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Surgical Research

Langer's Axillary Arch: A Frequently Missed Axillary Anomaly That Can Alter the Outcome of Breast Cancer Management- Case Series

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ABSTRACT

The axillopectoral muscle known as Langer's axillary arch (LAA), is considered the most common anatomical variation of the axilla. The muscular fibers typically originate from latissimus dorsi (LD) muscle, crossing over the axillary neurovascular bundle to insert deep to the insertion of pectoralis major muscle. Although it is frequently missed, surgeons must be attentive to its existence during axillary surgery or LD flap breast reconstruction. LAA fibers should be excised to expose the axillary nodes, vessels and nerves. Failure to identify this anomaly can jeopardize the LD flap vascularity, and can reduce the accuracy of retrieving sentinel lymph nodes, increase the false negative rate, and result in under staging and/or under treatment of the axilla in breast cancer patients. Consequently, altering the decision for adjuvant treatment like chemotherapy or radiation therapy, which would affect the patient's survival outcome.

In the present series, we report 7 cases of the LAA, and describe the surgical findings during axillary surgery for each case, paying special attention to the tips to identifying LAA, its different subtypes, and its clinical implication in breast cancer patients, and summarize existing literature.

Keywords

Langer's axillary arch, Axillopectoral muscle, Difficult axillary surgery, Sentinel lymph node biopsy, Axillary lymph node dissection, Breast cancer.

Introduction

The axilla is bounded by 4 muscles: the pectoralis major and minor medially, the serratus anterior inferio-medially and the latismus dorsai inferio-laterally. Whereas the axillary vein compromises the superior boundary of the axilla (Figure 1a) [1]. The axilla, along with its contents, is covered by a fibrous roof called the clavipectoral fascia, through which the lymphatic channels pass into the axilla to reach to the lymph nodes. During axillary dissection, two important structures must be identified and preserved: the long thoracic nerve (or Bell's nerve), which runs craniocaudally on the medial wall over the serratus anterior, and the neurovascular bundle to the latissimus dorsi, which runs craniocaudally on the posterior wall over the latissimus dorsi. (Figure 1b) [1]. This vascular bundle is particularly important as it is the pedicle on which the latissimus dorsi myocutaneous flap (LD flap) is based on during LD-breast reconstruction technique. Clinically not all muscular anomalies are important for axillary surgery, especially for ALND. From the topographical point of view, only the muscular bands that pass through the axilla or change the boundaries of the surgical field may affect axillary dissection. During axillary surgery, it is crucial for surgeons to pay continuous attention to the anatomical variations of the axilla due to their clinical importance. One of the well-known muscular anatomical variations in the axillary region is Langer's axillary arch (LAA), which is also known as axillopectoral muscle, pectodorsal muscle or arcus axillaris [1-3]. The axillary arch is a group of muscular fibers which forms of a thin muscular slip that extends between the *latissimus dorsi* (*LD)*

muscle and the *pectoralis major* muscle [4,5]. Such variation was encountered in 7% of the population [6]. It is key for surgeons to recognize LAA as an anatomical variation of the axillary region. It may enclose numerous neurovascular structures and lymph node continuing between the neck and the upper limb. The abnormal muscle fibers may cause obstruction of vessels and nerves within the axilla region [4]. Langer's axillary arch is usually asymptomatic and difficult to detect preoperatively. However, when present, it is clinically important for surgeons performing axillary surgery to recognize it immediately, especially during axillary surgery for breast cancer to ensure complete oncological procedure, and during breast reconstruction using the LD myocutaneous flap because of its close relationship to the neurovascular variations.

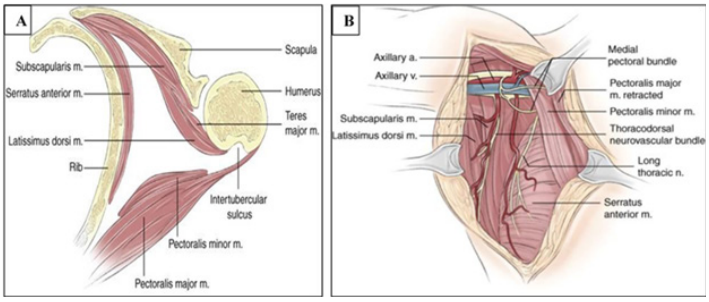

Figure 1: A; boundaries of the axilla, B; vital structures in the axilla.

