



# Langer axillary arch in breast surgery: a narrative review

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**Abstract:** The Langer’s axillary arch (LAA), an anomalous accessory muscle causing potential lymphedema and compression of vessels or nerves, has been long identified and described from cadaveric studies even if the presence of this muscular variation during axillary access in breast surgery plays a key-role in the correct identification of anatomical landmarks both in sentinel lymph node biopsy (SLNB) and in axillary lymph node dissection (ALND). As a consequence, the capability of pre-operatively and intra-operatively techniques to detect the LAA may prevent the surgeon to mistakes in axillary clearance. With the aim to point out about the feasibility of pre-operative techniques to identify the LAA in patients and to analyse the surgical implications from the LAA during axillary access, this narrative review screened the literature reports on clinical significance of LAA in breast surgery. Remarks on SLNB and lymphadenectomy where the positioning, the detectability with different tracers, and the malignancy of lymph nodes (LNs) might become crucial in relation to the LAA were detailed. Then, features taking part of a Decision Support System (DSS) to determine how to handle the surgical approach when LAA is encountered during breast surgery were investigated. Finally, open issues on the opportunity to resect or preserve such accessory muscle outlined the need motivate more research on clinical features of LAA in breast surgery.

**Keywords:** Breast surgery; Langer’s axillary arch (LAA); sentinel lymph node biopsy; axillary dissection; echography

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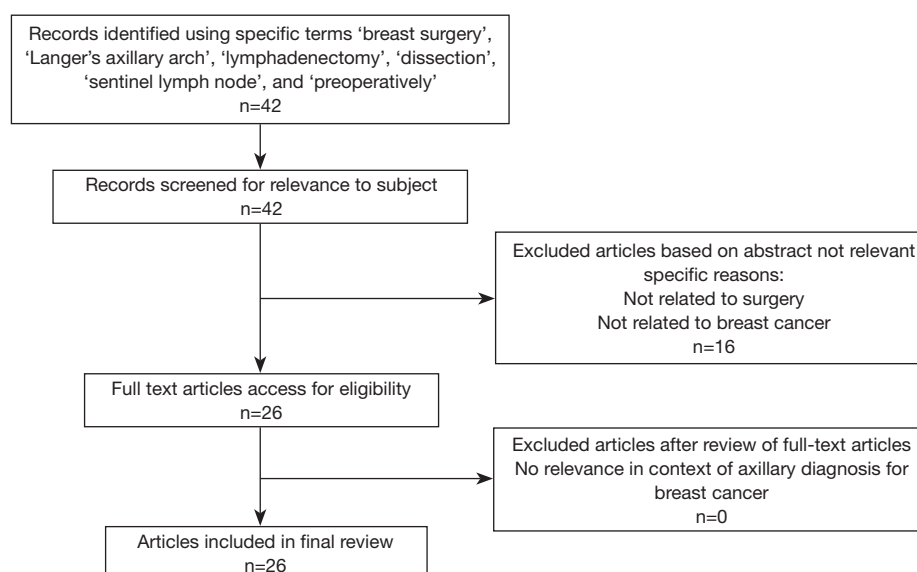
## Introduction

The axillary surgery plays a fundamental role in the treatment of breast cancer, melanoma of the trunk and the upper limb, in the histological diagnosis of lymphoma and in all those cases where it is necessary to remove for diagnostic purposes both lymph nodes (LNs), and axillary masses of unclear nature.

The axillary surgery for breast cancer has further stimulated the interest in Langer’s axillary arch (LAA) that was described as an extensive sheet of skin-associated musculature between the superficial fascia and the subcutaneous fat (1). Initially reported as muscle variation in the axillary fossa by Bugnone in 1783 (2), the “axillary arch” was identified by Ramsay in 1795 (3). However, it was Langer in 1846 who explained the axillary muscle more accurately, being aware of tension lines in the skin which were recognized as potentially related to surgical incisions

(4,5). Variants of LAA with possible structure and position in relation to muscles, nerves, and axillary vessels have been further described (6-9). LAA is usually asymptomatic, but it could be implicated in the syndrome of costoclavicular compression and of hyper abduction, thoracic outlet and shoulder instability, as like as in the entrapment of the median nerve; further it can present with upper limb deep vein thrombosis or venous congestive symptoms (10,11).

