Modern Plastic Surgery, 2023, 13, 63-73
https://www.scirp.org/journal/mps
ISSN Online: 2164-5280
ISSN Print: 2164-5213

# Chimeric ALT Perforator-Free Flap with Vastus Lateralis Muscle for the Obliteration of the Intrathoracic Dead Space Post-Pneumonectomy: A Case Report

**Nelson Oduor Ouma*, Daniel Odhiambo Otieno, Lee Njagi Munge, Ferdinand Wanjala Nang'ole**

Department of Surgery, Plastic, Reconstructive, and Aesthetic Surgery Thematic Unit, College of Health Sciences, The University of Nairobi, Nairobi, Kenya
Email: *oduor.nelson@yahoo.com

**How to cite this paper:** Ouma, N.O., Otieno, D.O., Munge, L.N. and Nang'ole, F.W. (2023) Chimeric ALT Perforator-Free Flap with Vastus Lateralis Muscle for the Obliteration of the Intrathoracic Dead Space Post-Pneumonectomy: A Case Report. *Modern Plastic Surgery*, **13**, 63-73.
https://doi.org/10.4236/mps.2023.133007

**Received:** April 12, 2023
**Accepted:** June 27, 2023
**Published:** June 30, 2023



## Abstract

Chest wall reconstruction is a surgical procedure aimed at restoring the integrity and function of the chest wall, which may be damaged due to trauma, cancer, infection, or congenital defects. The chest wall plays a vital role in protecting the thoracic organs, supporting the respiratory system, and maintaining the shape of the chest. Therefore, any defect or deformity of the chest wall can have significant functional and aesthetic consequences for the patient. The authors present a case report at Kenyatta National Hospital (KNH) of a dyspneic 47-year-old male patient with a right anterolateral chest wall defect post-pneumonectomy previously complicated by bronchopleural fistula. Past attempts at the chest wall reconstruction had utilized the ipsilateral latissimus dorsi muscle, pectoralis major muscle, and the omental pedicled flaps with limited success. A chimeric anterolateral thigh (ALT) perforator-free flap with vastus lateralis (VL) muscle was used to obliterate the post-pneumonectomy intrathoracic dead space and to provide a cutaneous paddle. This case report aims to show the versatility of the ALT flap for chest wall reconstruction to prevent the post-pneumonectomy syndrome associated with tracheal deviation, inspiratory stridor, and exertional dyspnea. In conclusion, chest wall reconstruction with obliteration of intrathoracic dead space post-pneumonectomy is challenging and needs careful planning and execution.

## Keywords

Chest Wall Reconstruction, Bronchopleural Fistula, Pneumonectomy, Chimeric ALT Flap, Intrathoracic Dead Spacepost-Pneumonectomy

## 1. Introduction

Bronchopleural fistula, a communication between a bronchus and the pleural cavity, can result from necrotizing pneumonia, necrosis of the bronchial wall secondary to radiation or infection, and dehiscence of the bronchial stump post-pneumonectomy [1]. This phenomenon, with a massive air leak between the large airways and the chest cavity, is unlikely to resolve without the interposition of healthy tissue in the form of flap coverage and can carry significant morbidity and mortality becoming a serious reconstructive challenge that is difficult to treat with any assurance of success. The omentum, latissimus dorsi, serratus anterior, pectoralis major, and rectus abdominus muscles have all been described for intrathoracic dead space-filling and reinforcement of the bronchial stump [2] [3]. An often-encountered problem with intrathoracic dead space filling is the sheer volume required to obliterate the thoracic cage. This can be overcome with thoracoplasty (partial rib/cage collapse) or with the use of multiple flaps [4]. While the dead space from the pneumonectomy is addressed, thoracoplasty is quite a morbid and disfiguring major surgery. The anterolateral thigh flap (ALT) has been well-known and popularized for its advantages of versatility and low morbidity. The chimeric concept based on the lateral circumflex femoral artery (LCFA) has then been elaborated in the literature for extensive extremity defects and complex head and neck reconstruction [5] [6]. The authors present a case report at The Kenyatta National Hospital (KNH) on the use of a chimeric ALT perforator-free flap with vastus lateralis (VL) muscle for the obliteration of the intrathoracic dead space post pneumonectomy and a cutaneous paddle for the right anterolateral chest wall reconstruction.

