European Journal of Radiology 113 (2019) 66–73

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Review

Review of axillary web syndrome: What the radiologist should know

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ARTICLE INFO

Keywords:
Axillary web syndrome
Axillary cording
Lymphatic cording
Axillary lymph node dissection
Sentinel lymph node biopsy
Axillary ultrasound

ABSTRACT

Axillary web syndrome is common after axillary surgery, frequently affecting breast cancer patients. In this condition, patients develop one or more linear bands of firm tissue, also known as “cords”, in the axilla and arm, associated with pain and limited range of motion of the shoulder and arm. Radiologists may encounter this syndrome in patients referred for axillary or upper extremity ultrasound, and should be aware of the physical examination and ultrasound findings for accurate diagnosis. However, there are currently limited articles about this syndrome published in radiology journals, suggesting that radiologists may be unaware of this entity. In this work, axillary web syndrome will be discussed, including background knowledge, incidence, clinical presentation, possible etiology, and ultrasound appearance.

1. Purpose

Axillary web syndrome, also known as cording or axillary cording, is a clinical entity affecting the soft tissues of the axilla and arm. Although well known to many of our clinical colleagues in surgery, oncology, radiation therapy and physical therapy, information in the radiology literature has been limited. Most articles describing this syndrome have appeared in breast, surgery, oncology, physical therapy, lymphology, dermatology and nursing journals, suggesting that radiologists may be unaware of this condition.

Diagnosis of axillary web syndrome is usually clinical, based on patient history, symptoms, visual inspection, and palpation. However, if the care team is unaware of this syndrome, patients may present to radiology for upper extremity ultrasound or to breast imaging for axillary ultrasound, before a diagnosis has been made. Therefore, improved awareness would assist radiologists, including breast imagers, to more confidently evaluate and diagnose this condition.

2. Literature review

In January 2019, a formal literature search was performed with the assistance of an experienced librarian, using the PubMed, Embase, Scopus, and CINAHL (Cumulative Index to Nursing and Allied Health Literature) databases. English language was specified. Articles published up to January 18, 2019 were included. Keywords used for the electronic search were “axillary web syndrome”, “cording”, “breast cancer”, “lymph nodes”, “sentinel lymph nodes”, “axillary”, and “lymphatic”. An online search of abstracts presented at the annual meetings of the Radiological Society of North America (RSNA) and American Roentgen Ray Society (ARRS) was also performed, using the keywords “axillary web syndrome”, “cording” and “lymphatic cording”. Following the computerized search, the titles and abstracts were reviewed by one of the authors to determine relevance and confirm English language. Duplicate articles, articles not related to axillary web syndrome, and articles in languages other than English were excluded from review.

The initial computerized search identified a total of 304 articles, 156 of which were duplicates. Of the remaining 148 articles, 53 were from PubMed, 68 from Embase, 10 from Scopus and 18 from CINAHL. Review of the titles and abstracts excluded 21 articles which were not related to axillary web syndrome and 9 which were not in English language. Of the 118 remaining articles, only a few records contained the word “ultrasound” in the title, including 3 journal articles. One meeting educational exhibit was also identified, covering the topic of ultrasound in axillary web syndrome.

3. Reports of axillary web syndrome

The term “axillary web syndrome” was first used by Moskovitz and colleagues in 2001. The authors described a pain syndrome in breast cancer patients who had undergone axillary lymph node dissection. Symptoms included axillary and arm pain, limited shoulder range-of-motion, and an axillary web of tissue, most apparent with the arm abducted at the shoulder. This retrospective review of breast cancer

Abbreviations: AWS, axillary web syndrome; ALND, axillary lymph node dissection; SLNB, sentinel lymph node biopsy

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https://doi.org/10.1016/j.ejrad.2019.02.001
Received 28 November 2018; Received in revised form 31 January 2019; Accepted 1 February 2019

patients treated between 1980 and 1996 found signs and symptoms of axillary web syndrome (AWS) in 44 out of 750 patients (6%). 43 of the 44 patients had been treated with axillary lymph node dissection (ALND) and one patient had Stage IV breast cancer with palpable fixed axillary nodes. The webs were described as "two or three taut, tender, nonerythematous cords of tissue under the skin", "always present in the axilla", extending "into the medial ipsilateral arm, frequently down to the antecubital space, and occasionally to the base of the thumb" [1]. In this group of patients, webs presented 1–8 weeks after surgery and resolved within 3 months. Development of AWS was independent of breast cancer histology or stage, patient age, and whether or not the removed lymph nodes demonstrated metastatic disease [1].