Case Report

Our series includes 7 cases of LAA observed by a single breast surgeon between September 2018 and February 2020. All reported cases were female patients diagnosed with invasive breast cancer and underwent axillary surgery, either sentinel lymph node biopsy (SLNB), axillary lymph node dissection (ALND), or both. The basic diagnostic workup included mammogram, breast and axillary ultrasound, and tru-cut biopsy of the breast mass and the suspicious axillary lymph node, if any. Metastatic workup was indicated in 6 out of the 7 patients and included computed tomography (CT) scan of the chest, abdomen and pelvis and whole-body bone scan. Breast MRI was performed in only 3 patients due to the presence of either ILC, BRCA mutation with dense breast tissue, or suspicion of multi-centric disease that was not confirmed by mammogram and ultrasound. The clinicopathological characteristics are described in (Table 1). Age at diagnosis ranged between 32 and 64 years. Six patients were diagnosed with invasive ductal carcinoma and most had a luminal B subtype. Three patients presented with a node positive (N1) disease. One patient had an oligo bone metastasis and was treated with curative intent. All performed CT and MRI scans did not report the presence of the LAA preoperatively. No axillary abnormality like pulsation, swelling or a mass was appreciated on physical examination. All patients were discussed in the breast multidisciplinary tumor board (MDT). The two patients with triple negative and Her2Neu positive breast cancer received neoadjuvant chemotherapy. The remaining 5 patients underwent up front surgery. Surgical procedures included mastectomy for patients with multi-centric disease, or BRCA mutation, and Breast conserving surgery (BCS) for patients with unifocal disease. Sentinel lymph node biopsy or axillary lymph node dissection was performed for patients with clinically negative or clinically positive axillary disease, respectively. The surgical and adjuvant treatment data of all seven cases are summarized in (Table 1). The details of the surgical finding are described for each case separately.

Intraoperative Surgical Findings

As described earlier, LAA is a group of muscle fibers extending between the *LD* and the *pectoralis* muscles. The number of fibers and their relation to each other, as well as the site of insertion may vary with different types of the LAA anomaly. However, they all share the same origin from the LD muscle, which makes it easier to recognize them if the surgeon has the knowledge and the anticipation in advance. Below, we describe the surgical finding in each reported care, including the type of LAA anomaly identified. In the discussion we elaborate on the implication and the potential complication in each case.

Case 1

Procedure: mastectomy with SLNB followed by ALND.

Surgical details: SLNB was performed using dual techniques, methylene blue and indocyanine green (ICG). five SLNs were identified. All were negative on frozen section. During mastectomy, dissection of the axillary tail of the breast revealed a slip of the LD muscle that crossed over anterior to the axillary vein before joining the pectoralis major muscle fibers and inserting into the humerus. This muscle was occluding the access to the superior (cephalic) part of the axilla. It was recognized as a Langer's arch anomaly and was excised to gain better exposure. Two additional SLNs were found behind the LAA fibers in the apex of the axilla.

Table 1: Clinico-pathological staging, surgical and adjuvant treatment data for all 7 cases.

Case	Clinical Stage	Cancer Type	Procedure	Pathological Stage	Adjuvant treatment
1	T2N0M0	IDC, Luminal B	Mastectomy +SLNB +ALND	pT2 pN1a	CT, XRT, HT
2	T2N1M0	IDC, Luminal B	MRM	pT2 pN3a	CT, XRT, HT
3	T1N0M0	IDC, Luminal B	BCS +SLNB	pT1N0	XRT, HT
4	T2N1M1	IDC, Luminal B	BCS +ALND	pT2N3a	CT, XRT, HT
5	T4aN1M0	IDC, HR negative, Her2 positive	BCS +ALND	ypT1bN1a	NACT, Herceptin, XRT
6	T2N0M0	IDC, Triple negative	Mastectomy+ SLNB	ypT0N0	NACT
7	T2N0M0	ILC, Luminal B	Mastectomy+ SLNB	pT2N0	HT

IDC: Invasive ductal carcinoma, ILC: Invasive lobular carcinoma, HR: Hormone receptor, MRM: Modified radical mastectomy, BCS: Breast conserving surgery, SLNB: Sentinel lymph node biopsy, ALND: Axillary lymph node dissection, CT: Chemotherapy, XRT: Radiation therapy, HT: Hormonal therapy, NACT: Neo adjuvant chemotherapy.

both were positive for macrometastasis on frozen section. Axillary dissection was performed.

Case 2

Procedure: modified radical mastectomy.

