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Langer's axillary arch lymph node metastasis in breast cancer patients: A prospective clinical study



Yuting Sang^a, Xiaoli Kong^a, Xiaoyan Li^a, Liyu Jiang^a, Tingting Ma^a, Wenjing Zhao^b,
Qifeng Yang^{a,b,*}

^a Department of Breast Surgery, Qilu Hospital of Shandong University, Ji'nan, Shandong, China

^b Pathology Tissue Bank, Qilu Hospital of Shandong University, Ji'nan, Shandong, China

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ABSTRACT

Background and objectives: Latissimus dorsi, an anatomical landmark for axillary lymph node dissection, was reported to harbor an anatomical variation named Langer's axillary arch (LAA). However, the incidence and clinical significance of LAA in breast cancer remain obscure.

Methods: We conducted a six-year prospective study, including 1724 breast cancer patients in Qilu hospital between January 2012 to February 2018. All patients received ALND were inspected for existence of LAA. All the surgeries were completed with the involvement of same experienced surgeon. Once the LAA was identified, all the lymph nodes located lateral to it, named LAA's lymph node, were dissected and collected for pathologic examination.

Results: Among 1724 breast cancer patients, LAA was identified in 132 patients (7.66%). 120 out of the 132 patients (90.91%) had at least two LAA's lymph nodes. 21 out of 120 patients (17.50%) were confirmed with cancer cell metastasis in LAA's lymph nodes. Among the 23 patients received sentinel lymph node tracing, sentinel lymph node was located lateral to LAA in 3 patients (13.04%).

Conclusions: Our results indicated that it is of great importance for surgeons to correctly ascertain LAA, and it should be taken as a nonnegligible parts during ALND or SLNB.

1. Introduction

Breast cancer is one of the most common cancers for female individuals in the world [1]. Even though the effective treatments for breast cancer patients are increasingly diversified, surgery is still generally accepted as the basic treatment. The breast cancer surgery experienced a complicated transition from lumpectomy, extended radical mastectomy, modified radical mastectomy and then to conserving surgery. Among them, modified radical mastectomy remains the most common surgical options for operable breast cancer patients nowadays. As an essential component of modified radical mastectomy, axillary lymph node dissection (ALND) plays a decisive role in identifying the status of lymph nodes [2], which is the most important factor for prognostic prediction, and indicator to guide individualized treatment [3].

Given that latissimus dorsi comprises the lateral border of the surgical field of ALND, this anatomic structure plays a vital role in surgical procedures of breast cancer patients. However, it was reported to have

an anatomical variant by Ramsay in 1795. Thereafter, Karl Langer gave a more accurate description of this variant in 1846, and named it as Langer's axillary arch (LAA) [4,5]. It is known that LAA is highly developed to form the pectoral group of muscles in lower mammals, while it is regressed due to decreased functional importance in human [6,7]. Because LAA is rarely reported with symptoms and only identified during the axillary surgery or anatomic research [8,9], little attention was paid to its occurrence rate and clinical importance. Considering the LAA originates from latissimus dorsi, crosses over the axillary neurovascular bundles [10,11], it might be mistaken for the true lateral border of ALND during the surgical procedures. However, there was no guidelines nor researches focused on whether there are lymph nodes that might be located around LAA. Moreover, if the lymph nodes exist, whether they could participate in the drainage of mammary gland and become a possible position for lymph nodes metastasis in breast cancer patients remain unclear.

Therefore, in order to investigate the incidence and clinical importance of LAA and the co-existent lymph nodes, we conducted a

Abbreviations: Langer's axillary arch, LAA; Indocyanine green, ICG; Sentinel lymph nodes, SLNs; Three-dimensional computed tomographic, 3D-CT

* Corresponding author. Department of Breast Surgery, Qilu Hospital, Shandong University, 107, Jinan Culture Road, Jinan, 250012, China.

E-mail address: qifengy_sdu@163.com (Q. Yang).

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prospective study involving a large cohort of breast cancer patients.

2. Materials and methods

2.1. Patients

A total of 1724 breast cancer patients were involved in our study, who received axillary procedures at Qilu Hospital of Shandong University between January 2012 and February 2018. The axillary lymphadenectomy procedures include ALND, sentinel lymph node biopsy (SLNB) or both. All of the surgeries were completed with involvement of the same experienced surgeon and all the patients got a histopathological diagnosis of breast cancer postoperatively. Based on axillary anatomic landmarks and judgment of surgeons, 132 breast cancer patients with LAA were identified and enrolled. The basic characteristics of these patients and pathological data of tumors were collected. Written informed consent was obtained and this project was approved by Ethics Committee on Scientific Research of Shandong University Qilu Hospital.

