anatomia

Case Report

# A Rare Bilateral Variation in the Branches of the Internal Thoracic Artery: A Case Report

**Jihad S. Hawi [1], Rosalyn A. Jurjus [2], Hisham S. Daouk [2], Maya N. Ghazi [2], Charbel A. Basset [3], Francesco Cappello [3], Inaya Hajj Hussein [4], Angelo Leone [3] and Abdo R. Jurjus [2,*]**

1 Faculty of Medicine and Medical Sciences, University of Balamand, Tripoli P.O. Box 100, Lebanon; jihad.hawi@balamand.edu.lb
2 Cell Biology and Physiological Sciences, Department of Anatomy, Faculty of Medicine, American University of Beirut, Beirut P.O. Box 11-0236, Lebanon; rosalynej@gmail.com (R.A.J.); hd09@aub.edu.lb (H.S.D.); mayanghazi99@gmail.com (M.N.G.)
3 Department of Biomedicine, Neuroscience and Advanced Diagnostics, Institute of Human Anatomy and Histology, University of Palermo, 90128 Palermo, Italy; cab19@mail.aub.edu (C.A.B.); francapp@hotmail.com (F.C.); angelo.leone@unipa.it (A.L.)
4 Department of Foundational Medical Studies, William Beaumont School of Medicine, Oakland University, Rochester, MI 48309, USA; hajjhuss@oakland.edu
* Correspondence: aj00@aub.edu.lb

**Abstract: Background:** Anatomical variations and, in particular, arterial variations constitute an important chapter in the learning of Clinical Anatomy. **Purpose:** The purpose of this report is to describe a rare bilateral anatomical variation in the internal thoracic artery (ITA) in a 60-year-old corpse and to depict its extreme clinical importance in coronary artery bypass surgery. **Methods:** The rare bilateral aberrant branches of the internal thoracic artery and their course in the thorax were incidentally discovered during routine anatomy dissection of the thorax at the Faculty of Medicine and Medical Sciences of the University of Balamand. The findings were thoroughly documented using digital photography, and the dissection followed the instructions from the "16th Edition of Grant's Dissector". **Results:** In the observed case, the left aberrant branch of ITA descends laterally and gives medial and lateral anterior intercostal branches at the first six intercostal spaces. Conversely, the right aberrant artery, which branches from the ITA, descends laterally and gives medial and lateral branches to every intercostal space in the first five intercostal spaces. **Conclusion:** This report emphasizes that any unexpected variations in the lateral aberrant branches of the internal thoracic artery may complicate the surgical procedure. Bilateral aberrant lateral branches of the internal thoracic artery constitute rare anatomical variations of the internal thoracic artery and have been rarely reported in the literature. Such a course for aberrant lateral branches in the thorax poses possible lethal complications during several procedures involving the thorax, including basic coronary artery bypass graft, thoracocentesis and intercostal paracentesis and breast reconstruction.

**Keywords:** internal thoracic artery; aberrant branches; arterial variation; thoracic wall; coronary artery bypass grafting; thoracocentesis; breast surgery

check for updates

**Citation:** Hawi, J.S.; Jurjus, R.A.; Daouk, H.S.; Ghazi, M.N.; Basset, C.A.; Cappello, F.; Hajj Hussein, I.; Leone, A.; Jurjus, A.R. A Rare Bilateral Variation in the Branches of the Internal Thoracic Artery: A Case Report. *Anatomia* **2023**, *2*, 320–327. https://doi.org/10.3390/anatomia2040028

Academic Editors: Gianfranco Natale and Francesco Fornai

Received: 21 July 2023
Revised: 9 October 2023
Accepted: 11 October 2023
Published: 12 October 2023



## 1. Introduction

The internal thoracic artery (ITA), also referred to as the internal mammary artery (IMA), arises from the antero-inferior branch of the first part of the subclavian artery [1,2]. As the largest artery in the thoracic wall, the ITA descends into the thorax region, coursing anterior to the pleura and separated from the posterior surface of the ribs by the transversus thoracis muscle [3,4]. Along its course, the ITA gives rise to branches that supply various structures, including the thymus, breast, mediastinum and sternum [3,5,6]. Typically, it gives rise to several branches, including the anterior intercostal arteries, perforating branches, pericardiophrenic, sternal and mediastinal, and terminates as the superior epigastric artery and musculophrenic artery [1,7–10]. Additionally, various cases of accessory internal thoracic vessels have been reported, which may give rise to superficial and deep cervical branches [11,12].