Surgical details: During the axillary surgery, difficult dissection was encountered at level I lymph nodes, secondary to adhesions and fibrous bands crossing the axilla and precluding the identification of axillary vein. The presence of LAA anomaly was recognized, with the muscle fibers crossing from LD towards the apex of the axilla, then splitting into anterior and posterior fibers to encase the axillary vein (Figure 2). Transection of anterior fibers, then complete excision of the Langer's Arch was done in order to properly expose the axillary vein and other vital structures, and to safely perform Level I and II axillary dissection. The total number of positive lymph nodes identified on final pathology was (30/34). An axillary arch anomaly in the left axilla could not be appreciated on CT or MRI neither preoperatively nor in retrospective review of images.

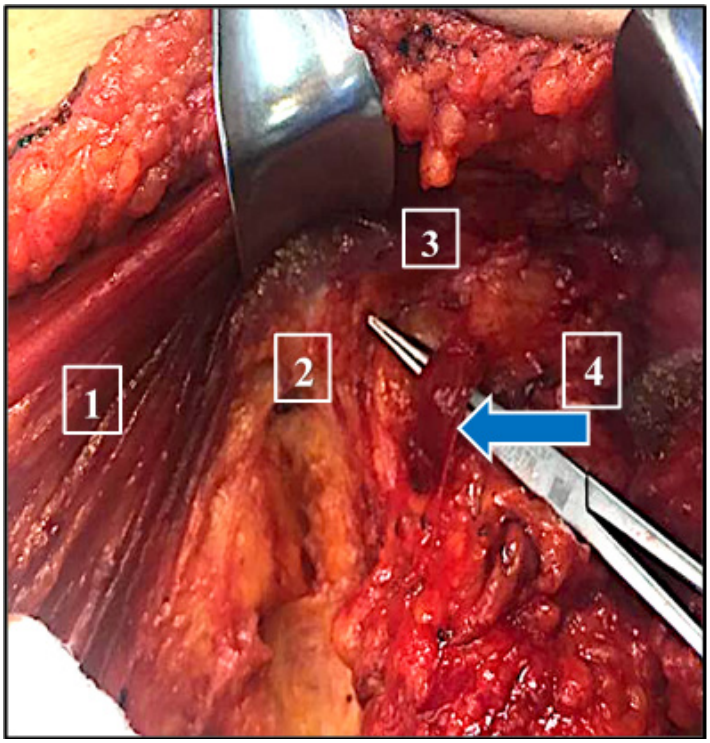

Figure 2: Case 2, Left axilla; 1. Pectoralis major muscle; 2. clavicopectoral fascia; 3. Axillary vein; 4. Latissimus dorsi muscle; Arrow: Langer's axillary arch.

Case 3

Procedure: wire localization breast conserving surgery and SLNB.

Surgical Details: Difficulty was encountered during the SLNB procedure performed through a small axillary incision; although the clavipectoral fascia was opened, no lymph nodes were identified during initial dissection. A thin layer of muscular fibers was identified in the field, that was traced coming from the LD and going towards the upper angle of the axilla. The LAA anomaly was recognized (Figure 3), and found to have divided the axilla into a superficial and deep compartments. The LAA carried the initial dissection into the superficial plane, obscuring the lymph nodes in the deeper compartment. Once the arch was dissected and incised, three blue nodes were easily identified underneath. All nodes were negative for malignancy by frozen section.

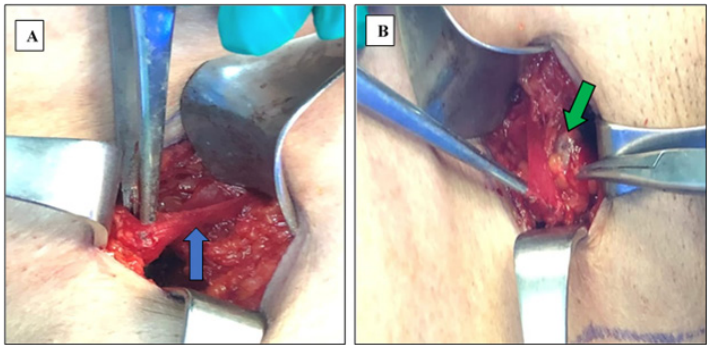

Figure 3: Case 3, Left axilla; 3A: arch fibers (blue arrow) identified through the small SLNB incision 3B: blue node (green arrow) retrieved from deeper compartment, that was covered by the arch fibers.

