Size(cm):	
Length	Mean 18 Median 19 Range 11-25
Width	Mean 10 Median 10.5 Range 6-14

Table (2): Flap data.

Type of the flap (n=24):	
Free	17 (70.9%)
Pedicled	7 (29.1%)
Number of the perforators:	
One	12 (50%)
Two	9 (37.5%)
Three	3 (12.5%)
Flap Size (cm):	
Length	Mean 19.1 Median 19 Range 12-26
Width	Mean 10.3 Median 10.5 Range 6-15
Donor site closure:	
Direct closure	24 (100%)

Case Illustrations

Case (1): Male patient 21 year old with post traumatic complex soft tissue loss in Rt forearm with exposed tendons/ radius, initial debridement was done followed by reconstruction with free TDAP Flap (Fig. 4).

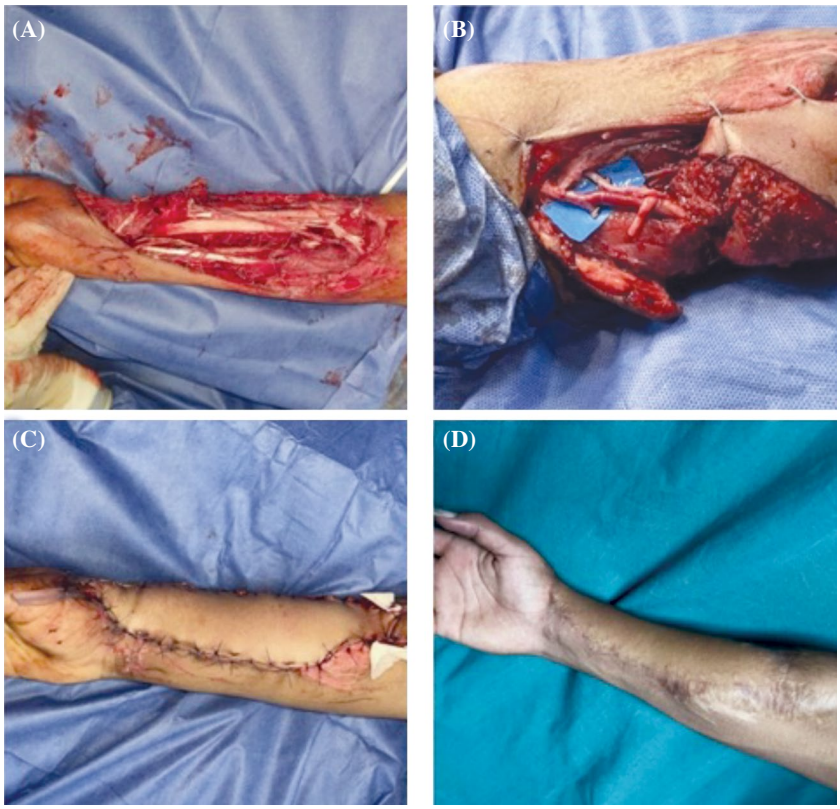

Fig. (4)

(A): Post traumatic complex soft tissue defect in Rt forearm with exposed radius, flexor tendons and loss of radial artery.

(B): Showing initial flap inset with microsurgical anastomosis of thoracodorsal pedicle on proximal stump of radial artery and cephalic vein.

(C): Showing immediate post-operative coverage.

(D): Showing 1 year late post-operative result.

Case (2): Male patient 40-year-old with crush trauma to Rt foot with exposed unstable ankle joint, initial debridement, fixation with k-wires and repair of tendons followed by reconstruction with free TDAP (Fig. 5).

Fig. (5)

(A): Showing complex soft tissue defect Rt foot with exposed ankle joint after initial debridement, tendon repair and k-wire fixation of ankle joint.

(B): Showing harvested TDAP flap with thoracodorsal pedicle and serratus pedicle included.

(C): Showing 3 month post-operative result.

Case (3): Female patient 19-year-old with post burn neck contracture. Complete release was done down to pre-tracheal fascia and reconstruction with free TDAP (Fig. 6).