Furthermore, prior anatomical studies of the ITA employing ink injection have reflected the territories and have elucidated the links with the adjacent vessels [13]. These studies also unveiled the presence of connecting vessels between the ITA and tissue perfusion [14]. Recent data emanating from plastic and reconstructive surgery of the breast, as well as head and neck procedures, highlighted the importance of ITA and its perforating medial intercostal branches for adipocutaneous flaps [15]. Moreover, the ITA is increasingly becoming the preferred choice for microsurgical breast reconstruction and cardiothoracic surgery, with an excellent prognostic outcome [16]. Understanding the variations concerning the ITA is crucial for better outcomes. The selection process relies on clinical observations that reveal distinct structural and behavioral differences between the internal thoracic artery (ITA) and other nearby pectoral vessels, such as the thoracodorsal artery and inferior epigastric artery [17]. These distinctions are imperative and play a crucial role in guiding the appropriate choice of the ITA for specific procedures. Microscopic examinations have demonstrated that for the ITA, once clamped and severed with scissors, its wall separates into sleeve-like layers [18]. The middle layer, known as the tunica media, becomes separated from the adventitia and extrudes like sleeves. Light microscopy studies of formalin-fixed ITA and multiple stainings, with routine hematoxylin and eosin or the Weigert van Geison and Verhoeff for elastic laminae, showed a relatively thick tunica media with several well-formed elastic lamellae more than the other nearby arteries [19]. In addition, there was no significant difference in the thickness of the tunica intima or adventitia. These data were confirmed via transmission electron microscopy, whereby the media of the ITA had less packed smooth muscle cells, sparsely distributed with a low number of fenestrations in the elastic lamellae [20]. Such histological characteristics provide protective effects against intimal thickening and smooth muscle penetrations, an important element for the prevention of atherosclerosis [21]

Aberrant lateral branches of the ITA are rare anatomical and vascular variations that have received limited attention in the medical literature [22]. These variations have an incidence between 10% and 40% [23]. As such, aberrant right ITA can arise directly from the aorta and not from the subclavian artery [24]. Table 1 summarizes some of the rare aberrant branches of the ITA (Table 1). This case report sheds light on the discovery of bilateral aberrant lateral branches of the ITA, detailing their course and exploring their clinical significance. By documenting this uncommon anatomical finding, the report contributes to our understanding of vascular variations and their potential implications in clinical practice. Such variation can involve the origin, number of branches or the path they take during their progression, making the vascular system different from one person to another.

**Table 1.** Some of the rare variations in the aberrant branches of the ITA.

| Variation | Description |
|---|---|
| Origination from extrascalenic (third part) of the SCA [25] | Incidence rate: 0.5–1% in anatomical studies. Descends inferomedially, anterior to the scalenus anterior muscle. |
| Origination from the third part of the subclavian artery [26] | Medial and lateral branches of ITA with high bifurcation. |
| Bilateral hypoplasia of the ITAs [27] | Link up between ventral somatic anastomosis fails |
| Hypoplasia of the left ITA [27] | Hypoplasia from the first part of SCA |
| Bilateral aberrant branches of the ITA [28] | Rare. Present within the upper thorax. Can be used during CABG for better myocardium perfusion. |

## 2. Case Report

This is a case of a remarkable new discovery during anatomical dissections at The Faculty of Medicine, University of Balamand, following the examination of over 400 corpses. The discovery was made in a 60-year-old male corpse, where both left and right aberrant lateral branches were identified originating from the left and right ITAs, respectively. These aberrant lateral branches exhibited an unusual pattern, as they appeared to supply the upper six anterior intercostal spaces on both the left and right sides, deviating from the typical course of the ITA. Specifically, the left aberrant branch of the ITA was situated 2.5 cm away from the manubrium. Descending laterally, it gave rise to medial and lateral anterior intercostal branches at the first four intercostal spaces. The branch terminated at the fifth intercostal space, bifurcating 14 cm away from the body of the sternum, into medial and lateral anterior intercostal branches. Similarly, the right aberrant artery, after branching off the internal thoracic, 2.5 cm away from the manubrium, descends laterally and gives rise to medial and lateral branches at every intercostal space. It terminates at the sixth intercostal space, 16.5 cm away from the body of the sternum, and bifurcates into medial and lateral collateral branches (Figures 1 and 2).

