Research Article ISSN 2689-1093

Surgical Research

# A Systematic Review On the Anatomy of the Descending Branch of the Lateral Circumflex Femoral Artery and The Vascularization of Fascia Lata and Its Implication for The Upper Abdominal Wall Reconstruction with Pedicle Fascia Lata Flap: Our Case Series

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**Received:** 04 Oct 2024; **Accepted:** 10 Nov 2024; **Published:** 20 Nov 2024

**Citation:** Menichini G, Tamburello S, Andreoli AL, et al. A Systematic Review On the Anatomy of the Descending Branch of the Lateral Circumflex Femoral Artery and The Vascularization of Fascia Lata and Its Implication for The Upper Abdominal Wall Reconstruction with Pedicle Fascia Lata Flap: Our Case Series. Surg Res. 2024; 6(6): 1-7.

## ABSTRACT

***Background:*** *The use of pedicled flaps from the thigh for abdominal wall reconstruction has been documented, although supraumbilical defects were previously thought unreachable.*

***Objective:*** *This systematic review aimed to assess the feasibility of upper abdominal wall reconstructions using pedicled fascia lata (FL) flaps and to conduct clinical cases based on these findings.*

***Methods:*** *A systematic review was conducted using PubMed and Embase databases, following the PRISMA statement. Studies examining the anatomy of the descending branch (DB) of the lateral circumflex femoral artery and the vascularization of the FL were reviewed. Five studies met the inclusion criteria, and three were further included for relevance. Additionally, five cases of large abdominal wall defect reconstructions, primarily in the central or upper quadrants, were selected following Mathes SJ's classification.*

***Results:*** *Anatomical studies revealed perforators nourishing a wide area of the FL. The FL flap pedicle can extend up to 14-16 cm, which can be further increased by 3 cm by passing the flap beneath the rectus femoris and sartorius muscles and severing all relevant connections. All selected cases were successfully treated using a pedicled FL flap on the DB. Defect dimensions ranged from 10-15 cm in diameter, with pedicle lengths from 12-17 cm and flap sizes from 8 x 10 cm to 15 x 15 cm, surpassing the literature's average of 8.3 cm. Early complications were minimal, with one patient developing a small hernia at 10 months and another experiencing cutaneous dehiscence, both managed conservatively. All patients reported relief from pain or discomfort during exertion and regained satisfactory abdominal function. Follow-up periods ranged from 8 to 72 months.*

***Conclusions:*** *The wide FL flap raised on DB perforators allows for a significant pedicle length to reach the supraumbilical area without tension, making it a viable option for upper abdominal wall reconstruction.*

## Keywords
Abdominal wall, Fascia lata, Pedicled flap, Descending branch.

## Introduction
The abdominal wall is a complex structure, and repairing defects due to trauma, hernias, infections, radiation necrosis, decompressive laparotomy, or tumor resection is challenging. There is no single best method for repair; choices depend on the defect's size, location, tissue viability, and contamination level. Abdominal defects are classified into Type I (intact/stable skin cover) and Type II (unstable/absent skin cover) defects, with Type II further divided into zones 1A, 1B, 2, and 3 as described by Mathes et al. classification [1]. Component separation and the use of autologous material and prosthetic material insertion methods can be used to manage Type I defects and small Type II defects [2].Large, contaminated defects are particularly difficult to manage due to the contraindication of synthetic materials. Effective repair involves tension-free restoration of the abdominal wall, often using autologous tissues. The thigh, with its reliable vascular supply and strong fascial layer, is a valuable donor site to reconstruct the abdominal defects but supraumbilical defects were previously thought unreachable by a pedicle flap from the thigh [3]. Flaps from this area, such as the Tensor Fascia Lata (TFL) and the anterolateral thigh (ALT) flaps, are commonly used. The TFL flap, though effective, has limitations like short pedicle length and donor site complications. The ALT flap, known for its versatility and longer pedicle, is gaining popularity. Recent studies have explored using the pedicled vascularized only Fascia lata (FL) flap, based on the same pedicle as the ALT flap (the descending branch of the lateral circumflex femoral artery), for upper abdominal wall defects. The FL flap is advantageous due to its thin, pliable, hairless, and semi-rigid fascia, capable of covering large areas (up to 20 cm wide and 35 cm long). However, its thinness sometimes necessitates mesh reinforcement. A systematic review of the literature on the vascular variations of the descending branch and its perforators was conducted to assess the feasibility of using the FL flap harvesting it in total on the descending branch pedicle. Based on these findings, five clinical cases were performed using the fascia lata pedicled flap for abdominal wall reconstruction, which will be discussed.