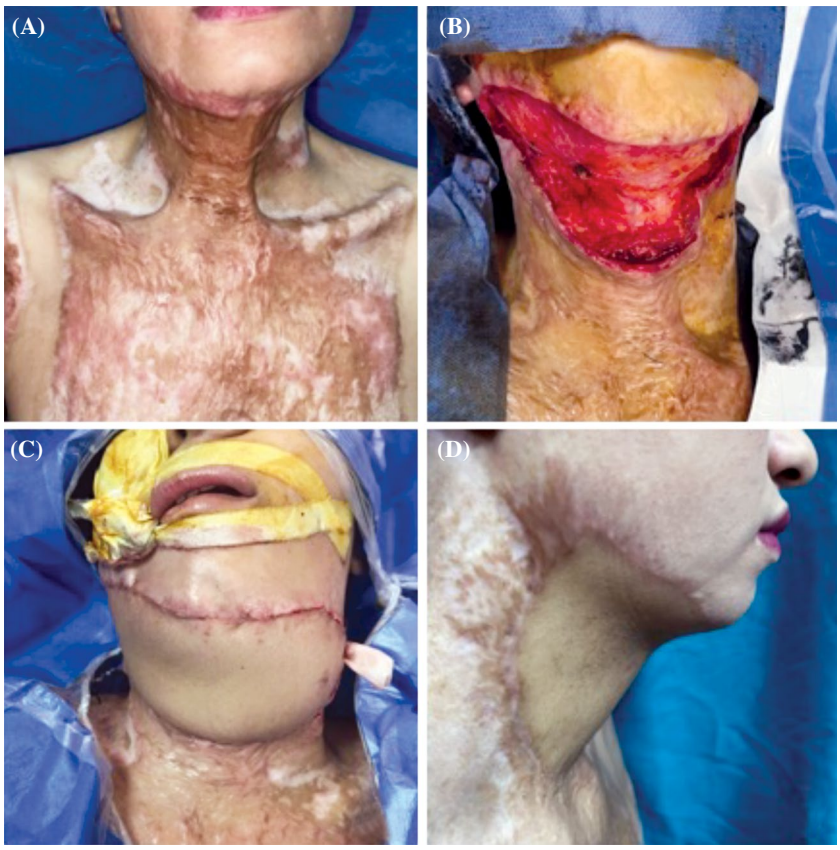

Fig. (6)

(A): Showing post burn neck contracture.

(B): Showing release of contracture and excision of keloid tissue.

(C): Immediate post-operative flap inset.

(D): Showing 9 months late post-operative result after single stage of liposuction.

Case (4): Male child 5-year-old with post burn axillary contracture with limited range of motion, complete release and coverage by pedicled TDAP flap was done (Fig. 7).

Fig. (7)

(A): Showing post burn axillary contracture.

(B): Showing complex soft tissue defect after release of axillary contracture.

(C): Showing coverage of defect with pedicled TDAP flap with full range of motion, closure of donor site and suction drain inset in donor site and below flap.

(D): Showing 1year late post-operative follow-up.

Case (5): 7-year-old male child with post-burn axillary and elbow contracture, release of contracture was done and coverage of axillary defect with TDAP flap (Fig. 8).

Fig. (8)

(A): Showing post burn axillary contracture.

(B): Pre-operative marking with identification of perforators by doppler within anterior border of LD muscle.

(C): Showing flap inset and restoration of range of motion.

(D): Showing 3-month post operative follow-up.

Case (6): Female patient 17-year-old with post burn breast deformity with absent infra-mammary fold and distorted NAC, release and reconstruction of IMF was done by pedicled TDAP flap followed by reconstruction of NAC by tattooing (Fig. 9).

Fig. (9)

(A): Showing post burn RT breast deformity with absent IMF.

(B): Showing release of contracture and creation of IMF at level of contralateral IMF.

(C): Showing post-operative result of volume gain and creation of IMF on RT side.

(D): Showing 3 month post-operative result with reconstruction of NAC with tattooing.

Discussion

Creation of the "ideal beautiful normal" is the aim of reconstruction. This essentially implies replacing like with like, which is easily accomplished using perforator flaps that are predominantly thinned. The attempt to reconstruct the normal should be made with the fundamental prerequisite that the donor site morbidity should be minimal [12].