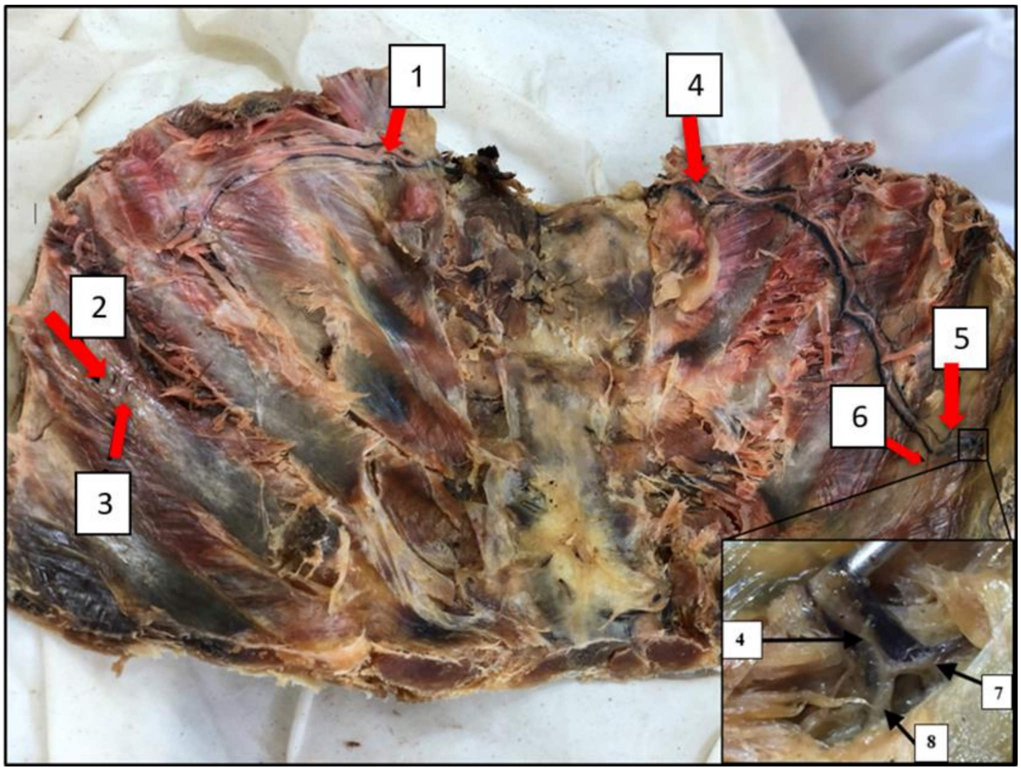


**Figure 1.** This photograph displays the bilateral aberrant lateral branches of the internal thoracic artery, with the following labeled structures: (1) left aberrant lateral artery; (2) left anterior lateral intercostal artery; (3) left anterior medial intercostal artery; (4) right aberrant lateral artery; (5) right anterior lateral intercostal artery; (6) right anterior medial intercostal artery; (7) right lateral collateral artery; (8) right medial collateral artery.

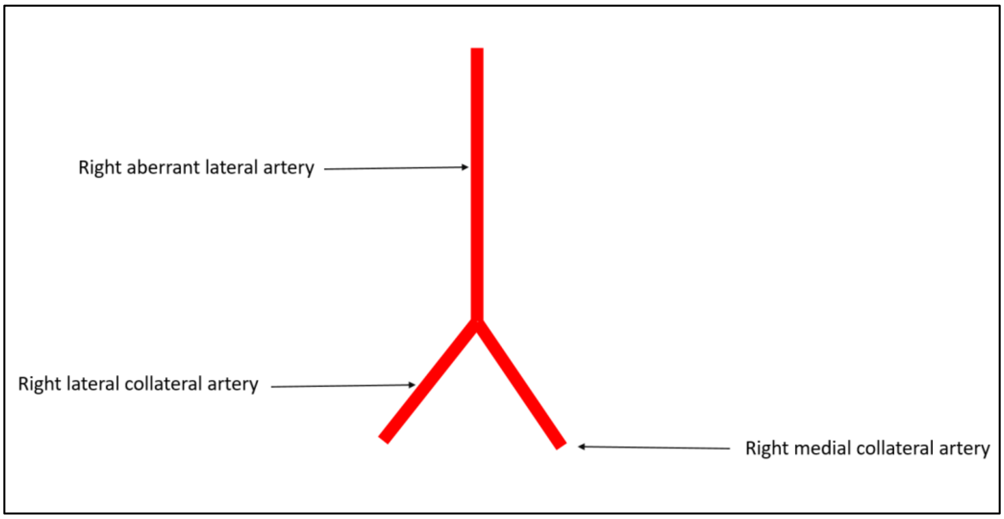


**Figure 2.** Simple scheme showing the right aberrant lateral artery with its lateral branches and medial collateral arteries.