## 2. Case Report

### 2.1. Patient TK

A 47-year-old male patient with exertional dyspnea and a history of bronchopleural fistula post-pneumonectomy presented at Kenyatta National Hospital (KNH), a public, tertiary, and the biggest referral hospital in Kenya, East & Central Africa with a bed capacity of 1800, 6000+ staff members, 50 wards, 22 out-patient clinics, 24 theaters (16 specialized) and an Accident & Emergency Department. It is also the teaching hospital of the University of Nairobi College of Health Sciences. The patient had a right anterolateral intrathoracic defect measuring 14 cm * 13 cm * 15 cm involving the lateral portion of the pectoralis major, segmental loss of serratus, and several missing ribs for reconstruction (**Figure 1**).

The patient had previously undergone 10 operations to reconstruct the chest wall. A multidisciplinary team comprising Thoracic and Cardiovascular Surgery (TCVS) and the Plastic, Reconstructive, and Aesthetic Surgery (PRAS) Thematic Units was convened to plan the chest wall reconstruction for optimal functional and cosmetic outcomes while minimizing complications associated with the surgery. The authors decided to obliterate the intrathoracic cavity using a

**Figure 1.** Right anterolateral chest wall defect measuring 14 cm * 13 cm * 15 cm with previous peri-wound surgical site scars.

chimeric ALT perforator-free flap with vastus lateralis (VL) muscle because he did not have local chest wall muscles for reconstruction, and his omentum had also been manipulated in the previous operations. The patient also had a central venous catheter (CVC) on the right thigh so this meant the chimeric ALT free flap was to be harvested from the left thigh. The patient and family were counseled on the extent of the surgery and how it may improve the quality of life even if it does not lengthen survival. Written consent for the surgery was then obtained preoperatively. While in theater, induction of general anesthesia was done with fentanyl 100 mcg, propofol 150 mg, and atracurium 40 mg with an endotracheal tube (ETT) size 6.5 cm at a depth of 19 cm for mechanical ventilation. Pain control was with subcutaneous morphine 10 mg, paracetamol 1 gm and Ketesse 50 mg. Intraoperative fluids of 3 liters and antiemetics with ondansetron 4 mg were administered while mean arterial blood pressure of 85 mmHg was to be maintained during the surgery. After the general anesthesia, preoperative Doppler ultrasound was performed on the left thigh along the line connecting the anterior superior iliac spine (ASIS) and the superolateral margin of the patella to identify perforators to the anterolateral thigh skin. This imaginary line is the superficial projection of the intermuscular septum between the rectus femoris and the vastus lateralis muscles. A circle with a 3 cm radius was centered in the middle of this line where septocutaneous and/or musculocutaneous perforators from the descending branch of LCFA were mapped and marked, the majority of perforators being in the inferior external quadrant of the circle. The cutaneous part of the flap was the first thing to be determined and the VL muscle was to be adjusted after the identification of available cutaneous perforators intraoperatively. After debridement of the recipient site, an exploratory incision from the anterolateral chest wall defect towards the posterior axilla was made to expose the thoracodorsal neurovascular bundles that served as the recipient vessels for microvascular anastomosis due to their proximity to the chest defect (**Figure 2**).

The required volume of muscle needed to obliterate the intrathoracic dead space and the dimension of the cutaneous flap for the anterolateral chest wall defect was then estimated and sketched using a template. The distance from the recipient's vessels to where the muscle would be inset was also measured to decide the length of the flap pedicle required.

### 2.2. Chimeric Flap Design and Surgical Technique

Based on the perforators mapped by Doppler ultrasound preoperatively, the cutaneous flap was drawn on the anterolateral aspect of the thigh. The authors began the dissection at the medial border of the flap, over the rectus femoris muscle, to prevent injuries to the septocutaneous perforators. Sharp dissection of the intra-muscular and intraseptal perforators with scissors was preferred toward the descending branch of LCFA. The cutaneous component of this flap was mobilized by extending the incision to the lateral margin while the muscular component based on the distal runoff of the LFCA was dissected to offer more degrees of freedom for the flap inset (**Figure 3**).