Several data about morphological terminology and frequency of LAA can be obtained from the study by Jelev *et al.* (6) along with the clinical significance of axillary arch which presents some peculiar features to be taken into account during procedures of axillary surgery. Despite this, a recent meta-analysis (12) outlined that the majority of studies have been conducted on cadavers. Consequently, the possibility to calculate the total prevalence of the atypical muscles in the general population comes from cadaveric studies (13), more than from surgical axillary procedures (12).



**Figure 1** Diagram, modified from PRISMA chart, detailing identification of studies included in narrative review. PRISMA, Preferred Reporting Items for Systematic Review and Meta-Analysis.

The occurrence of LAA is at 7–8%, varying frequencies from 0.25–43.8% depending on the population studied. Probably on account of most of the axillary surgery applied to women, the reported occurrence of the LAA is major on female than male patients, bilateral or unilateral as well (3,6,8,14).

Although intraoperative recognition of muscle variations in a given anatomical region does not necessarily reflect its surgical significance (9), the failure to report or to identify the accessory muscles of the axilla undoubtedly affects their clinical significance so that even experienced breast or thoracic surgeons are expected to deliver a detailed knowledge of the axilla (8,9,15–18).

Therefore, this review seeks to explore the literature on LAA in breast surgery along with features of the Decision Support System (DSS) used by surgeons (15) to identify whether the LAA might be preserved or resected. We present the following article in accordance with the Narrative review reporting checklist (available at <http://dx.doi.org/10.21037/abs-20-115>).

## Methods

### Search strategy

The major electronic database (PubMed, Web of Science, and Scopus) were thoroughly searched for studies on 'breast surgery', 'Langer's axillary arch', 'lymphadenectomy',

'dissection', 'sentinel lymph node', and 'preoperatively'. Following acquisition of the full texts, other potentially eligible articles that could have been missing in the electronic databases' search were screened with a reference search. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines (19) was applied in scrutinising references of relevant articles for pertinent studies. Articles which did not identify the LAA in breast surgery were excluded. The search was carried out in August 2020 with no prior time limit set for inclusion of data as well as inclusion of every original language of publication.

### Study endpoints

The primary endpoint was finding the capability of pre-operatively and intra-operatively techniques to detect the LAA in breast surgery. The secondary endpoint included surgeon DSS while encountering LAA during axillary access and examining features associated with the arch.

## Results

### Literature search

There was a total of 42 potential citations from the initial database search (*Figure 1*). Amongst these, articles discussed only axillary dissection in cadavers and anatomical studies

**Table 1** Number of detected LAAs and related treatment during SLNB and ALND in 17 studies with breast surgeries selected in this review