## 3. Discussion

The discovery of such bilateral variation in the ITA has not been previously reported in the existing literature. Other case reports and studies have identified different ITA variations, including variation in the ITA on the right side, in a female dead body [26]. In this corpse, the ITA descends to the right second costal cartilage where it splits into medial and lateral branches that give rise to the sternal and anterior intercostal arteries, respectively. The medial and lateral branches anastomose in a horizontal pattern. Puri and colleagues studied 100 adult corpses, of which 24 were females and 76 were males [29]. According to their study, the ITA on the left in 96 specimens took origin from the first part of the subclavian artery, while in 4 other dead bodies, it was a branch of a common trunk. The ITA on the right took origin from the first part of the subclavian in 88 corpses, and in 12 cases, it was a branch of a common trunk. The artery was of similar length on both sides in most specimens. On the left side, the mean length of the ITA was $1.925 \pm 0.23$ cm, while on the right, the mean length was $1.954 \pm 0.224$ cm [18]. In most of the corpses studied, the ITA terminated on both sides at the sixth intercostal space [30].

According to the literature, the lateral costal artery (LCA), the lateral branch of the ITA, is known to be the largest artery in the thoracic wall, arising from the subclavian artery and located 1.5 cm lateral to the sternum [31,32]. Because of its critical location, understanding the development of this artery can give insight into the development of these unexpected bilateral aberrant lateral branches and their subsequent clinical significance [31]. Due to the clinical importance of this area, particularly in thoracic surgery, knowledge of possible anatomic variations is essential in preventing clinical errors.

As cited in the "Compendium of Human Anatomic Variations" by Ronald A. Bergman and co-workers, the ITA may develop from different embryologic origins [8,33]. It can develop from the subclavian artery and passes either in front or behind the scalenus anterior muscle. Additionally, the ITA can ascend from a common trunk with the inferior thyroid artery. It can also develop from the brachiocephalic artery that is branching from the ascending aorta [34]. As the ITA descends into the thorax, it reaches the sixth intercostal space, where it anastomoses with the intercostal arteries. In fact, the lateral ITA can originate from different arteries. It can branch out from the thyrocervical trunk or the costocervical trunk. It can even arise from the ascending cervical artery [35]. These diverse embryologic origins contribute to the anatomical complexity of the ITA and offer insights into potential variations in its course and branching patterns. Hence, in any surgical procedure performed in this area, the possible variations in the ITA must be taken into consideration and must be of great concern to physicians [6].

The ITA is the origin of several branches, including the pericardial, pericardiophrenic, sternal, mediastinal, anterior intercostal, terminal and perforating branches [18,24]. It is considered to be the main blood supply to the sternum, and any mistake during procedures involving the thorax can limit the sternum supply and result in sternal wound complication [36]. Therefore, care must be taken during procedures on the thoracic walls, including percutaneous subclavian vein catheterization and introducing pacemakers [37]. This area must be avoided during intercostal paracentesis of the pericardial sac, and the needle must be distanced from the sternal margin [38]. The ITA is most popular for its use in coronary artery bypass grafts (CABGs) [39]. During CABG procedures, the ITA is mobilized from its location and surgically anastomosed with the coronary artery to revascularize the myocardium [40]. Consequent to the critical location and passage of the ITA and its involvement in several critical procedures, any missed anatomic variation, such as the one reported here, may lead to complications involving the CABG procedure or any other thoracic wall procedure.

The long-term clinical benefits of ITA in the field of cardiothoracic surgery have been established, and several studies investigated the detailed histologic characteristics behind such benefits. The consensus is that the ITA is a transitional-type artery with an elastic nature in its upper part (second intercostal space), then elasto-muscular later and finally a muscular-type artery in the rest of the chest [41]. Such histological differences could impact on its successful long-term use in cardiac bypass surgery. For instance, studies have found that the histology of ITA plays a mandatory role in its function and duration [42]. Furthermore, the ITA and its perforators have been reported in the flap reconstruction of the tracheostoma and anterior neck to replace the deltopectoral flap with less flap necrosis [43,44].