The long axis of the muscle flap was parallel to the descending branch of the LCFA and one sizable muscular branch was included in the dissection. The authors harvested the chimeric ALT perforator-free flap with vastus lateralis muscle based on the descending branch of LCFA and also included the motor nerve from the femoral nerve to the vastus lateralis muscle (**Figure 4**).

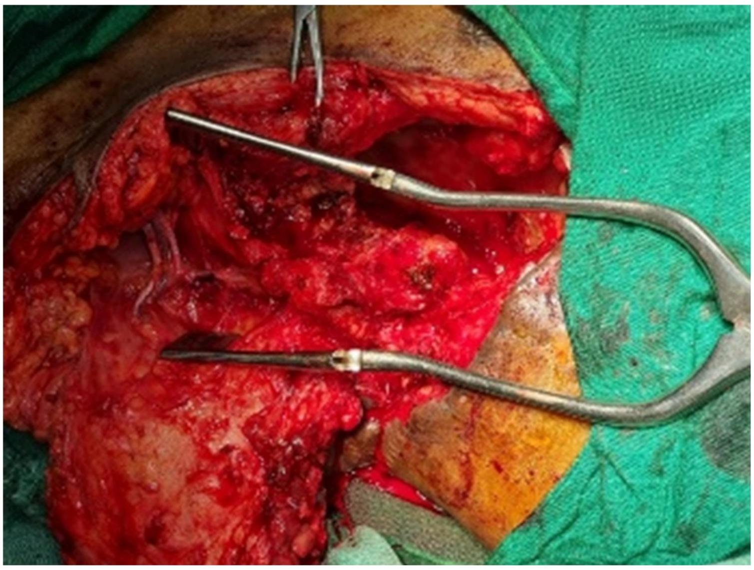

**Figure 2.** The thoracodorsal neurovascular bundles identified as the recipient vessels.

**Figure 3.** Intra-muscular and intraseptal perforators from the descending branch of the lateral circumflex femoral artery (LCFA) and motor nerve to vastus lateralis muscle.

**Figure 4.** Chimeric ALT perforator-free flap with vastus lateralis muscle based on the descending branch of LCFA and the motor nerve to vastus lateralis.

Microvascular anastomosis and neurorrhaphy of the recipient thoracodorsal neurovascular bundles with the donor flap LCFA vessels and the motor nerve to vastus lateralis muscle were done with nylon 9-0 sutures under loupe magnification of x6. The vessels were topically irrigated with heparin in saline and lidocaine to prevent microvessel thrombosis and spasms respectively (**Figure 5**).

A chest tube was fixed and pedicle kinking was carefully avoided while inserting the flap with vicryl 2-0 sutures over the chest wall defect. The distance between the perforator of the cutaneous flap and the muscle component was about 3 - 5 cm, which provided a greater degree of freedom to inset the muscle bulk into the intrathoracic cavity (**Figure 6**).

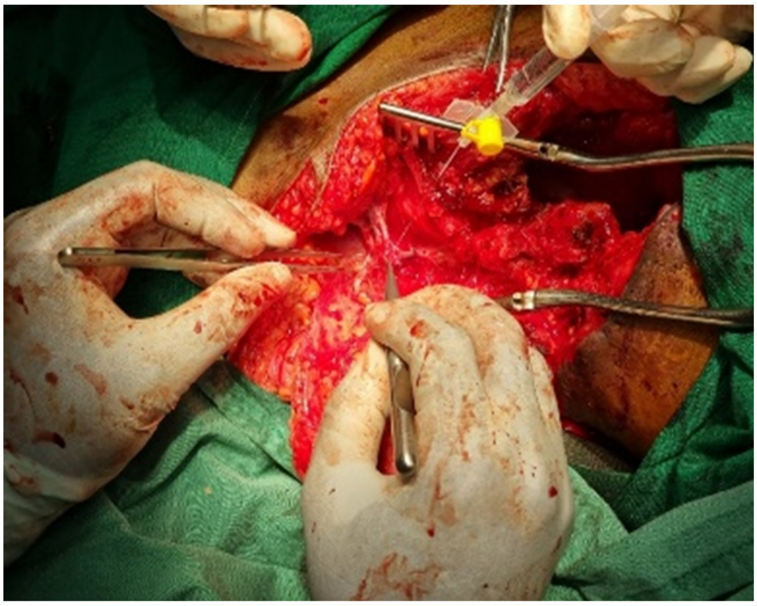

**Figure 5.** Recipient thoracodorsal neurovascular bundles with topical heparin in saline and lidocaine irrigation to prevent microvascular thrombosis and vessel spasms respectively.