In 2003, Leidenius and colleagues published a prospective study of 85 breast cancer patients; 49 underwent only sentinel lymph node biopsy (SLNB) and 36 had SNLB followed by ALND. The patients were examined before and after surgery for shoulder range of motion and presence of AWS. AWS was found in 20% of the SLNB group and 72% of the ALND group. AWS was more common in women with low BMI. Physical examination 2 weeks after surgery showed limited shoulder range of motion in 45% of the SLNB group and 86% of the AC group, which resolved at 3 months in most patients. The authors concluded that there is less arm morbidity related to SLNB compared to ALND [2].

Multiple additional case reports of axillary web syndrome occurring in breast cancer patients treated with axillary node dissection or sentinel node biopsy have been published [3–7].

Axillary web syndrome has also been reported in clinical settings without axillary surgery for breast cancer. These include: sentinel lymph node biopsy for staging of melanoma [8–11], axillary surgery for excision of microcystic adnexal carcinoma [12], axillary infection, furuncle, or ruptured epidermal inclusion cyst [13–15], and transaxillary robotic thyroidectomy [16]. There is even a case report of AWS occurring in a male squash player with no history of axillary surgery [17].

4. Clinical presentation

Patients usually present with one or more palpable or visible firm linear bands, referred to as "cords", superficially in the axilla, extending along the medial/ventral arm, occasionally crossing the antecubital fossa and even into the wrist or hand. The cords look like guitar strings or wires under the skin and become tighter and more visible with shoulder abduction and arm extension (Figs. 1 and 2). Symptoms include dull or burning pain, a pulling sensation and limited range of motion, including limited abduction at the shoulder [1,2,18–21]. The cords may be associated with palpable nodules in the axilla or arm [4]. The most common locations of the cords are the axilla and arm, but they can also appear as a thin, firm linear band or bands in the breast or along the lateral thoracic wall [7,22]. As this syndrome may not be well recognized by patients and clinicians, some breast cancer programs have developed self- assessment questionnaires to improve diagnosis and patient awareness [23,24].

The most commonly affected patients are those treated for breast cancer with axillary node surgery. The cords or webs usually appear in the early postoperative period (weeks 1–2) [1,2,19], but can be noted several months to years later and may recur after resolution [18,21,25]. The symptoms of pain and limited motion tend to resolve over a few months, although the cord may still be present.

There have been many reports of cording in patients who either have not had axillary surgery or do not have breast cancer. Cording has been reported in breast cancer patients with metastatic axillary lymph nodes, even before surgery [1,22,26]. AWS can also occur in melanoma patients after sentinel node biopsy [8–11] and also in patients who have undergone excision of axillary skin lesions without removal of any axillary nodes [12,27] Patients with skin infections involving the axilla can also develop cording [13–15]. The syndrome has even been reported in some patients with no obvious cause [17,28].

Axillary web syndrome has sometimes been described as a variant of Mondor's disease [1,29], but other authors state that AWS is *not* the same entity [22,30]. Mondor's disease is generally described as thrombosis of a superficial vein, often in the breast or chest wall [29]. Although the etiology of AWS is not completely understood, it likely has a lymphatic origin [4,13]. Mondor's disease presents as a palpable cord in the breast or anterolateral chest wall, so there can be overlap with the clinical presentation of AWS. However, the cord in Mondor's disease is often tender, and thicker than a lymphatic cord. Ultrasound of Mondor's disease usually demonstrates a non-compressible thrombosed superficial vein, which is not seen in AWS [22].

5. Incidence of AWS

The earliest report of AWS, a retrospective review of breast cancer patients, noted an incidence of 6% in ALND patients [1]. The reported incidence of AWS ranges from 5.2% [31] to 72% [2] in patients undergoing axillary node dissection and the incidence with sentinel node biopsy ranges from 0.9% [31] to 45% [2,32]. In a 2017 study, a physical therapy group noted AWS in up to 90.9% of patients with axillary surgery for breast cancer. They detected the clinical findings using a careful prospective diagnostic physical examination protocol [21]. There have been multiple studies of axillary web syndrome in the setting of axillary surgery for breast cancer, with a wide range of reported incidence (Table 1). The reported incidence is higher in prospective studies than retrospective studies.

In patients treated with SLNB for melanoma, there are 2 retrospective studies reporting an AWS incidence of 2.2%(8/365 patients) [10] and 4.5%(21/465 patients) [9,10]. A third retrospective study reported AWS in 58.3% of patients with melanoma referred for physical therapy after axillary surgery; the high percentage could be related to the small sample size (12 patients) or the fact that these patients was symptomatic after surgery and were referred for therapy [11]. Axillary web syndrome has been reported in several other clinical settings, but the incidence in these populations has not been studied.