2.2. Pathology and immunohistochemistry

All patients had pathological diagnosis conducted by pathologists at Shandong University Qilu Hospital. Estrogen receptor (ER), progesterone receptor (PR), HER2 status and ki-67 index was analyzed on consecutive tissue sections from resected tumors using immunohistochemical (IHC) staining. ER and PR positive were defined as 1% or more of cells staining. HER2 overexpression was defined as 3+ staining by IHC or fluorescence in situ hybridization (FISH) assays in cases with equivocal (2+) immunohistochemical results to decide whether the gene amplified or not.

2.3. Sentinel lymph nodes biopsy (SLNB) technique

Methylene blue was injected subcutaneous into the periareolar tissue before the surgery, followed by Indocyanine green (ICG) five minutes later in the same position. Then, A near-infrared illumination system for ICG lymphography (Ming De Fluorescence Imaging System) was applied to real time visualization of the fluorescent lymph nodes, and the methylene blue stained lymphatic vessels and lymph nodes were identified with bare eyes of the surgeons. Next, after incising the skin, guided by both tracing methods, several blue dyed lymph nodes with shiny fluorescent spots can be firstly traced down. These lymph nodes were regard as sentinel lymph nodes (SLNs).

2.4. Three-dimensional computed tomographic (3D-CT) reconstruction of axilla

Computed tomographic (CT) scanning was performed with a 64-slice CT scanner (GE Discovery CT750, General Electric, Waukesha, WI, USA). Patients were required to take the supine position with arms extended overhead. CT images were transferred to a PACS workstation (IMPAX 6.3.1.4095, Agfa Healthcare NV, Belgium), and 3D-CT reconstruction was also finished with this software using the images of chest with muscular algorithm.

2.5. Statistical analysis

Fisher's exact test and Pearson's chi-squared test were applied to Categorical variables of tumor characteristics for statistical analysis. In this project, p-values less than 0.05 are considered as significant associations. All statistical analyses in the study were carried out using IBM SPSS Statistics 22.0.

Table 1
Patient demographics and tumor characteristics.

Variables	N	%	Median	Range
Age(y), Median(range)			50	25–75
Body Mass Index (BMI), Median(range)			24.83	16.01–34.47
Tumor Location (%)				
Upper outer quadrant	79	59.8		
Upper inner quadrant	28	21.2		
Lower outer quadrant	21	15.9		
Lower inner quadrant	4	3.0		
Deeper Areola area	4	3.0		
T stage (%)				
T1	68	51.5		
T2	55	41.7		
T3	9	6.8		
N stage (%)				
N0	78	59.1		
N1/N2	46	34.8		
N3	8	6.1		
Histology (%)				
Invasive breast cancer	97	73.5		
Ductal carcinoma in situ	12	9.1		
Both	19	14.4		
Others	4	3.0		
Histological grade				
I	3	2.8		
II	74	69.8		
III	29	27.3		
Molecular type (%)				
Luminal A	43	33.1		
Luminal B	45	34.6		
Her2 overexpression	25	19.2		
Basal-like	17	13.1		
ER status (%)				
Positive	44	33.8		
Negative	86	66.2		
PR status (%)				
Positive	43	33.1		
Negative	87	66.9		
Her2 status (%)				
Overexpression	41	31.5		
Non-overexpression	89	68.5		
Ki-67 expression (%)				
≤ 14%	40	30.8		
> 14%	90	69.2		

3. Results

3.1. Prevalence of LAA and characteristics of patients

The study included 1724 breast cancer patients who received mastectomy with ALND, SLNB or both from January 2012 to February 2018 at Qilu Hospital of Shandong University. Within the 1724 breast cancer cases, 132 patients (7.66%) were confirmed to have LAA, suggesting that LAA is relatively common anatomical variant of latissimus dorsi in breast cancer patients. The age range of these 132 patients covers from 25 to 75, with a median of 50. The average size of the tumor was 2.04 ± 1.1 cm (range:0.2–10 cm). For all the patients who had LAA, 4 (3.03%) patients underwent SLNB only, and 106 (80.30%) patients received ALND only and the remaining patients were treated by both. Table 1 shows the patient demographics and tumor characteristics. All of the identified LAA were asymptomatic and found to extend from latissimus dorsi across the axillary neurovascular bundle to the tendon of pectoralis major or minor (Fig. 1a). The majority of patients were identified to have unilateral LAA (Fig. 1b).