## Materials and Methods
### Literature Search
### Protocol, information sources, literature search and data extraction
This systematic review was performed following PRISMA Guidelines. The literature search was performed by an experienced research librarian in the following database: MEDLINE (PubMed interface) and EMBASE. The database search was conducted in September of 2023. Search strategy included a combination of the relevant medical subject headings (MeSH) and key words with different variants such as “fascia lata”, “iliotibial band”, "fasciae latae", “vascularization”, “vessel”, “pedicled” as key words to identify studies in the English language published between 1990 and 2023. The strings used for the literature systematic review were for PUBMED: (fascia lata OR iliotibial OR "fasciae latae") AND (vascularization OR vessel OR neovascularization OR "Neovascularization, Physiologic"[Mesh] OR angiogen*) AND (pedicled OR pedunculata). For EMBASE: ('fascia lata'/syn OR 'fascia lata') AND ('vascularization'/syn OR 'vascularization' OR 'blood vessel'/syn OR vessel* OR 'angiogenesis'/syn OR angiogen*) AND (pedicled OR 'pedunculata'/exp OR pedunculata). The articles were examined, and references were screened for further relevant articles. The search yielded a total of 113 titles. Inclusion criteria were English-language publication, human subjects, extractable outcomes on the anatomy of the descending branch, and full-text availability. We included all types of observational studies (case-control studies, cross-sectional studies and longitudinal studies), case-report and case-series. Non-English publications for which the authors couldn't obtain a translation, not full-available publications, non-human subjects and letters to the editors were excluded. Two independent reviewers selected the articles on the base of title and abstract; the selection by title brought to 54 articles, than selected by abstract down to 34. after the first selection review authors evaluated the full text. Disagreements between reviewers were solved by consensus after deep discussion. Anatomical data of the DB of LCFA and vascular supply of the FL of each study were recorded. One Hundred Eight Studies were excluded, yielding to 5 articles suitable for analysis and 3 were added from the literature (Figure 1).

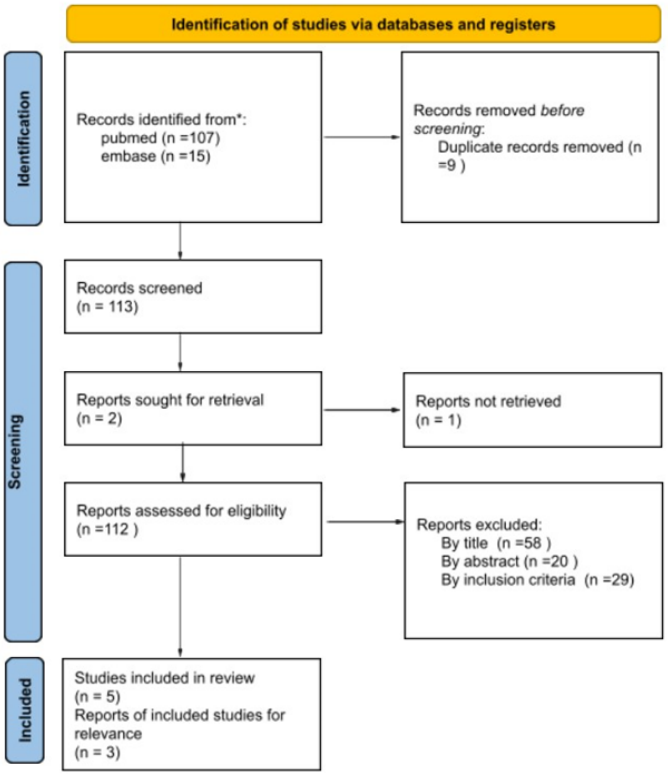


**Figure 1:** Search strategy. From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

### Outcome Measures

For all the included papers the following outcome measures were analyzed:

- Anatomy of the DB of LCFA
- Vascular supply of the FL

### Patient's Data Extraction

This case series includes patients with abdominal defects Type II reconstructed with tunneled pedicled FL flap based on the DB. The cause of the defect for all patients was iatrogenic laparocele referred to our department after abdominal wall dehiscence and complications. We included 5 patients, 4 females 1 male operated in our department between January 2016 and December 2023. Patient's demographics, BMI, location of defect categorized according to *Mathes SJ* et al. [1], defect size, presence of a cutaneous defect, presence of infection, pedicle length, the use of a mash, follow-up data including recurrences, complications and their management were collected and are presented in table 2. Pre-operatory CT-scan to study the abdominal wall defects and components and Doppler of the donor site to identify the perforator were performed. Intraoperative indocyanine green test (ICG) was used in the cases performed in 2023 to evaluate the perfusion of the FL flap on its pedicle before transfer. Annual check-ups were conducted with ultrasound, and in more complex cases MRI was performed to evaluate continuity of the abdominal wall and presence of new dehiscence or bulging. The minimum follow-up was 8 months, the maximum was 72 months.

### Surgical Technique

The antero-superior iliac spine (ASIS) and the supero-lateral border of the patella were marked. An italic "S" incision was drowned starting from 10 cm caudal the ASIS on the longitudinal line connecting the two main reference points. The incision was deepened to the fascial plane and the dissection was subfascial. The perforators were identified and evaluated, the appropriate most distal perforator artery branching from the DB was chosen to allow adequate length and appropriate rotation of the pedicled flap. The subcutaneous adipose tissue was separated from the fascia, as described by Syncier et al. [3]. It is recommended to preserve some adherent adipose tissue to protect the vascular supply rather than to completely uncover the fascial surface. The area to be harvested was eccentrically centered on the selected perforator. It was incised, cleaving it from the underlying muscles, rectus femoris and vastus lateralis. The femoro-cutaneous nerve was identified and protected from subsequent maneuvers to create the suprafascial subcutaneous tunnel in the inguinal region. To increase the pedicle reach the flap was passed medially beneath the RF muscle and sartorius muscle to avoid hindrance of the pedicles by the two muscles during cranial transfer. After complete dissection of the pedicle, the transfer of the flap was performed avoiding excessive tension on their vascular pedicles with a medial rotation of 120°. The flap was transferred to the abdominal region. A mash can be placed above the rectus abdominis muscles as a reinforcement layer for the abdominal wall. The flap fascial edges are sutured to the fascial edges of the original defect. At the end of the operation compression bandages with an elastic fascia are placed in the abdominal region and maintained for at least 30 days.

## Results

### Included studies

At the end of the article selection process, 5 articles were included from the systematic review and 3 were added for relevance. The 8 articles published between 1989 and 2023 were: 6 anatomical dissection studies, 1 retrospective case series and 1 clinical review. The articles selection flow diagram according to PRISMA Guideline is reported in. The main characteristics of each included study are summarized in Table 1. Four were conducted on cadavers and four on alive patients during surgery. The total number of thighs included in the different studied was 333. All studies were conducted in an institutional environment.