Retrospective review of CT images reveled the faint fibers of the Langer's arch that were better visualized by constructed images, (Figure 4). The fibers originating from the LD were running superior-medially, splitting half way into posterior (deep) band inserting into pectoralis minor muscle, and anterior (superficial) band inserting into pectoralis major muscle. During our initial dissection, the superficial band was excised with the clavipectoral fascia and the search for the SLN was going on above the deep band that was covering the deep portion of the axilla along with the SLNs.

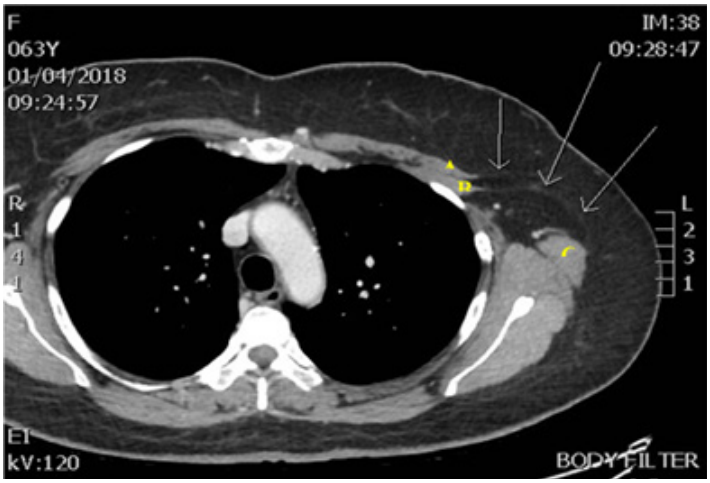

Figure 4: Case 3, Constructed images by CT scan of the left axilla; A; Pectoralis major muscle, B; Pectoralis minor muscle, C; Latissimus dorsi muscle, Arrows; muscular fibers of the Langer's arch.

Case 4

Procedure: Breast conserving surgery with ALND.

Surgical details: During axillary dissection LAA was identified at the roof of axilla just below the clavipectoral fascia, it was incised instantly to expose the axillary fat and vital structures. ALND for

level I & II went smoothly afterwards. Final pathology showed 9 out of 30 positive lymph nodes.

Case 5

Procedure: Post Neoadjuvant chemotherapy- Ultrasound guided BCS with ALND.

Surgical details: During Axillary dissection an LAA anomaly was recognized at the superior part of the axilla, with its fibers inserting into the pectoralis minor muscle, which was blocking the access to level II axillary lymph nodes, The LAA was excised to gain better exposure, and dissection of the axilla was completed. The final histopathology showed 1 out of 32 positive lymph nodes.

Case 6

Procedure: Mastectomy and SLNB.

Surgical details: The SLNB procedure was done first through an axillary incision. The clavico-pectoral fascia was incised. Langer's arch was identified deep to the fascia at the roof of the axilla. It was easily retracted, and 2 sentinel lymph nodes were identified deep to its fibers. Frozen section showed 2 lymph nodes negative for metastasis.

Case 7

Procedure: Mastectomy and SLNB.

Surgical details: After mastectomy, SLNB procedure was performed through the mastectomy incision. The fibers of the Langer's arch were identified at the border of the pectoralis major muscle, coming from the LD in one band covering the level 1 axillary contents. After incising the LAA band, 4 lymph nodes were Identified and sent for permanent pathology. Final result showed all 4 nodes negative for metastasis.

Discussion

Langer's axillary arch is an asymptomatic anomaly that is challenging to identify preoperatively and is frequently missed intraoperatively.

The presence of the axillary arch was first known to anatomists, and, subsequently, by many surgeons who emphasized its implication in axillary surgery. Anatomically, the axillary arch can be found in 7-12% of population. However, its recognition is challenging where it was reported in only 0.25% during axillary surgical procedures [2-6]. This difference between surgical and anatomical incidence suggests a problem of either reporting or recognizing Langer's axillary arch during surgery. axillary arch muscle originates from *panniculus carnosus*, which is an embryological remnant of a more extensive sheet of skin. *Panniculus carnosus* in humans is only evident as muscular structure such as *platysma* and *dartos*. Its embryological association with the brachial plexus is suggested throughout the literature [8-11].

According to Testu's classification (1884), a complete axillary arch extended between the *latissimus dorsi* and the tendon of the *pectoralis major* at its insertion on the *humerus*; the incomplete axillary arch extends from the *latissimus dorsi* to be inserted in the axillary fascia, *biceps brachii* muscle, *coracobrachialis* muscle, the inferior edge of *pectoralis minor* muscle or *coracoid* process [12-16]. All the patients we have reported had a complete axillary arch, except patient number 5 who had the fibers of LAA inserting into the pectoralis minor muscle.