| Ref. | Study (year)                         | Procedure                                                  | Number of LAAs | Treatment of LAA                |
|------|--------------------------------------|------------------------------------------------------------|----------------|---------------------------------|
| (8)  | Kutiyanawala <i>et al.</i> (1998)    | ALND                                                       | 6              | Resection                       |
| (14) | Suzuma <i>et al.</i> (2003)          | SLNB with indigo carmine                                   | 1              | Resection during secondary ALND |
| (15) | Rassu (2020)                         | SLNB with TcLC and ICG and ALND                            | 10             | 8 preserved, 2 resected         |
| (16) | Ridgway <i>et al.</i> (2011)         | SLNB with technetium and blue dye                          | 1              | Resection during secondary ALND |
| (17) | Upasna <i>et al.</i> (2015)          | ALND                                                       | 2              | Resection                       |
| (18) | Daniels & Querci della Rovere (2000) | ALND                                                       | 1              | Resection                       |
| (20) | Karanlik <i>et al.</i> (2013)        | ALND                                                       | 9              | 7 preserved, 2 resected         |
| (21) | Ando <i>et al.</i> (2010)            | SLNB with indigo carmine                                   | 59             | Not reported                    |
| (22) | Keshtgar <i>et al.</i> (1999)        | SLNB with radioisotope colloid                             | 2              | Resection during secondary ALND |
| (23) | Abudhaise <i>et al.</i> (2019)       | SLNB                                                       | 8              | Not reported                    |
| (24) | Sang <i>et al.</i> (2019)            | SLNB with methylene blue and ICG                           | 132            | Resection during secondary ALND |
| (25) | Chêne <i>et al.</i> (2007)           | SLNB with radioisotope colloid                             | 5              | Resection during secondary ALND |
| (26) | Smart <i>et al.</i> (2005)           | SLNB with technetium antimony sulphide and patent blue dye | 1              | Resection                       |
| (27) | Ku <i>et al.</i> (2008)              | ALND                                                       | 1              | Resection                       |
| (28) | Petrasek <i>et al.</i> (1997)        | ALND                                                       | 1              | Preservation                    |
| (29) | Lamichhane <i>et al.</i> (2017)      | ALND                                                       | 1              | Preservation                    |
| (30) | Al Maksoud <i>et al.</i> (2015)      | ALND                                                       | 1              | Preservation                    |

LAA, Langer's axillary arch; SLNB, sentinel lymph node biopsy; ALND, axillary lymph node dissection; TcLC, 99mTc-labeled nanocolloid; ICG, indocyanine green.

on LAA along with studies examining LAA in other surgery than the ones for breast cancer were excluded. In total, 26 articles discussing relevant issues pertaining to LAA in breast surgery were included in this review. LAA occurrence during breast surgery either in sentinel lymph node biopsy (SLNB) or in axillary lymph node dissection (ALND) along with LAA treatment is described in 17 studies (*Table 1*). Other four papers evaluated the preoperative investigation of the axillary arch, whilst the remaining five articles described implications of LAA in breast surgical procedures like SLNB and ALND. Due to the few studies concerning breast surgery and management of LAA in clinical setting, a narrative review was performed.

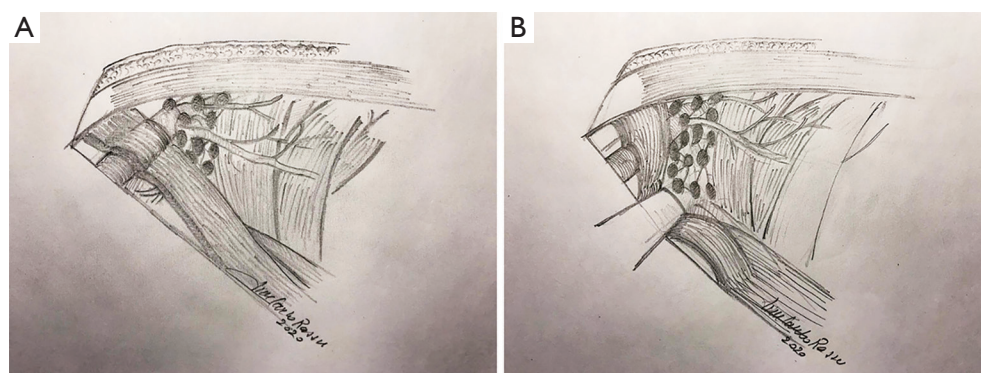
## Discussion

### Preoperatively diagnosis of LAA

Preoperative diagnosis of the axillary arch supplies pieces of

information for intraoperative navigation of SLNB, even if it appears to be difficult as this muscular variation crosses in front of the great axillary vessels and the first intercostal brachial nerve. Since LAA may hide the LNs of the first level of Berg (*Figure 2*), it can be confused with enlarged LNs or soft tissues tumours (8,9,20,21). Intermittent compression of the axillary vein or hyperabduction syndrome could be indicative for LAA presence (10,11,18).