3.2. Incidence and metastasis rate of LAA's lymph node

Specifically, in most of the patients identified with LAA, a set of lymph nodes were detected constantly located lateral to the LAA during the surgeries, named as LAA's lymph node. There were only 12 (9.09%)

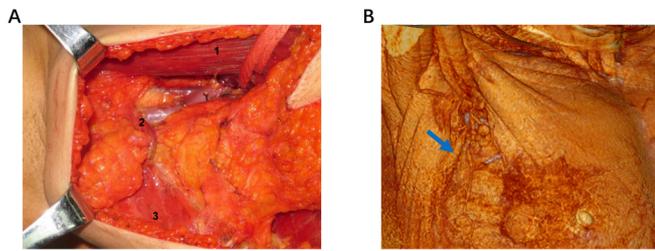


Figure 1. Resection and 3D-CT reconstruction of the Langer's axillary arch. A, Langer's axillary arch extending from Latissimus dorsi muscle to Pectoralis minor tendon in the left axilla crossing over axillary neurovascular structures 1. Pectoralis major muscle; 2. Langer's axillary arch; 3. Latissimus dorsi muscle. B, 3D-CT reconstruction image of a 44-year-old woman who received right breast mastectomy and ALND. The blue arrows represent Langer's axillary arch.

patients didn't have LAA's lymph nodes, whereas others had more than one LAA's lymph nodes (range:2–14, median:4). Since these lymph nodes were quite common, we further explored the metastasis rate of them. Among the 120 patients confirmed with LAA's lymph nodes, 21 (17.50%) patients were diagnosed with cancer cell metastasis, and it was identified as the only group of lymph nodes with metastasis in 6 patients. Taken together, our data indicated that the LAA's lymph node was quite common in breast cancer patients harboring LAA with relatively high metastasis rate.

3.3. Correlation between LAA's lymph node metastasis and other groups of axillary lymph node metastasis

Of the patients with LAA's lymph node who underwent SLNB (n = 23), we found that 3 patients (13.04%) had SLNs located just lateral to the LAA, which means those SLNs were also LAA's lymph node. Moreover, LAA's lymph node (also SLN) was pathologically confirmed as the only metastatic lymph node in one of the patients (Fig. 2). We further investigated the distribution of metastatic axillary lymph nodes in patients having LAA's lymph node. Among the patients diagnosed with LAA's lymph node metastasis, 8 of them with no lymph node metastasis in any other groups, and 1 patient had skipping metastasis in level 3 besides the LAA's lymph node (Table 2). In addition, it had been found that the LAA's lymph node metastasis has no correlation with level I, II or III axillary lymph node (Table 3). The data above

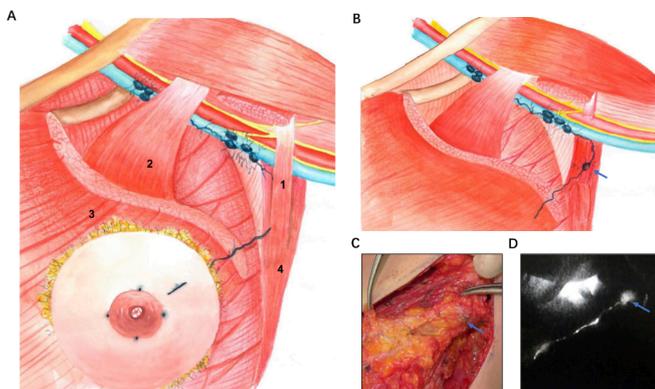


Fig. 2. Process of sentinel lymph nodes dissection in patient with sentinel lymph nodes (LAA's lymph nodes) under LAA. A, Schematic diagram after indocyanine green fluorescence and methylene blue have been injected subcutaneous. 1. Langer's axillary arch; 2. Pectoralis minor muscle; 3. Pectoralis major muscle; 4. Latissimus dorsi muscle. B, Schematic diagram of identification of sentinel lymph node after cutting the LAA. C, Dissection of lymphatic vessels and sentinel lymph node beneath the LAA. D, The shiny fluorescent image of the sentinel lymph node on the monitor screen of the dynamic imaging system. The blue arrows represent the same sentinel lymph nodes (LAA's lymph nodes).

Table 2
Metastatic distribution of axillary lymph nodes in patients with positive LAA's lymph node.