Recently, post-mastectomy reconstruction of the breast using ITA branches for the flaps has become an appealing procedure. Such a procedure utilizes the tissue flaps along with ITA perforators to attain the appropriate symmetry and correct deformities. Such a technique makes good use of a dermoglandular perforating branch of the IMA present in each of the 5–6 intercostal spaces, laterodorsal to the lateral border of the sternum [45]. Such branches run superficially in a laterocaudal direction to supply skin of the medial two-thirds of the pectoral region in a sequential order. In addition, perforators of the fourth and fifth intercostal spaces have been proven to contribute to the blood supply of the areola and the direct inframammary fold and area [46]. Information on the vascular anatomy of the region, in particular, the IMA preoperatively to detect possible variation patterns, is essential.

## 4. Conclusions

Bilateral aberrant branches of the ITA were found during anatomy laboratory dissection, which had an unusual vascular pattern. They introduced a new vascular pattern that challenges surgical procedures. Such findings are exceptionally uncommon and have received limited attention in the existing medical literature. Hence, such a discovery emphasizes the importance of further investigations concerning genetic development and the evolution aspects of these variations. However, these findings highlight the diversity of the anatomical variations that might be present in the human vascular system. Perhaps understanding these variations is crucial for the impact on multiple medical procedures. Given the critical role of the ITA in various thoracic procedures, particularly the coronary artery bypass graft (CABG) procedure, where surgeons rely on this artery, any undetected anatomical variation can lead to potentially life-threatening complications. Such an unexpected anatomical variation can force surgeons to go for further investigations, implicating imaging studies for better vascular architecture comprehension. In addition, the presence of these aberrant branches can have a significant impact on breast plastic and reconstructive surgeries. Understanding the variations is mandatory for a good surgical plan that might require the adjustment of conventional surgical procedures.

While the presence of bilateral aberrant branches holds clinical importance and potential applicability, their extremely rare occurrence necessitates further exploration to fully comprehend their clinical implications in thoracic procedures. The understanding of such anatomical variations can significantly contribute to surgical precision and patient safety in cardiothoracic and reconstructive interventions. The ITA does not have a unique structure, and it can vary among the population. This case report sheds light on the need for continued research exploring the complexity of the human body and highlighting the importance of the variation, especially in heart and chest surgeries. Thus, careful investigation and documentation of these unique findings may provide adjustments to surgical techniques accordingly and may broaden our knowledge of vascular anatomy and enhance medical practices to better serve patients and advance the medical field.

**Author Contributions:** J.S.H.: The author identified the anatomical variation, wrote the case report, collected data, and provided supervision throughout the development of the manuscript. H.S.D.: The author collected data and contributed to the manuscript writing. C.A.B.: The author contributed to the manuscript writing, and formatting. F.C.: The author contributed to the manuscript writing, manuscript format editing. I.H.H.: The author contributed to the manuscript writing, formatting, and editing. M.N.G.: The author contributed to manuscript writing, editing, formatting, and reviewing. A.L. and R.A.J.: The authors contributed to manuscript writing, formatting, and editing. A.R.J.: The author contributed to manuscript writing, formatting, editing, and provided supervision throughout the development of the manuscript. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The IRB at the Department of Health and Human Services (DHHS) at the American University of Beirut reviewed the manuscript and declare that no living individual was concerned in this paper, hence the proposed activity is not ''Human Subject Research". Code of Federal Regulations for the Protection of Human Subjects ("The Common Rule") 45CFR46, subparts A, B, C, and D, with 21CFR56; and operate in a manner consistent with the Belmont report, FDA guidance, Good Clinical Practices under the ICH guidelines, and applicable national/local regulations.

**Informed Consent Statement:** This work received an exemption from IRB.

**Data Availability Statement:** Data is available with first and corresponding authors.

**Conflicts of Interest:** The authors declare that they have no conflict of interest. The dead body was treated ethically, and the dissection was conducted in accordance with the "16th Edition of Grant's Dissector" instructions.