The bulk and donor defect of the latissimus dorsi musculocutaneous flap make it unsuitable for resurfacing shallow distal limb defects, despite being one of the most dependable flaps. Furthermore, the extent of the reconstruction will remain unclear due to the unpredictable atrophy of denervated muscle tissue included into the musculocutaneous flap. To cover a tissue defect on the hand or foot and achieve both functional and aesthetic refinement in one step, a thin flap is typically needed [13].

The TDAP flap was originally described in 1992 as a method of harvesting the skin and subcutaneous island of the traditional latissimus dorsi musculocutaneous (LD-MC) flap without the muscle. It was reported as a possible breast reconstruction method in 1996, and Hamdi published its first clinical use for breast reconstruction in 2004. Several studies have demonstrated that the TDAP flap is a reliable and safe technique [14].

The ages of patients in our study ranged from 4 to 49 years. 16 patients were male (66.6%), and 8 patients were female (33.3%). The most common cause of soft tissue defects was post-traumatic 15 patients (62.5%) which correlates to male dominance of incidence, followed by post burn release & reconstruction in 8 patients (33%) and reconstruction after Hidradenitis suppurativa excision defect in one patient (4%). The size of the flaps ranged from 6 to 15cm in width and 12 to 26cm in length. One perforator was found in 12 cases, two perforators in 9 cases and 3 perforators in 3 cases.

A Strip of muscle from LD 2cm wide was harvested starting from below and around perforator/s and extending up towards thoracodorsal pedicle. Patients were followed-up for 3 months to 1 year with no detected muscle movement affection and full range of motion. This technique reduced operation time to 320 minutes on average (range 270-500 minutes) for free flaps in comparison to Hantash et al., where mean operative time was 390 minutes (range 300-540 minutes) and 220 minutes (range from 180 to 250 minutes) in pedicled flaps in comparison to Hantash et al., where mean operative time was 255 minutes (range 210-300 minutes). Most of the time was spent in the intramuscular dissection of perforators. This technique of muscle strip avoided tedious intramuscular dissection, shortened operation time and provided good protection to perforator/s with no functional movement affection.

One the same hand, inclusion of muscle strip instead of muscle cuff provides muscle bulk to some extent which improves contour in both axilla and breast reconstruction and resistance of infection and reduction of dead space in free flaps.

In all of cases who underwent free flaps, single vein was found in thoracodorsal pedicle. This vein was sufficient to drain the flap in most cases, however sometimes additional venous drainage was required especially in extremities. In-corporation of serratus anterior pedicle in flap by harvesting of pedicle above bifurcation into descending branch and branch to serratus anterior provides additional tool to drain flap. Where main thoracodorsal vein was anastomosed on one vein while vein of serratus anterior muscle anastomosed to another vein. This technique dramatically reduced venous congestion and post operative flap complications. Post operative venous congestion wasn't reported in any case in comparison to Hantash et al., where venous congestion occurred in 4 cases (20%), all of them in the extremities. However, serratus anterior artery may be used to augment flap vascularity by turbo charging or used as a flow through flap.

The donor site directly closed in all patients with no reported wound dehiscence occurred. However, late post operative scar widening was reported in 4 patients in whom more flap width was harvested and hence moderate tension on closure.

Post operative seroma rates were markedly reduced by meticulous hemostasis, closure of skin and subcutaneous in 2 layers and drain insertion followed by post-operative binder for 10 days, marked seroma occurred in one case after early slippage of drain, and was treated by drain re-insertion and followed up for one week. Otherwise, no donor site seroma encountered.

Many studies have evaluated the TDAP flap regarding indications, approach, harvesting cons and pros and it's proven that it's indeed a versatile flap. It's considered as one of workhorse flaps because of constant perforators, large caliper pedicle, reliable skin paddle, limited donor site morbidity, 2 team approach, and flexibility of flap modifications like sensate flap, chimeric flap, preplanned thinning. In our study, evolution of technique came from variation of defects, patient and age groups and anatomical variation.

The aim of our study was to ease flap harvest, shorten operation time, minimize donor site morbidity, maximize esthetic outcome, decrease complication rates and post-operative recovery time and therefore TDAP flap is considered as a work horse flap.

Conclusion:

Thoracodorsal artery perforator flap provides excellent choice for complex soft tissue reconstruction with thin reliable skin paddle and considered a workhorse flap. Flap harvest modification including small muscle strip around perforators and serratus anterior pedicle inclusion in flap provide excellent access to additional flap drainage and vascularity, minimize operation time, limit donor site morbidity, limit complication rates and gives superior esthetic outcome.