Sometimes, the arch could be easily visible at clinic judgment (*Figure 3*). Imaging analysis, as like as mammography, echography, computed tomography (CT) and magnetic resonance imaging (MRI) have demonstrated to detect the presence of the axillary arch only in few clinical reports (22,31-35). Ko *et al.* (32) detailed on the capability of mammography to get imagines about a band-like structure overlapped with pectoralis muscle which they revealed to be the axillary arch. Keshtgar *et al.* reported that the LAA is fully stretched during imaging, so that



**Figure 2** Displacement of the LAA muscular structure in the axilla. (A) The LAA appears as a ventral extension of the anterior margin of the latissimus dorsi; (B) the LAA is displaced laterally to allow the complete view of the surgical field. LAA, Langer's axillary arch.



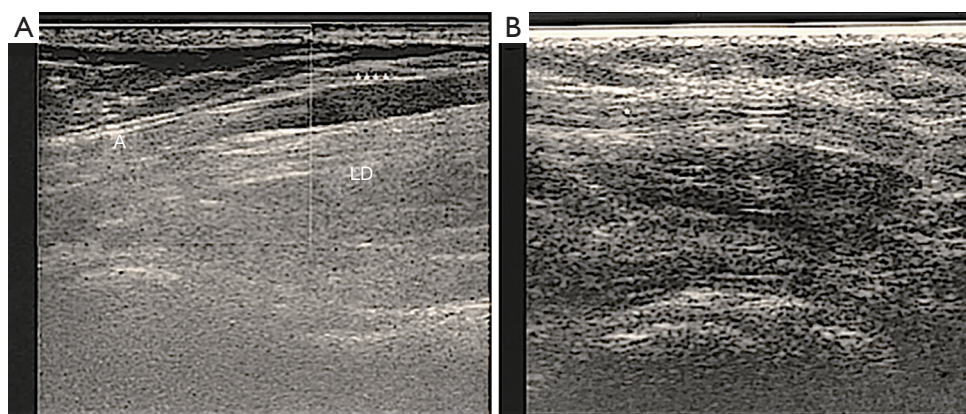
**Figure 3** Occurrence of LAA at clinical examination in two patients (own data). LAA, Langer's axillary arch.

the echography scanning was misleading in showing the location of the SLN (22). Indeed, echography examination could be more easily provided after surgery as an attempt to assess if a mass due to LAA could be resolved in patients where LAA is preserved (*Figure 4*). Anyway, at ultrasonography inspection, the muscular arch seemed to appear as a grey oval structure (15).

Multidetector row CT (MDCT) and MRI may allow at obtaining LAA recognition preoperatively (14,21,31). Rajakulasingam & Saifuddin reported MRI images with two slips of muscle arising from the anterior margin of the left latissimus dorsi muscle (33). The thicker slip crosses antero-inferior to the axillary neurovascular bundle without any compression or displacement. Guy *et al.* characterized at first the prevalence, anatomic relations, possible LN concealment, and potential neurovascular impingement of the axillary arch muscle in an extensive review of shoulder MRI data (34). They reported that the LAA was detected or excluded best on oblique coronal

images more with fast spin-echo T2-weighted images than on spin-echo T1-weighted images thanks to the signal intensity contrast between LAA and fat. For a preoperative diagnosis with MRI, Suzuma *et al.* described the anatomical site of LAA takes origin at the anterior edge of the latissimus dorsi in the middle of the posterior fold of the axilla and tapering to a narrow tendon which was inserted into the posterior aspect of the trilaminar tendon of the pectoralis major (14).