**Figure 6.** Vastus lateralis muscle flap inset over a drain to obliterate the intrathoracic dead space.

The cutaneous flap was used to reconstruct the right anterolateral chest wall defect while the skin was closed with staples and nylon 3-0 sutures. The left thigh donor site was closed primarily and a drain was also left in situ (**Figure 7**).

At the end of the surgery, the patient was stable and reversal of anesthesia was done with Atropine 1 mg and neostigmine 2.5 mg. He was then taken to the post-anesthesia care unit (PACU) to be transferred to the high-dependency unit (HDU) for monitoring.

## 3. Discussion

At present, myocutaneous flaps are the method of choice for chest wall reconstruction because they offer large amounts of skin and soft tissue, optimal cosmetic results, and adequate chest wall support without the need for any prosthetic material [7]. Free anterolateral thigh (ALT), vastus lateralis (VL), tensor fascia lata, latissimus dorsi, and abdominal flaps have been described for chest wall reconstruction where the regional flaps are not available. In a complex wound, which needs different tissue components for reconstruction, multiple flap transfers used to be an option of choice. For a multiple-flap transfer, more than one pair of recipient vessels, or a flow-through flap to revascularize the second free flap is required. Some disadvantages to the use of multiple flaps are [6]:

1) Higher donor site morbidity from more than one flap harvested.

2) More time-consuming for additional microsurgical anastomosis of the second flap.

3) More technically demanding to perform a bridge flap with the flow-through technique.

A compound flap solves some of the issues with multiple flaps and implies that more than a single tissue structure has been linked together to achieve a common purpose. A composite flap, a type of compound flap, incorporates multiple tissue

**Figure 7.** The chest wall wound closed with skin staples and nylon 3-0 sutures (right) and the left thigh donor site wound closed primarily with skin staples (left).

types, but the vascularization of all contained parts is interdependent and inseparable. The bridge flap is separate flaps with short vascular pedicles fabricated together to form a compound flap supplied with a solitary vascular source. Themosaic flap consists of 2 adjacent flaps that are simultaneously elevated, and the pedicle of the distal flap is anastomosed to the pedicle branch of the proximal flap in the "bridge" fashion. The vascular pedicle of the proximal flap is anastomosed to a single vascular source. The chain-circle flap has 2 or more flaps and the distal end of the vascular source is anastomosed to the branch of the recipient's vessel [8]. In Greek mythology, Chimera, a fire-breathing monster with a lion's head, a goat's body, and the tail of a serpent, was the offspring between Typhon and Echidna. The chimeric concept represents an example of dissimilar tissues that are separate in action but joined together for survival [9] [10]. In the chimeric flap, a type of compound flap, different types of tissue components within a geographically identical region may be simultaneously transposed as independently viable flaps relying on only a single source vessel [9]. Although the individual parts may consist of only a single different tissue type, each may also be a composite flap (**Figure 8**).

In 1984, Song *et al.* defined the ALT flap as a fasciocutaneous flap based on septocutaneous perforators but primarily on the musculocutaneous perforators from the LFCA [11]. A chimeric concept [9] [12] in the application of the ALT flap considers the muscle, and skin as individual units although they are based on a single pedicle. The dimension of the skin and the volume of muscle can be tailored as desired as it is not necessary to design the orientation of donor skin and muscle simultaneously before the surgery. The cutaneous paddle is the first thing to be determined, and the VL muscle can be adjusted after the identification of available cutaneous perforators which simplifies the chimeric design and gives it more degrees of freedom to inset the flap. Chimeric flaps have the following advantages [6] [10]:

1) Less harvest time.

2) The economy of donor site incisions.