### Anatomy of the Descending Branch of LCFA

The DB presents two main anatomical types [4]. In the first type, the feeding artery of the Rectus femoris (RF) muscle directly branches out from the lateral circumflex femoral artery. This anatomical type is defined as Type 1. In the second type, the feeding artery of the RF muscle arises more inferiorly from the DB and hence creates a pivot point for the pedicle more distally in the thigh, limiting the arc of rotation. This anatomical type is defined as Type 2. For lower limbs presenting Type 2 anatomy, transfer of ALT flaps is restricted by the main artery of the RF muscle. This can be eliminated by severing the artery, and further extension of about 3 cm can be achieved [6-8]. In raising ALT flaps the flap can be transferred in the cranial direction by draping its pedicle over the superficial surface of the RF and SA muscles but additional extension of about 3 cm can be achieved by placing the vascular pedicle beneath the RF and SA muscles, which is defined as deep positioning [6].

The pattern of the distribution of the perforators of the DB was shown in an article by Kimata et al. [9]. They demonstrated that 81.9 % of the perforators are musculocutaneous, concentrated near the midpoint of the lateral thigh, however perforators are also distal to it and if chosen they allow to have a pedicle around 20 cm. Shieh et al. described a classification on ALT perforators: type I is a vertical musculocutaneous perforator and type III is a vertical septocutaneous perforator both from the DB of LCFA [10]. In the study conducted by Shin-Chen Pan et al showed the presence of Type I or type III perforators in 10 of 11 cadaveric thighs and all descending branches could be traced distally to connect with the lateral superior genicular artery or profunda femoral artery, in an intramuscular or septocutaneous course up to 3 to 10 cm above the knee, meaning up to the distal end of the FL [11].

### Vascular supply of fascia lata

In an article of Abeer et all conducted on 16 cadavers by indocyanine green contrast demonstrated that the whole iliotibial tract can receive its main blood supply from perforators from the DB [12]. The presence of two or three significant perforators that pierce the deep fascia (iliotibial tract), close to the inter muscular

**Table 1:** Study and characteristics of the reviewed studies.

| Study title | Year of publication | Journal | Study type | Cadaver/live | Number of patients | Number of thigh |
|---|---|---|---|---|---|---|
| Distally Based Anterolateral Thigh Flap: An Anatomic and Clinical Study | 2004 | Plastic and reconstructive surgery | Anatomical study and clinical study | Cadaver | 6 | 11 |
| Three-Dimensional Vascular Anatomical Study of the Tensor Fasciae Latae Muscle and Perforators | 2018 | J Reconstructive Microsurgery | Anatomical study | cadaver | / | 16 |
| A Description of the Vascular Anatomy of the Tensor Fascia Lata Perforator Flap Using Computed Tomography Angiography | 2018 | Annals of Plastic surgery | Anatomical study | live | 33 | 59 |
| The anterolateral thigh flap; variations in its vascular pedicle | 1989 | British Journal of Plastic Surgery | Anatomical study | live | 13 | 13 |
| Anatomic Variations and Technical Problems of the Anterolateral Thigh 74 Cases | 1998 | Plastic and Reconstructive surgery | Case Report and anatomical study | live | 74 | 74 |
| ***added studies based on topic competence*** | | | | | | |
| Rotation arc of pedicled anterolateral thigh flap for abdominal wall reconstruction: How far can it reach? | 2015 | JPRAS | anatomical study | cadaver | 60 | 60 |
| Increasing Pedicle Reach with Musculocutaneous Perforator Dissection in Anterolateral Thigh Free Flaps | 2023 | The laryngoscope | retrospective cohort study | live | 80 | 85 |
| The vascularized fascia lata free fap: an anatomical study and clinical considerations | 2020 | European Archives of Oto-Rhino-Laryngology | anatomical study | cadaver | 15 | 25 |

**Table 2:** Patient's demographics, defect size, pedicle length, the use of a mash, follow-up data including presence of complications and their management.