Positive lymph node distribution	Case number
LAA's lymph node	8
LAA's lymph node + I ^a	6
LAA's lymph node + I + II ^b	5
LAA's lymph node + I + II + III ^c	1
LAA's lymph node + III	1

^a Level I lymph nodes of axillary.

^b Level II lymph nodes of axillary.

^c Level III lymph nodes of axillary.

Table 3
Association between LAA's lymph node and axillary lymph node status.

Position of lymph nodes	LAA's lymph node status		P
	Positive	Negative	
Level I			
Positive	14	19	0.527
Negative	7	6	
Level II			
Positive	7	8	0.923
Negative	14	17	
Level III			
Positive	3	3	1.000
Negative	18	22	

indicated that the LAA's lymph node could be SLN and was irrelevant with the status of other axillary lymph nodes.

3.4. Relationship between LAA's lymph node metastasis and clinicopathological factors

Given the untraditional position and relatively high metastasis rate of LAA's lymph node, a univariate analysis was employed to explore whether the status LAA's lymph node has correlation with other tumor characteristics. However, as showed in Table 4, there was no statistically significant difference in LAA's lymph node status in tumor location (p = 0.346), T stage (p = 0.324), histology (p = 0.089), histological grade (p = 0.927), molecular classification (p = 0.487), ER (p = 0.641), PR (p = 0.641), Her2 (p = 0.292) and ki-67 index (p = 0.988), except for N stage (p = 0.035).

4. Discussion

Axillary lymph nodes dissection is an essential constituent part for the modified radical mastectomy, which is the most common surgical approach for the breast cancer patients. During the procedure of lymph nodes dissection in axilla, it has been reported that several anatomical variations would occur, such as Langer's axillary arch, pectoralis quartus and pectoralis major aplasia [3]. Among them, Langer's axillary arch, an anatomical variation of latissimus dorsi, is a muscular or a fibromuscular slip extending from the latissimus dorsi. It crosses the neurovascular structure and joins the tendons, muscles or fasciae around the superior part of the humerus [11,12]. Considering lateral border of latissimus dorsi comprises the boundaries of surgical field of ALND, the existence of LAA could confuse the true margin during the procedure. The present prospective study offers insight into the occurrence rate and clinical significance of LAA in breast cancer patients.

The prevalence of Langer's axillary arch is highly variable and shows a significant difference on the basis of research samples. For cadaveric investigations, Natsis et al. reported that the occurrence rate of LAA was 7.28% by dissecting 107 cadavers [3], similar to 6.4% reported by Takafuji et al. [13]. Whereas Miguel et al.'s study showed a

Table 4
Relationship between LAA's lymph node status and clinicopathological characteristics.

Tumor characteristics	LAA's lymph node status		
Variables	Metastatic Cohort (n = 21)	Non-Metastatic Cohort (n = 25)	P value
Tumor Location (%)			0.346
Upper outer quadrant	13 (61.9)	14 (56.0)	
Upper inner quadrant	3 (14.3)	1 (4.0)	
Lower outer quadrant	3 (14.3)	6 (24.0)	
Lower inner quadrant	2 (9.5)	1 (4.0)	
Deeper Areola area	–	3 (12.0)	
T stage (%)			0.324
T1	5 (23.8)	11 (44.0)	
T2	14 (66.7)	12 (48.0)	
T3	2 (9.5)	2 (8.0)	
N stage (%)			0.035
N1	9 (42.8)	16 (64.0)	
N2	7 (33.3)	9 (36.0)	
N3	5 (23.8)	–	
Histology (%)			0.089
Invasive ductal carcinoma	14 (66.7)	23 (92.0)	
Invasive lobular carcinoma	2(9.5)	–	
Invasive and DCIS	5 (23.8)	2 (8.0)	
Histological grade (%)			0.927
I	–	–	
II	12 (66.7)	17 (68.0)	
III	6 (33.3)	8 (32.0)	
Molecular classification (%)			0.487
Luminal A	2 (9.5)	5 (20.0)	
Luminal B	13 (61.9)	12 (48.0)	
Her2 overexpression	5 (23.8)	4 (16.0)	
Basal-like	1 (4.7)	4 (16.0)	
ER status (%)			0.641
Positive	14 (66.7)	15 (60.0)	
Negative	7 (33.3)	10 (40.0)	
PR status (%)			0.641
Positive	14 (66.7)	15 (60.0)	
Negative	7 (33.3)	10 (40.0)	
Her2 status (%)			0.292
Overexpression	9 (42.8)	7 (28.0)	
Non-overexpression	12 (57.2)	18 (72.0)	
Ki-67 expression (%)			0.988
≤ 14%	5 (23.8)	6 (24.0)	
> 14%	16 (76.2)	19 (76.0)	