A typical axillary arch in the literature was described by crossing over the neurovascular bundle of the axilla and was characterized by three main descriptions: it has a constant origin from the *latissimus dorsi* muscle and inserts into structures around the anterosuperior part of the *humerus*. The axillary arch always crosses the axillary neurovascular bundle from ventrolateral to dorsomedial [3-5].

Although LAA is usually asymptomatic, it can occasionally be palpable, and it can be confused with enlarged lymph nodes or soft tissue tumors. This muscular arch may cause intermittent compression of the axillary vein. It has also been reported to cause lymphatic compression with venous thrombosis or lymphedema, or thoracic outlet obstruction and shoulder instability syndrome [17-20]. However, the most important fact about this axillary anomaly is its associated with neurovascular structures which has clinical significance during axillary surgery. The presence of LAA may limit access to the lower lateral group of Level I axillary lymph nodes, thus resulting in an incomplete axillary clearance. This obviously has serious implications for accurate staging of the nodal disease, indications of adjuvant treatment, and local recurrence. Moreover, LAA could be falsely regarded as the lateral border of the ALND which normally is the anterior margin of the latissimus dorsi muscle resulting to lead the surgeon one level above the axillary vein with the associated risk of injuring the neurovascular bundle of the axilla.

In the setting of axillary or breast reconstructive surgery, using a flap from the latissimus dorsi may cause technical difficulties while dissecting the neurovascular structures secondary to the course of the muscle [21]. 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.

As we described in the first case, the Langer's arch was not recognized initially through the small SLNB incision. And despite the use of dual techniques and retrieving five SLNs, we still missed the positive lymph nodes in the lateral group that was covered by the axillary arch. It was only during dissection of the axillary tail of the breast as part of mastectomy, that the arch was recognized and excised, along with the lateral group of 8 lymph nodes that harbored macroscopic metastasis in two of them. If this patient was having a breast conserving surgery instead of mastectomy, those metastatic lymph nodes would have been missed, leading to under staging the axillary disease to pN0 instead of pN1. This would have resulted in different recommendation for adjuvant treatment, particularly radiation therapy. The proper surgical staging of the axilla is fundamental in tailoring adjuvant radiation therapy. The

recently published meta-analysis by Early Breast Cancer Trialists Collaborative Group (EBCTCG), that included 13,000 women in 14 different trials, confirmed that nodal radiotherapy reduced breast cancer recurrence (RR=0.86, 95% CI: 0.79–0.94, *P*=0.0006), breast cancer mortality (RR=0.81, 0.74–0.90, $P < 0.0001$) and overall mortality (RR=0.86, 0.80–0.93, *P*=0.0002) [22]. Consequently, breast surgeon should scrutinize on identifying Langer's arch during axillary surgery.

The preoperative recognition of this variant by radiologists can prevent unnecessary intervention to the axilla, and guide breast, plastic and vascular surgeons during axillary surgery, to avoid difficult dissection and reduce operative complications. Although Langer's arch is usually occult in standard imaging and cannot be identified preoperatively unless the axillary arch is big enough, magnetic resonance imaging (MRI) can be a helpful tool to diagnose its presence [18]. It can detect the presence of the axillary arch, especially with neurovascular entrapment symptoms. If identified preoperatively, it can also assess its anatomical relations to surrounding structures while planning for an axillary lymph node dissection. Unfortunately, this anomaly was not identifiable preoperatively in our patients, not even with MRI, likely due to the small size of the muscular bundle. The presence of the arch created a difficulty in identifying the SLNs and in performing proper ALND. This has resulted in prolonged operative time. Although there was no injury to vital structures, preoperative recognition of the anomaly would have prepared the surgeon and saved time and efforts. A prospective study by Chene et al., reported that sentinel node biopsy dissection was difficult in about 40% of patients with LAA anomaly. And the sentinel lymph nodes were found just near or behind the LAA muscle fibers. As the experience builds up, there was a short learning curve observed in our experience. After the first 3 cases, the recognition and identification of the LAA fibers became faster due to the knowledge and the anticipation the surgeon had in mind for such an anatomical variation.

Conclusion

Langer's axillary arch is the most frequent, yet frequently missed asymptomatic anomaly in the axilla. Simple division or excision is crucial for complete exposure of the axillary contents. Failure to recognize this anomaly by the operating surgeon may result in incomplete axillary treatment and inaccurate axillary staging in patients with breast cancer, misleading the decision making for adjuvant treatment, and affecting the rates of local recurrence, and overall survival.

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