## Abbreviations

| | |
|---|---|
| ITA | Internal thoracic artery |
| IMA | Internal mammary artery |
| CABG | Coronary artery bypass surgery |
| SCA | Subclavian artery |
| LCA | Lateral costal artery |

## References


1. Hadley, G. Essential Clinical Anatomy. *J. Anat.* **2007**, *211*, 413. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2375806/ (accessed on 29 August 2023). [CrossRef]
2. Internal Thoracic Artery—An Overview | ScienceDirect Topics. Available online: https://www.sciencedirect.com/topics/medicine-and-dentistry/internal-thoracic-artery (accessed on 9 October 2023).
3. Shahoud, J.S.; Kerndt, C.C.; Burns, B. Anatomy, Thorax, Internal Mammary (Internal Thoracic) Arteries. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK537337/ (accessed on 29 August 2023).
4. Otaki, M.; Lust, R.M.; Sun, Y.S.; Norton, T.O.; Spence, P.A.; Zeri, R.S.; Hopson, S.B.; Chitwood, W.R. Bilateral vs Single Internal Thoracic Artery Grafting for Left Main Coronary Artery Occlusion. *Chest* **1994**, *106*, 1260–1263. Available online: https://www.sciencedirect.com/science/article/pii/S0012369216333839 (accessed on 29 August 2023). [CrossRef]

5. Stoddard, N.; Heil, J.R.; Lowery, D.R. Anatomy, Thorax, Mediastinum. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK539819/ (accessed on 29 August 2023).
6. Sajja, L.R.; Mannam, G. Internal thoracic artery: Anatomical and biological characteristics revisited. *Asian Cardiovasc. Thorac. Ann.* **2015**, *23*, 88–99. [CrossRef]
7. Palanisamy, V.; Mohandoss, B.K.; Ravikumar, M.S.; Raman, R.K.; Rajakumar, A.P.; Kurian, V.M. Uncommon Anatomic Variation of Left Internal Mammary Artery: God-Created Y-Graft Conduit. *Ann. Thorac. Surg.* **2020**, *109*, e113–e114. Available online: https://www.sciencedirect.com/science/article/pii/S000349751930877X (accessed on 29 August 2023). [CrossRef]
8. Internal Thoracic Artery. Available online: https://www.kenhub.com/en/library/anatomy/internal-thoracic-artery (accessed on 29 August 2023).
9. Moore, K.L.; Dalley, A.F.; Agur, A.M.R. *Clinically Oriented Anatomy*; Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2013; 1171p, ISBN 978-1-4511-1945-9.
10. Vorster, W.; du Plooy, P.T.; Meiring, J.H. Abnormal origin of internal thoracic and vertebral arteries. *Clin. Anat.* **1998**, *11*, 33–37. [CrossRef]
11. Akgun, V.; Hamcan, S.; Bozkurt, Y.; Battal, B. Thoracic Aorta. In *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*; John Wiley & Sons, Ltd.: New York, NY, USA, 2016; pp. 501–529. ISBN 978-1-118-43030-9. Available online: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118430309.ch49 (accessed on 29 August 2023).
12. Tunali, S. Subclavian Artery. In *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*; John Wiley & Sons, Ltd.: New York, NY, USA, 2016; pp. 575–582. ISBN 978-1-118-43030-9. Available online: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118430309.ch52 (accessed on 29 August 2023).
13. Palmer, J.H.; Ian Taylor, G. The vascular territories of the anterior chest wall. *Br. J. Plast. Surg.* **1986**, *39*, 287–299. Available online: https://www.sciencedirect.com/science/article/pii/0007122686900378 (accessed on 29 August 2023). [CrossRef]
14. Tafner, P.F.d.A.; Chen, F.K.; Rabello Filho, R.; Corrêa, T.D.; de Freitas Chaves, R.C.; Serpa Neto, A. Recent advances in bedside microcirculation assessment in critically ill patients. *Rev. Bras. Ter. Intensiv.* **2017**, *29*, 238–247. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5496759/ (accessed on 29 August 2023). [CrossRef]