| patient | Age | sex | BMI kg/m² | site of defect | size | cutaneus defect | infection | surgery type | pedicle lenght | mesh | complication | recurrence | treatment of complications | follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55 | F | 31 | 1B | 15x12 cm | yes | no | FL pedicled flap | 14cm | no | no | no | -- | 36m |
| 2 | 70 | F | 34 | 1B | 15x15 cm | no | no | FL pedicled flap | 12cm | yes | no | yes at 10 months | 3x3 right ipocondrium gore dual mesh | 36m |
| 3 | 51 | F | 27 | 2 | 8x10 | no | no | FL pedicled flap | 17cm | yes | no | no | -- | 46m |
| 4 | 76 | F | 29 | 1B | 11x8 | yes | no | FL pedicled flap | 14cm | no | no | no | -- | 72m |
| 5 | 68 | M | 33 | 1A | 10x11 | yes | yes | FL pedicled flap | 16cm | yes | yes cutaneous dehiscence | no | medications | 8m |

septum between the rectus femoris and vastus lateralis muscles, is also supported by Jamik et al. [13]. They have studied the perfusion of the FL based on the DB. In their studies the mean length and width of the fascia that was stained in a cadaveric study from those perforators: it was 15.8 ± 4.1cm and 8.7 ±2.0cm respectively.

This means that a wide FL flap could be based on one of those perforators. If ALT flaps survive up to 9 cm from the perforator [2,14], the FL flap can be shifted caudally to increase pedicle length to include the most distal portion of the iliotibial tract without compromising its vascularization. Distally and medially the deep fascia tends to become thinner and more attenuated and this has to be taken in consideration.

## Clinical Cases

In the period between January 2016 and December 2023 5 patients with complex abdominal wall defects underwent reconstruction with pedicled FL flap. The mean age of the patients included was 64 years old. In 3 patients out of 5 the BMI (>30). The pedicled FL flap has also been combined in two cases (case 2 and 3) with prosthetic meshes: the first case involved an underlay placement of a prolene mesh to close the hernia gate; in the second case an onlay polypropylene mesh has been placed over anterior fascia of the rectus muscles, before the reconstruction with FL flap. In the last three cases, the reconstruction has been executed using the FL flap alone. No complications occurred at the donor site, despite the high BMI of 3 out of 5 patients. no vascular complications were

observed. The subcutaneous tunnel, positioned above the fascial plane of the superficial inguinal lymph nodes, allowed preservation of lymphatic drainage, preventing potential intraoperative accidental injuries that could lead to limb lymphedema. Sensitivity was preserved by protecting the femoral cutaneous nerve during dissection. The recipient site was similarly unaffected. In one case at 10 months follow-up detected at US of the abdominal wall we observed 3x3 right ipocondrium hernia managed by placement of a gore dual mesh. In another case we had a cutaneous dehiscence managed conservatively with medications. Nowadays none had a recurrence of the hernia with no complications or recurrence of incisional hernia along the reinforced linea alba with a vascularized flap of the same tissue type. The compressive dressings used proved effective in preventing fluid accumulation and seromas. Annual check-ups were conducted with ultrasound, and in more complex cases, MRI, during which the continuity of the wall without new dehiscence or bulging, with a preserved profile, was evident. Furthermore, thickening of the fascial layer corresponding to the reinforcement fascial surface was observed. With contrast imaging the same area appeared vital and well-vascularized and integrated. All patients had relief from symptoms of pain or discomfort during exertional activities. We describe below the three cases representative of the versatility of the flap, numbers refers to Table 2.

## Case 1

A 55-year-old female with a BMI of 32kg/m² experienced post-surgical dehiscence after a recurrent incisional hernia repair. The defect, measuring 15x12cm, involved skin, subcutaneous tissue, and fascia, located from below the umbilicus to the pubic region (zone 1B), (Figure 2). Due to tissue laxity and abdominal wall muscle tone loss, reconstructive surgery was necessary. The vascularized FL flap was prepared, with a pedicle length of 14cm with dimensions matching the ones of defect. A subcutaneous tunnel was created above the inguinal ligament, and the FL was sutured to reinforce the rectus muscle fascia (Figure 3). The patient was followed-up for 36 months without complications or recurrence.

**Figure 2:** Case 1; Female patient, 55 years old presented with a post-surgical dehiscence following a previous repair of a recurrent incisional hernia. The tissue loss involved skin, subcutaneous tissue and fascia. It was located along the linea alba, starting below the umbilicus and extending to the pubic region, zone 1B. The dimensions of the defect were 15x12cm.