Hong *et al.* presented the submission to MDCT of a case with a palpable, non-tender mass in left axilla with complains of intermittent ulnar numbness in left arm to forearm, aggravated with hyperabduction and relieved with adduction of the arm. The MDCT was able to discriminate between right and left axilla where a nodular elongated soft tissue structure was detected (35). With the same imaging technique, Ando *et al.* reported not significant different numbers of MDCT-LNs and failure rates of SLN identification between patients with or without the LAA (21).



**Figure 4** Tentative detection of LAA with echography after axillary surgery. (A) Right LAA in a patient submitted to SLNB with TcLC and to secondary ALND (own data); (B) left LAA in a patient submitted to SLNB with ICG (own data). A and \*\*\* = arch. LAA, Langer's axillary arch; SLNB, sentinel lymph node biopsy; TcLC,  $^{99m}\text{Tc}$ -labeled nanocolloid; ALND, axillary lymph node dissection; ICG, indocyanine green; LD, latissimus dorsi.

### LAA in SLNB

The presence of LAA might affect the SLNB. Keshtgar *et al.* reported that the SLN localization was extremely easy when the node was lying over the arch, whilst if the SLN was underneath LAA the node detection was more difficult (22). Ando *et al.* detailed the anatomical localization of LNs with respect to the common position of a SLN in a group of 56 patients with a diagnosis of axillary arch and SLNs identification (21). In some cases, SLNs were located in more lateral and superficial axillary positions, in others they were allocated in more cranial positions or in more dorsal positions or below anomalous muscles of the axilla. Examining eight patients over 3 years, Abudhaise *et al.* found sentinel LNs laterally to the LAA in the sub-pectoral region and associated with stretching of the efferent lymphatic vessels (23).

Few pieces of information are currently available in literature (Table 1) on the most useful tracers to be used during axillary access to avoid mistakes due to LAA. Inadequate clearance of Level 1 nodes due to them being partially covered by the arch (Figure 2A) could lead relatively inexperienced surgeons to a level above the axillary vein, with an increased risk of lymphedema of the arm postoperatively. Besides, as the LAA could act as a potential site of metastatic LNs (24) accurate identification by means of intraoperative localization with standardised techniques and performing tracers is strongly advised (15,16,24).

Ridgway *et al.* reported that percutaneous radioisotope

counts are commonly maximal at the inferior edge of the axillary hairline just posterior to the pectoralis muscle in usual SLNB (16). In their experience, the maximal counts were more cranial and lateral than the common location of the sentinel nodes when LAA occurred. Further, they found no difficulty in finding LNs under an arch when radioisotope was used, even if an arch could conceal the nodes when blue dye was applied. In his paper investigating SLNB with  $^{99m}\text{Tc}$ -labeled nanocolloid (TcLC) and indocyanine green (ICG) as tracers, Rassu (15) outlined that in the patient group with only SLNB, a mean number of  $2.42 (\pm 1.76)$  and  $2.42 (\pm 1.83)$  LNs per patient were harvested with TcLC and ICG, respectively. Similarly, the metastatic LNs were not significantly different:  $0.08 (\pm 0.34)$  with TcLC and  $0.14 (\pm 0.55)$  with ICG (15) so to corroborate the ability of radioisotope colloids “technetium-based” to provide accuracy in collecting LNs even in presence of anomalous muscular structure in the axilla (16,22,25).

The ICG tracer was evaluated along with methylene blue only in another study to identify LNs when masked by LAA (24). Literature reports evidence that SLNB using the fluorescent dye ICG allows at detecting LNs non-invasively with high accuracy and sensitivity (36). Indeed, Rassu outlined the meaningful advantage recorded applying the ICG tracer to map lymphatic vessels in order to minimize the confounding factor given by the anatomical limits of the operative field in case of Langer's anatomical variation (15).