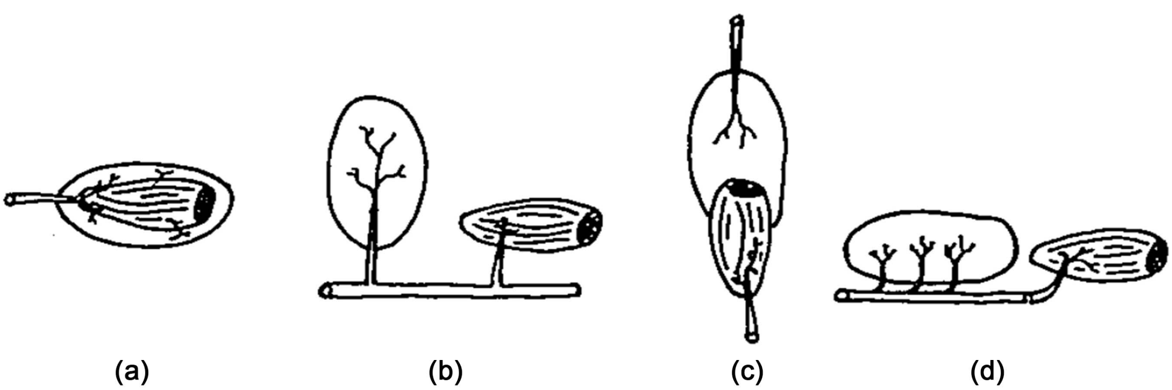


**Figure 8.** (a) Composite flap with a solitary vascular source and dependent components. (b) Chimeric flap with the solitary source but independent parts. (c) Siamese flap with independent vascular sources but dependent jointure. (d) Chain-link or bridge flaps are independent but fabricated together by microvascular anastomosis to a solitary source.

3) Availability of various tissue components for transfer.

4) Reduced number of operative procedures and donor site morbidity.

5) Preservation of recipient's vessels.

From the anatomic studies of the LFCA [11] [13], the iliac bone can be included based on the ascending branch, the tensor fascia lata can be included according to the transverse branch, and the rectus femoris and vastus lateralis (VL) muscle can be included along the descending branch. Usually, the intramuscular perforators travel through the VL muscle for more than 5 cm, and the total pedicle length can be more than 8 - 10 cm in most cases. When the VL muscle is included as distal as possible along the descending branch of the LFCA, there will be more degrees of freedom due to the longer pedicle from the bifurcation to the skin and the muscle. Identification of the muscular branch from the descending branch of LFCA and sharp dissection with scissors could be the key points to prevent ischemia characterized by a fibrotic change of the transferred VL muscle [6]. The authors report on the application of a chimeric ALT perforator-free flap with vastus lateralis muscle for the obliteration of the intrathoracic dead space post-pneumonectomy and to provide a skin paddle for the right anterolateral chest wall reconstruction. The limitations of this case report include:

1) Lack of follow-up since the authors only report on the patient's condition at a single point in time.

2) Lack of generalizability as this case report described the experiences of one individual, making it difficult to generalize the findings to larger populations.

3) The lack of controls makes it difficult to determine the efficacy of the treatment or intervention being described.

4) Limited statistical analysis with difficulty in determining the statistical significance of the outcome.

## 4. Conclusion

Chest wall reconstruction is a challenging surgical procedure that requires careful planning and execution. Further studies are needed to evaluate the long-term outcomes of these procedures to identify optimal techniques for the obliteration of intrathoracic dead space post-pneumonectomy and prevent the syndrome of tracheal deviation, inspiratory stridor, and exertional dyspnea.

## 5. Recommendations

Longer-term follow-up may be necessary to assess the durability and sustainability of the reconstruction. Future research is to be done on treatment efficacy, cost-effectiveness, and patient characteristics, such as age, comorbidities, or smoking which impact the success and outcomes of chest wall reconstruction.

## Ethical Considerations

Informed consent was acquired from the patient for publication of the case report.

## Authors' Contributions

Nelson Oduor Ouma led the conceptualization and writing of the first draft. All the other authors contributed equally to reviewing and editing the original draft.


## Acknowledgements

We thank the ward team, the theatre team, and the HDU team that nursed the patient.


## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References


[1] Jadczuk, E. (1998) Postpneumonectomy Empyema. *European Journal of Cardio-Thoracic Surgery*, **14**, 123-126. https://doi.org/10.1016/S1010-7940(98)00156-0

[2] Iverson, L.I.G., Young, J.N., Ecker, R.R., Ennix, C.L., Lau, G., Stallone, R., *et al.* (1986) Closure of Bronchopleural Fistulas by an Omental Pedicle Flap. *The American Journal of Surgery*, **152**, 40-42. https://doi.org/10.1016/0002-9610(86)90134-0

[3] Arnold, P.G. and Pairolero, P.C. (1990) Intrathoracic Muscle Flaps. An Account of Their Use in the Management of 100 Consecutive Patients. *Plastic and Reconstructive Surgery*, **88**, 1123. https://doi.org/10.1097/00006534-199112000-00077

[4] Rand, R.P., Maser, B., Dry. G. and Vallieres, E. (2000) Reconstruction of Irradiated Postpneumonectomy Empyema Cavity with Chain-Link Coupled Microsurgical Omental and TRAM Flaps. *Plastic and Reconstructive Surgery*, **105**, 187. https://doi.org/10.1097/00006534-200001000-00033

[5] Yang, R., Wu, X., Kumar, P.A., Xiong, Y., Jiang, C., Jian, X., *et al.* (2020) Application of Chimerical ALT Perforator Flap with Vastus Lateralis Muscle Mass for the Reconstruction of Oral and Submandibular Defects after Radical Resection of Tongue Carcinoma: A Retrospective Cohort Study. *BMC Oral Health*. https://doi.org/10.21203/rs.2.16485/v1

[6] Lin, Y.T., Lin, C.H. and Wei, F.C. (2006) More Degrees of Freedom by Using Chimeric Concept in the Applications of Anterolateral Thigh Flap. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, **59**, 622-627. https://doi.org/10.1016/j.bjps.2005.07.015

[7] McKenna, R.J., Mountain, C.F., McMurtrey, M.J., Larson, D. and Stiles, Q.R. (1988) Current Techniques for Chest Wall Reconstruction: Expanded Possibilities for Treatment. *The Annals of Thoracic Surgery*, **46**, 508-512. https://doi.org/10.1016/S0003-4975(10)64686-3

[8] Koshima, I. (2001) A New Classification of Free Combined or Connected Tissue Transfers: Introduction to the Concept of Bridge, Siamese, Chimeric, Mosaic, and Chain-Circle Flaps. *Acta Medica Okayama*, **55**, 329-332.

[9] Hallock, G.G. (1991) Simultaneous Transposition of Anterior Thigh Muscle and Fascia Flaps: An Introduction to the Chimera Flap Principle. *Annals of Plastic Surgery*, **27**, 126-131. https://doi.org/10.1097/00000637-199108000-00006

[10] Kim, J.T., Kim, Y.H. and Ghanem, A.M. (2015) Perforator Chimerism for the Reconstruction of Complex Defects: A New Chimeric Free Flap Classification System.

*Journal of Plastic, Reconstructive & Aesthetic Surgery*, **68**, 1556-1567. https://doi.org/10.1016/j.bjps.2015.07.004

[11] Valdatta, L., Tuinder, S., Buoro, M., Thione, A., Faga, A. and Putz, R. (2002) Lateral Circumflex Femoral Arterial System and Perforators of the Anterolateral Thigh Flap: An Anatomic Study. *Annals of Plastic Surgery*, **49**, 145-150. https://doi.org/10.1097/00000637-200208000-00006

[12] Koshima, I., Yamamoto, H., Hosoda, M., Moriguchi, T., Orita, Y. and Nagayama, H. (1993) Free Combined Composite Flaps Using the Lateral Circumflex Femoral System for Repair of Massive Defects of the Head and Neck Regions: An Introduction to the Chimeric Flap Principle. *Plastic and Reconstructive Surgery*, **92**, 411-420. https://doi.org/10.1097/00006534-199309000-00004

[13] Kimata, Y., Uchiyama, K., Ebihara, S., Nakatsuka, T. and Harii, K. (1998) Anatomic Variations and Technical Problems of the Anterolateral Thigh Flap: A Report of 74 Cases. *Plastic and Reconstructive Surgery*, **102**, 1517-1525. https://doi.org/10.1097/00006534-199810000-00026