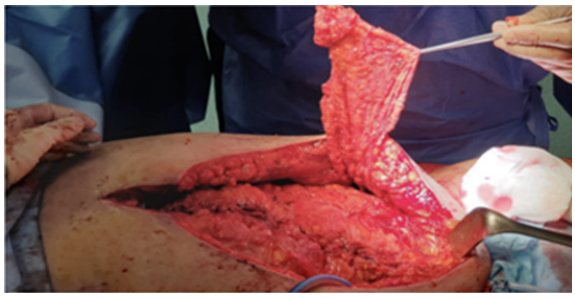

**Figure 3:** Case 1; a FL flap of the same dimension of the defect was raised. The pedicle was freed up to 14cm to obtain an adequate length and rotation of the flap to reach the abdominal wall defect area. The FL was sutured to reinforce the rectus muscle fascia.

## Case 2

A 51-year-old woman with a BMI of 27kg/m² had a post-surgical subcostal incisional hernia (8x10cm). Reconstruction involved a prosthetic mesh and a FL flap. The hernia sac was resected, and a 15x12 cm polypropylene mesh was inserted. The FL flap pedicle was isolated to 13cm (Figure 4), extended to 17cm by freeing up the origin, and was passed medially under the RF and sartorius muscle (Figure 5). The flap was sutured to cover the mesh. The patient was followed for 46 months with no complications or recurrence.

**Figure 4:** Case 3; 51-year-old womanpresented with a post-surgical subcostal incisional hernia of approximately 8x10cm.The flap was then prepared by making an incision on the anterolateral aspect of the ipsilateral thigh and identifying the perforating artery of the FL originating from the DB. The pedicle was isolated up to 13 cm but it was not sufficient to reach the defect.

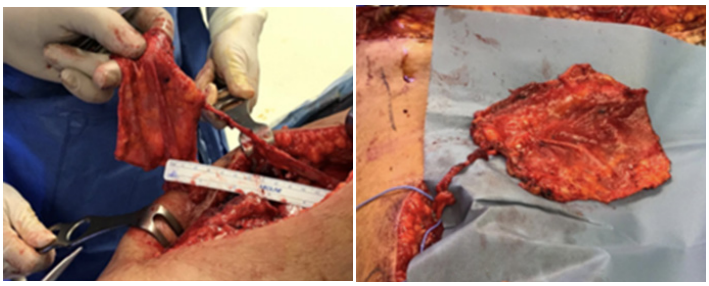

**Figure 5:** Case 3; In order to increase pedicle length it was freed up to its origin severing all muscular branches and it was passed medially under the RF and sartorius muscle. This maneuver granted another 4 cm in length for a total pedicle length of 17cm.

## Case 3

A 68-year-old male with a BMI of 33kg/m² had a supraumbilical hernia repair in 2016, a recurrence in 2017, and another recurrence in 2022 with cutaneous dehiscence and infected mesh exposure and wound swabs positive for Proteus Mirabilis (Figure 6). Surgical debridement and reconstruction with a 10x11cm FL flap and abdominal flap advancement were performed (Figure 7). The patient was discharged on post-op day 5. After three weeks, cutaneous dehiscence occurred but resolved with dressings within one month. The patient was followed for 8 months with no complications or recurrence.

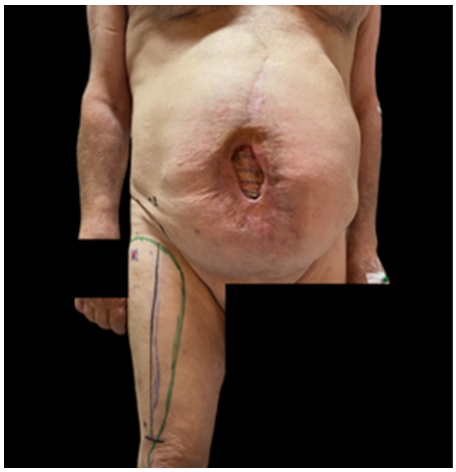

**Figure 6:** Case 5; A 68-year-old male underwent several surgeries over the years of an umbilical hernia repair with placement of a prosthetic mesh. He came to our attention with the presence of cutaneous dehiscence in the umbilical region measuring 10x11cm with exposure of the prosthetic mesh and wound swabs positive for Proteus Mirabilis.