prevalence of 3% in 100 axillary dissections [4]. However, Karanlik et al. demonstrated that 9 (1.2%) out of 758 patients who received axillary procedures were identified with LAA [11], which is different from the 6.52% indicated by Besana-Cian et al. [14], and 0.25% reported by Serpell et al. [15]. Moreover, Guy et al. indicated that LAA was found in approximately 6% of shoulder MRI examinations [7]. Recently, Dominik et al. conducted a meta-analysis, which illustrated a prevalence of 5.3% by reviewing 29 studies [16]. Involving a large cohort of breast cancer patients underwent axillary surgical procedures, our results indicated that the incidence of LAA is 7.66%. Consequently, LAA is relatively common in breast cancer patients.

Complete ALND plays a vital role in determining the accurate status of axillary lymph nodes, reducing the risk of local recurrence and guiding the treatment for breast cancer patients. However, once the LAA occurs, the true lateral boundary of ALND might be overlooked and replaced by the LAA. In our study, after thoroughly checking the existence of LAA, we found that the majority of patients harbored a series of lymph nodes (range from 2–14) located lateral to LAA, named LAA's lymph node. All of those lymph nodes were dissected and collected for pathological examination. The results showed that LAA's lymph node has a relatively high metastasis rate, and could act as the only site of metastatic lymph nodes. Hence, LAA's lymph node was an important candidate for metastasis, which should be detected and

dissected during the ALND. However, the metastasis status between LAA's lymph node and the level I, II and III group of axillary lymph node are irrelevant. Taken together, we strongly advised that surgeons should be alert to this muscle variant and the lateral part of LAA should be incorporated into the dissection scope of ALND. Once the LAA's lymph node was verified during the surgery, it must be dissected thoroughly, regardless of the status of other axillary lymph node.

More importantly, different from the classical position of SLN, which is at the medial part of the axilla or alongside the lateral thoracic vein [17,18], we reported some of the LAA's lymph node were also SLN. Among these lymph nodes, one of them was diagnosed as the only metastatic lymph node by postoperative pathology, which has never been reported before. Therefore, the LAA's lymph node was an unconventional but potential candidate for SLN. Besides, the occurrence of this special circumstances indicated that accurate identification of SLN should be based on the result of intraoperative localization, like ICG fluorescence and methylene blue dye, rather than experience. Nevertheless, a larger sample size and multi-center study was required to figure out the incidence of the SLN locating lateral to LAA.

Based on the univariate analysis between tumor characteristics and LAA's lymph node status, the node stage (N stage) is the only independent factor that has statistically significance. Whereas neither clinical parameters nor other pathological markers were associated with it, which prompts us to step up our vigilance during the surgical procedure of ALND. Moreover, variations of origins and insertions of LAA have been reported substantially, and it generally originates from latissimus dorsi, crosses the axillary neurovascular bundle with various insertions [6,19,20]. The majority of LAAs that discovered during the surgeries were also the classic form. In accordance with the study conducted by Besana-Ciani et al. [14], we reported a patient who received bilateral ALND had LAA on both side, which confirmed this variant can be unilateral or bilateral.

5. Conclusions

To our best knowledge, this is the first report to study the prevalence and clinical importance of LAA with a large cohort of breast cancer patients. We demonstrated that LAA is a common anatomical variant with great clinical importance. Moreover, enlarged LAA's lymph nodes were identified in the majority of patients with LAA, which showed a comparatively high metastatic rate. Since the thoroughness of lymph nodes dissection has direct impact on treatment determination and local recurrence risk, precise recognition of LAA and complete dissection of LAA's lymph node during the ALND is essential. In addition, surgeons should pay more attention to this anatomic variant in SLNB, as it could be an unconventional location of sentinel lymph node. Taken together, our study provides a solid data on the clinical importance of LAA, suggesting it should be considered as an indispensable part for breast cancer patients receiving ALND and SLNB.

Ethical approval

All procedures performed in studies involving human participants was approved by Ethics Committee on Scientific Research of Shandong University Qilu Hospital.

Declarations of interest

None.