References

1- Lee K.T., Wiraatmadja E.S. and Mun G.H.: Free latissimus dorsi muscle-chimeric thoracodorsal artery perforator flaps for reconstruction of complicated defects: Does muscle still have a place in the domain of perforator flaps? Ann. Plast. Surg., May 74 (5): 565-72, 2015.

2- Homsen J.B. and Gunnarsson G.L.: The evolving breast reconstruction: From latissimus dorsi musculocutaneous flap to a propeller thoracodorsal fasciocutaneous flap. Gland Surg., Aug. 3 (3): 151-4, 2014.

3- Feng A.L., Nasser H.B., Rosko A.J., Casper K.A., Malloy K.M., Stucken C.L., Prince M.E., Chinn S.B. and Spector M.E.: Revisiting pedicled latissimus dorsi flaps in head and neck reconstruction: Contrasting shoulder morbidities across myofascial flaps. Plast. Aesthet. Res., 2021; 8:10.20517/2347-9264.2021.03.

4- Chen S.L., Chen T.M. and Wang H.J.: Free thoracodorsal artery perforator flap in extremity reconstruction: 12 cases. Br. J. Plast. Surg., 57: 525-30, 2004.

5- Park B.Y.: Flap thinning: Defatting after conventional elevation. Arch. Plast. Surg., Jul. 45 (4): 314-318, 2018.

6- Sever C., Uygur F., Kulahci Y., Karagoz H. and Sahin C.: Thoracodorsal artery perforator fasciocutaneous flap: A versatile alternative for coverage of various soft tissue defects. Indian J. Plast. Surg., Sep. 45 (3): 478-84, 2012.

7- Ezequiel Escudero, Ludmila Grassano, Claudio Angrigiani, Alberto Rancati, Roger K. and Khouri Jr., B.S.: Thoracodorsal Artery Perforator Flap for Bilateral Breast Reconstruction: Simultaneous Vs Staged. Michigan Journal of Medicine, April Volume 2, Issue 1, 2017.

8- Mustafa A.Y.A.A. and Alasmari W.: Anatomical Study of the Latissimus Dorsi Muscle Flap. Int. J. Morphol., Vol. 40, n.3, pp.562-565, 2022.

9- Hassan K., Awadein A. and Abdelhamid M.: Neurovascular Anatomy of the Split Latissimus Dorsi Muscle Flap for the Purpose of Smile Restoration. The Egyptian Journal of Plastic and Reconstructive Surgery, 43 (3): 565-573, 2019.

10- Li S-Q., Zheng Z-F., Li H., Zhang J-F., Zheng Y. and Lin L-S.: Clinical Study on the Thoracodorsal Artery Perforator Flap in Breast-Conserving Reconstruction of T2 Breast Cancer. Surgical Innovation, 31 (1): 16-25, 2024.

11- Tansatit T., Chokrungvaranont P., Wanidchaphloi S. and Sanguansit P.: The anatomy of the thoracodorsal artery in perforator flap for resurfacing shallow defect. J. Med. Assoc. Thai., May 90 (5): 947-55, 2007.

12- Hifny M.A., Tohamy A.M.A., Rabie O. and Ali A.A.A.: Propeller perforator flaps for coverage of soft tissue defects in the middle and distal lower extremities, Annales de Chirurgic Plastique Esthétique, Volume 65, Issue 1: 54-60, 2020.

13- Hantash S., Ayad W., Hendy A.A. and Sadaka M.S.: Clinical applications of the thoracodorsal artery perforator flap in extremity soft tissue reconstruction. The Egyptian Journal of Plastic and Reconstructive Surgery, 44 (2): 353-359, 2020.

14- Dias, Leonardo Pires Novais, Marzia Salgarello and Moustapha Hamdi: "History of Pedicled Perforator Flaps for Breast Reconstruction." Pedicled Flaps in Partial Breast Reconstruction. Springer International Publishing, 1-18, 2023.

15- Angrigiani C., Grilli D. and Siebert J.: Latissimus dorsi musculocutaneous flap without muscle. Plast. Reconstr. Surg., 96: 1608–14, 1995.