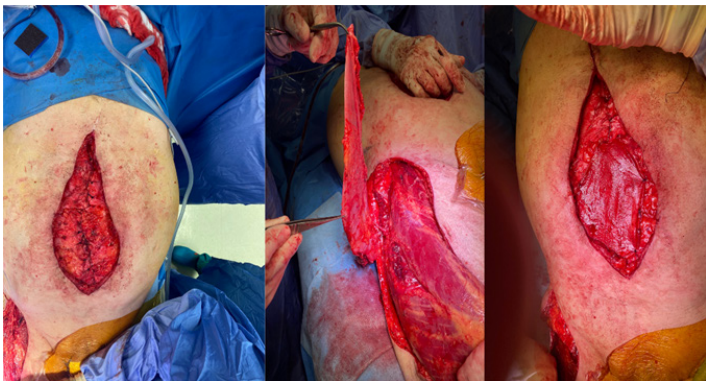

**Figure 7:** Case 5; reconstructive program of removal of the infected mesh and to reconstruct abdominal competence by pedicled FL flap and advancement of the abdominal flaps for closure of the cutaneous defect. The pedicle length was 16cm and the dimension of the FL flap were 16x11cm.

## Discussion

In the management of abdominal wall defects, four main factors should be taken into consideration: (1) medical status of the patient (in particular, the presence of any comorbidities); (2) wound depth (full-thickness versus partial-thickness defects); and (3) size and position of the defect. (4) the anatomical variants of the patient [4,15]. Reconstructing large abdominal defects or contaminated loss of substances often necessitate the use of autologous reconstructions. The thigh is a perfect donor site for well-vascularized tissue for the abdominal wall. The presence of a strong deep fascia, including the stronger iliotibial tract, can be used to reconstruct the musculofascial layer of the abdominal wall. The advantages of the thigh include an abundant vascular supply that allow to harvest different type of flap like TFL on the ascending branch and ALT flap and its variation the FL flap on the DB of the LCFA [2]. According to previous literature it was considered that defects above the umbilicus could not be managed by pedicled flaps from the thigh due to their limited pedicle length. In the literature there are no publications regarding the use of FL alone in fascial wall reconstruction and no publications regarding its use for sovraumbelicus defect. By performing this systematic review several anatomical and cadaver studies were included to better understand if it was possibly feasible to extend beyond the umbilicus in pedicled reconstructions from the thigh and how to further increase the pedicle reach by deepening our knowledge on the anatomy of the tight, inguinal region and the vascular supply of the FL. In our case series in agreement with the data reported in the literature for the anatomy of the DB of LCFA and the vascular anatomy of the FL and FL flap we were able to treat central and upper abdominal quadrants defects with FL pedicle flaps based on perforators of the DB without encountering tension or excessive pedicle torsion, reducing the surgical length and complications of free flap procedures that could impact negatively in this fragile cohort of patients.

## Clinical Implications

The presence of perforators from the DB of the LCFA allows for large surface FL harvesting, this doesn't necessary imply the presence of distal perforators to grant its vascular supply in the most distal segment. A wide FL pedicled flap is suitable and safe to perform reconstruction of abdominal defects able to reach even above the umbilical region.

## Conclusion

Repair of abdominal wall defects, including upper quadrants, can be achieved by pedicled flaps from the thigh. The subcutaneous pedicled FL flap's sensate potential, durable fascia, large dimensions, extensive reach, and 180-degree arc of rotation make it the ideal donor site. The literature review conducted confirmed that FL flap can be raised on distal perforators of the DB of the LCFA and allow a major pedicle length able to reach the supraumbilical area without tension.

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