15. Deramo, P.; Rose, J. Flaps: Muscle and Musculocutaneous. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK546581/ (accessed on 29 August 2023).
16. Fischer, S.; Diehm, Y.F.; Kotsougiani-Fischer, D.; Gazyakan, E.; Radu, C.A.; Kremer, T.; Hirche, C.; Kneser, U. Teaching Microsurgical Breast Reconstruction—A Retrospective Cohort Study. *J. Clin. Med.* **2021**, *10*, 5875. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8707719/ (accessed on 29 August 2023). [CrossRef]
17. Conduits for Coronary Bypass: Arteries Other Than the Internal Thoracic Artery's—PMC. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3680601/ (accessed on 29 August 2023).
18. Paliouras, D.; Rallis, T.; Gogakos, A.; Asteriou, C.; Chatzinikolaou, F.; Georgios, T.; Tsirgogianni, K.; Tsakiridis, K.; Mpakas, A.; Sachpekidis, N.; et al. Surgical anatomy of the internal thoracic arteries and their branching pattern: A cadaveric study. *Ann. Transl. Med.* **2015**, *3*, 212. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4583587/ (accessed on 29 August 2023).
19. Piccinin, M.A.; Schwartz, J. Histology, Verhoeff Stain. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK519050/ (accessed on 29 August 2023).
20. Nag, A.C. Study of non-muscle cells of the adult mammalian heart: A fine structural analysis and distribution. *Cytobios* **1980**, *28*, 41–61.
21. Camaré, C.; Pucelle, M.; Nègre-Salvayre, A.; Salvayre, R. Angiogenesis in the atherosclerotic plaque. *Redox Biol.* **2017**, *12*, 18–34. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5312547/ (accessed on 29 August 2023). [CrossRef]
22. Anagiotos, A.; Kazantzi, M.; Tapis, M. Aberrant internal carotid artery in the middle ear: The duplication variant. *BMJ Case Rep.* **2019**, *12*, e228865. [CrossRef]
23. Bernardes, M.N.D.; Cascudo, N.C.M.; El Cheikh, M.R.; Gonçalves, V.F.; Lamounier, P.; Ramos, H.V.L.; Costa, C.C. Aberrant common and internal carotid arteries and their surgical implications: A case report. *Braz. J. Otorhinolaryngol.* **2020**, *87*, 366–369. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9422460/ (accessed on 29 August 2023). [CrossRef]
24. Mahmodlou, R.; Sepehrvand, N.; Hatami, S. Aberrant Right Subclavian Artery: A Life-threatening Anomaly that should be considered during Esophagectomy. *J. Surg. Tech. Case Rep.* **2014**, *6*, 61–63. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4290042/ (accessed on 29 August 2023).
25. Andreou, A.Y.; Iakovou, I.; Vasiliadis, I.; Psathas, C.; Prokovas, E.; Pavlides, G. Aberrant left internal thoracic artery origin from the extrascalenic part of the subclavian artery. *Exp. Clin. Cardiol.* **2011**, *16*, 62–64. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3126687/ (accessed on 29 August 2023).
26. Nanthakumar, H.; Iwanaga, J.; Dumont, A.S.; Tubbs, R.S. A rare cadaveric case of a duplicated internal thoracic artery. *Anat. Cell Biol.* **2020**, *53*, 366–368. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7527130/ (accessed on 29 August 2023). [CrossRef]
27. Sajja, L.R.; Mannam, G. Rare variants of internal thoracic artery in patients with coronary artery disease. *Indian J. Thorac. Cardiovasc. Surg.* **2009**, *25*, 68–70. [CrossRef]