### **LAA in lymphadenectomy**

The surgeon awareness of the anatomical variations that may appear in a specific axillary region is the leading factor for their intraoperative recognition along with their main anatomical features (9). During lymphadenectomy in LAA's patients, Rassu outlined the axillary location that contains the vast majority of the LNs as almost fully covered by the arch (15): thus, amplifies the recurrence risk from undissected axillopectoral muscles harbouring positive nodes. Indeed, a very recent work confirmed that LAA's LN has a relatively high metastasis rate (24), but the same research did not provide any comparison between LN status of patients with and without LAA as it was provided previously by Smart *et al.* (26) and more recently by Rassu (15) who observed no metastatic LNs in LAA patients even in secondary ALND.

In their systematic review of medical literature published between 1996 and 1999, Babu & Khashaba concluded that LAA should be recognized in axillary dissection to avoid confusion in staging of LNs and to prevent injury to axillary vessels and brachial plexus (37). The LAA might restrict axillary access during ALND as it is tautened by abduction and elevation of the arm: thus, allowing free mobility and relaxation of the muscle is therefore advocated (26).

## **Conclusions**

### **LAA and features of the decision supporting system in breast surgery**

The presence of the LAA muscular structure on the lateral side of the surgical field may be mistakenly confused with the latissimus dorsi muscle (*Figure 2A*). In this situation, the band that adheres to the medial edge of the muscle could not be recognized and the dissection might be continued along in a wrong plan too cranial than the axillary vein. As a consequence, the cords of the brachial plexus would be exposed to the risk to be injured with impairment of breast reconstruction (1,8,14,18,20,26) even after a radical mastectomy (27).

On the other hand, the LAA may complicate procedures as the SLNB and the lymphadenectomy giving risks as like as suboptimal staging and limited regional control of disease (1,16,17,20-22,24,26).

Accordingly, in order to get an optimal axillary clearance, research commonly suggests the cutting of this anomalous axillary muscle (*Table 1*). In detail, authors who support such a decision consider performing the LAA resection

because of the recurrence risk to undissected axillopectoral muscles harbouring positive nodes is larger in magnitude (14,24). With a procedure of LAA division, as illustrated in *Figure 2B*, Ku *et al.* obtained a complete dissection of the medial and lateral axillary group with no evidence of axillary recurrence, lymphedema or any limitation of motion of the right arm after 2-year follow-up (27).

Another reason for muscle resection is based on the association of LAA with neurovascular compression leading to postoperative upper limb lymphedema and thoracic outlet syndrome with compression particularly noted during abduction or external rotation of the arm (18,20,25).

On the other hand, especially whether the LAA does not reveal to be problematic for the patient in order to permit later reconstructive surgery (1,8,14,18,20,26) the preservation of the neurovascular elements should continuously be taken into consideration by the surgeon (15). Gentle dissection of tissues with a reluctance to divide any horizontally lying veins should allow this anomaly to be identified and prevent inadvertent damage (8,38). This suggested to preserve the arch in certain LAA patients in line with the "SLNB era" advocated by Veronesi *et al.* (39). In two studies (15,20), the LAA was kept (*Table 1*). Indeed, in a mean 23 months follow-up carried out by Petrasek *et al.* there were no known complications related to the axillary arch, such as lymphedema, brachial plexus injury, axillary vein injury or thrombosis (28). The same uneventful procedure was provided by Lamichhane *et al.* (29) and Al Maksoud *et al.* (30) who were able to dissect nodes beneath the arch without the need to divide it.

Thus, breast surgeon's awareness of the possible complications of an axillary arch muscle, the understanding of any functional deficit from it, along with their clinical judgment targeted for each patient may continue to stimulate the debate on the preservation or the cutting of axillary arches. Karanlik *et al.* and Rassu asserted their clinical judgment in a DSS to determine how to identify LAA, to question whether the axillary arch could be perceived as potentially problematic for the patient, and to handle results to the final decision (15,20). Such DSS approach, based on multiple variables, could motivate more research on clinical features of LAA in breast surgery where also patient age and status should be taken into account.

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## Footnote

**Reporting Checklist:** The author has completed the Narrative review reporting checklist. Available at <http://dx.doi.org/10.21037/abs-20-115>

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**Ethical Statement:** The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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