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References

- [1] R.L. Siegel, K.D. Miller, A. Jemal, Cancer statistics, 2018, *CA A Cancer J. Clin.* 68 (1) (2018) 7–30.
- [2] A. Luini, G. Gatti, B. Ballardini, et al., Development of axillary surgery in breast cancer, *Ann. Oncol.: Off. J. Eur. Soc. Med. Oncol.* 16 (2) (2005) 259–262.
- [3] K. Natsis, K. Vlasis, T. Totlis, et al., Abnormal muscles that may affect axillary lymphadenectomy: surgical anatomy, *Breast Canc. Res. Treat.* 120 (1) (2010) 77–82.
- [4] M. Miguel, M. Llusà, J.C. Ortiz, N. Porta, M. Lorente, V. Gotzens, The axillopectoral muscle (of Langer): report of three cases, *Surg. Radiol. Anat.: SRA* 23 (5) (2001) 341–343.
- [5] A.J. Petrusek, J.L. Semple, D.R. McCready, The surgical and oncologic significance of the axillary arch during axillary lymphadenectomy, *Canadian J. Sur. J. Can. Chir.* 40 (1) (1997) 44–47.
- [6] V. Bonastre, M. Rodríguez-Niedenfuhr, D. Choi, J.R. Sanudo, Coexistence of a pectoralis quartus muscle and an unusual axillary arch: case report and review, *Clin. Anat.* 15 (5) (2002) 366–370.
- [7] M.S. Guy, S.K. Sandhu, J.M. Gowdy, C.C. Cartier, J.H. Adams, MRI of the axillary arch muscle: prevalence, anatomic relations, and potential consequences, *AJR Am. J. Roentgenol.* 196 (1) (2011) W52–W57.
- [8] H.B. Turgut, T. Peker, N. Gulekon, A. Anil, M. Karakose, Axillopectoral muscle (Langer's muscle), *Clin. Anat.* 18 (3) (2005) 220–223.
- [9] H. Ucerler, Z.A. İkiz, Y. Pinan, Clinical importance of the muscular arch of the axilla (axillopectoral muscle, Langer's axillary arch), *Acta Chir. Belg.* 105 (3) (2005) 326–328.
- [10] L. Jeleu, G.P. Georgiev, L. Surchev, Axillary arch in human: common morphology and variety. Definition of "clinical" axillary arch and its classification, *Ann. Anat. = Anat. Anzeiger: Off. Org. Anat. Gesellsch.* 189 (5) (2007) 473–481.
- [11] H. Karanlik, A. Fathalizadeh, B. İlhan, K. Serin, S. Kurul, Axillary arch may affect axillary lymphadenectomy, *Breast Care* 8 (6) (2013) 424–427.
- [12] M.A. Turki, P.J. Addis, Langer's axillary arch: a rare variant, and prevalence among Caucasians, *Folia Morphol.* 76 (3) (2017) 536–539.
- [13] T. Takafuji, J. Igarashi, T. Kanbayashi, et al., [The muscular arch of the axilla and its nerve supply in Japanese adults], *Kaibogaku Zasshi J. Anat.* 66 (6) (1991) 511–523.
- [14] I. Besana-Ciani, M.J. Greenall, Langer's axillary arch: anatomy, embryological features and surgical implications, *Surgeon: J. Roy. Coll. Surg. Edinb. Irel.* 3 (5) (2005) 325–327.
- [15] J.W. Serpell, M. Baum, Significance of 'Langer's axillary arch' in axillary dissection, *Aust. N. Z. J. Surg.* 61 (4) (1991) 310–312.
- [16] T. Dominik, B.M. Henry, M.P. Zarzecki, et al., Prevalence and anatomy of the axillary arch and its implications in surgical practice: a meta-analysis, *Surgeon: J. Roy. Coll. Surg. Edinb. Irel.* 17 (1) (2019) 43–51.
- [17] K.B. Clough, R. Nasr, C. Nos, M. Vieira, C. Inguenault, B. Poulet, New anatomical classification of the axilla with implications for sentinel node biopsy, *Br. J. Surg.* 97 (11) (2010) 1659–1665.
- [18] X. Li, S. Chen, L. Jiang, et al., Precise intraoperative sentinel lymph node biopsies guided by lymphatic drainage in breast cancer, *Oncotarget* 8 (38) (2017) 63064–63072.
- [19] S. Ramanadham, S.G. Kalthur, S.R. Pai, Unilateral axillary arch and variations in the axillary vein and intercostal nerves: a case report, *Malays. J. Med. Sci.: MJMS* 18 (1) (2011) 68–71.
- [20] G. Chene, G. Le Bouedec, J. Dauplat, Arch and sentinel: surgical technique of sentinel node biopsy with the axillopectoral muscle, *Gynecol. Obstet. Fertil.* 35 (1) (2007) 25–29.