28. Burton, K.R.; Ditkofsky, N. Incidental discovery of a new and clinically important anatomic variant of the internal thoracic artery in a young male trauma patient. *BMJ Case Rep.* **2018**, *2018*, bcr-2017. Available online: https://www.proquest.com/docview/2010536726/abstract/AFCF8082BDB3481APQ/1 (accessed on 29 August 2023). [CrossRef]
29. Bilateral Internal Thoracic Artery Harvesting; Anatomical Variations to Be Considered | SpringerLink. Available online: https://link.springer.com/article/10.1007/s12055-007-0036-3 (accessed on 29 August 2023).
30. Odo, Y.; Iwanaga, J.; Tabira, Y.; Watanabe, K.; Saga, T.; Tubbs, R.S.; Fujishima, Y.; Yamaki, K.-I. Bilateral Lateral Costal Branches of the Internal Thoracic Arteries: A Case Report. *Kurume Med. J.* **2018**, *65*, 105–108. Available online: https://www.jstage.jst.go.jp/article/kurumemedj/65/3/65_MS653003/_article (accessed on 29 August 2023). [CrossRef]
31. Bax, M.; Romanov, V.; Junday, K.; Giannoulatou, E.; Martinac, B.; Kovacic, J.C.; Liu, R.; Iismaa, S.E.; Graham, R.M. Arterial dissections: Common features and new perspectives. *Front. Cardiovasc. Med.* **2022**, *9*, 1055862. Available online: https://www.frontiersin.org/articles/10.3389/fcvm.2022.1055862 (accessed on 29 August 2023). [CrossRef]
32. Vural, Ü.; Aglar, A.A.; Sahin, S.; Kizilay, M. Lateral Costal Artery: Clinical Importance of an Accessory Thoracic Artery. *Braz. J. Cardiovasc. Surg.* **2018**, *33*, 626–630. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6326454/ (accessed on 29 August 2023). [CrossRef] [PubMed]
33. Tubbs, R.S.; Loukas, M. Common Carotid and Cervical Part of the Internal Carotid Arteries. In *Bergman's Comprehensive Encyclopedia of Human Anatomic Variation*; John Wiley & Sons, Ltd.: New York, NY, USA, 2016; pp. 475–476. ISBN 978-1-118-43030-9. Available online: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118430309.ch46 (accessed on 29 August 2023).
34. Westrych, K.; Ruzik, K.; Zielinska, N.; Paulsen, F.; Georgiev, G.; Olewnik, Ł.; Łabętowicz, P. Common trunk of the internal thoracic artery, inferior thyroid artery and thyrocervical trunk from the subclavian artery: A rare arterial variant. *Surg. Radiol. Anat.* **2022**, *44*, 983–986. [CrossRef] [PubMed]
35. Knipe, H. Internal Thoracic Artery | Radiology Reference Article | Radiopaedia.org. Available online: https://radiopaedia.org/articles/internal-thoracic-artery (accessed on 29 August 2023).
36. Singh, K.; Anderson, E.; Harper, J.G. Overview and Management of Sternal Wound Infection. *Semin. Plast. Surg.* **2011**, *25*, 25–33. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3140234/ (accessed on 29 August 2023). [CrossRef]
37. Deere, M.; Singh, A.; Burns, B. Central Venous Access of the Subclavian Vein. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK482224/ (accessed on 29 August 2023).
38. Willner, D.A.; Grossman, S.A. Pericardiocentesis. In *StatPearls*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: http://www.ncbi.nlm.nih.gov/books/NBK470347/ (accessed on 29 August 2023).
39. Carrier, M.; Grégoire, J.; Tronc, F.; Cartier, R.; Leclerc, Y.; Pelletier, L.C. Effect of internal mammary artery dissection on sternal vascularization. *Ann. Thorac. Surg.* **1992**, *53*, 115–119. [CrossRef]
40. Samak, M.; Fatullayev, J.; Sabashnikov, A.; Zeriouh, M.; Schmack, B.; Ruhparwar, A.; Karck, M.; Popov, A.-F.; Dohmen, P.M.; Weymann, A. Total Arterial Revascularization: Bypassing Antiquated Notions to Better Alternatives for Coronary Artery Disease. *Med. Sci. Monit. Basic Res.* **2016**, *22*, 107–114. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5063431/ (accessed on 30 August 2023). [CrossRef] [PubMed]
41. Borović, M.L.; Borović, S.; Perić, M.; Vuković, P.; Marinković, J.; Todorović, V.; Radak, D.; Lacković, V. The internal thoracic artery as a transitional type of artery: A morphological and morphometric study. *Histol. Histopathol.* **2010**, *25*, 561–576. [PubMed]
42. Resilience of the Internal Mammary Artery to Atherogenesis: Shifting From Risk to Resistance to Address Unmet Needs | Arteriosclerosis, Thrombosis, and Vascular Biology. Available online: https://www.ahajournals.org/doi/10.1161/ATVBAHA.121.316256 (accessed on 9 October 2023).
43. Ibrahim, A.; Atiyeh, B.; Karami, R.; Adelman, D.M.; Papazian, N.J. The Deltopectoral Flap Revisited: The Internal Mammary Artery Perforator Flap. *J. Craniofac. Surg.* **2016**, *27*, e189–e192. [CrossRef]
44. Vesely, M.J.J.; Murray, D.J.; Novak, C.B.; Gullane, P.J.; Neligan, P.C. The internal mammary artery perforator flap: An anatomical study and a case report. *Ann. Plast. Surg.* **2007**, *58*, 156–161. [CrossRef]
45. Abdelmonem, K.; Elshahat, A.; Abol-Atta, H.; Abou-Gamrah, S.; Abd Eltawab, R.; Massoud, K. Breast reconstruction using internal mammary artery perforator (IMAP) flap. *Ain Shams J. Surg.* **2013**, *6*, 173–190. Available online: https://asjs.journals.ekb.eg/article_179840.html (accessed on 30 August 2023). [CrossRef]
46. Vesely, M.; Murray, D.; Novak, C.; Gullane, P.; Neligan, P. The Internal Mammary Artery Perforator Flap. *Ann. Plast. Surg.* **2007**, *58*, 156–161. [CrossRef]