6. Risk factors

Most reported AWS cases occurred after axillary surgery. Among patients with a history of axillary surgery, reported risk factors for development of AWS include increased number of nodes removed at surgery, with a higher incidence in patients undergoing ALND compared to SLNB [2,31,33], younger age [19,33–35] and low body mass index (BMI) [2,18,19,34]. Postoperative numbness in the intercostobrachial nerve distribution [34] and hypertension have also been noted as risk factors [21]. A few case reports have described AWS in association with axillary infection/inflammation or vigorous arm exercise [13,14,17], even without any axillary surgery, so these may also be risk factors.

7. Etiology

The etiology of axillary web syndrome is unknown, although a lymphatic origin is suggested. Four of the AWS patients in the 2001 Moskovitz study underwent biopsy of the cords, showing dilated thrombosed lymphatics or thrombosed superficial veins. The authors noted that the location of the axillary cords corresponds with the anatomic location of lymphatic vessels seen in arm lymphangiograms. It was proposed that the etiology of AWS is a combination of lymphovenous and tissue damage with disruption of superficial lymphatics and veins during surgery, resulting in superficial venous and lymphaic stasis and local hypercoagulability and thrombosis [1].

Reedijk et al reported a case of AWS associated with subcutaneous nodules in the arm; biopsy of one of the nodules showed a non-muscular fibrotic wall without an elastic lamina, with inflammatory cells and central organizing thrombotic material without significant

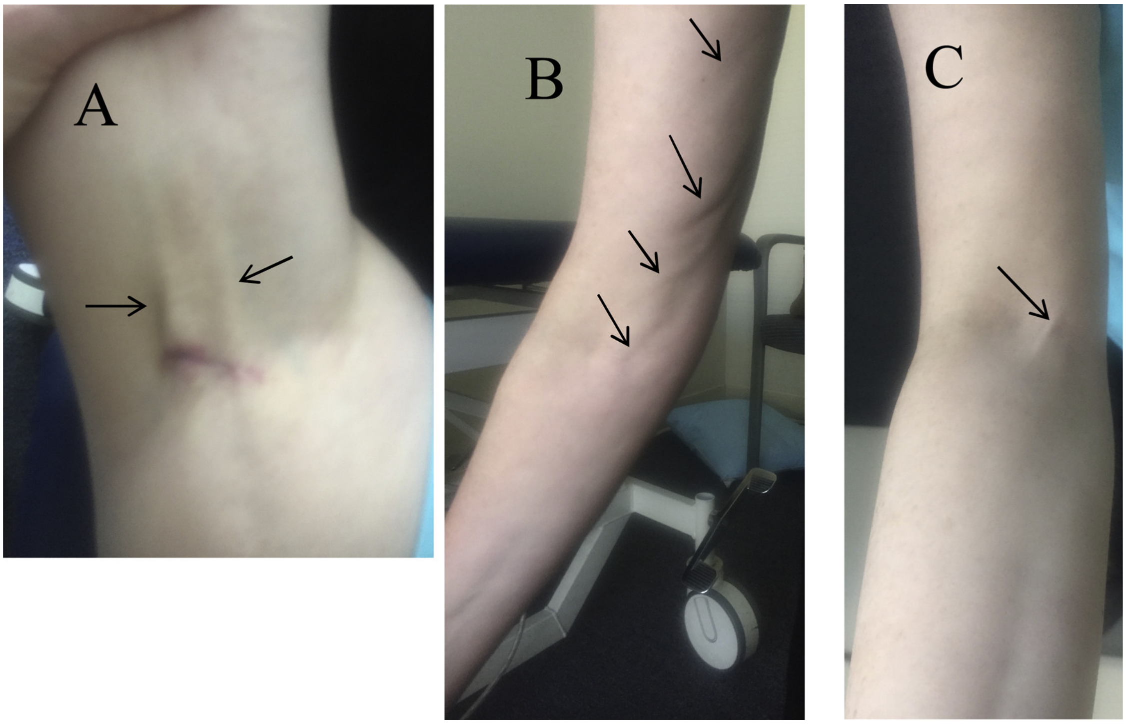

Fig. 1. 51-year-old woman 3 weeks after surgical removal of an infected sebaceous cyst in the right axilla presents with palpable cords in the axilla, burning pain in the arm, limited shoulder abduction and limited arm reach. A: 2 linear cords in the axilla, B: cords causing puckering of the skin of the upper arm, C: visible cord crossing the antecubital fossa.

hemorrhage or hemosiderin. The histology findings suggested thrombotic occlusion of a lymphatic vessel [4].

Leduc evaluated a series of 15 women with AWS, and found the cords follow the anatomical course of the antero-radial pedicle of the lymphatic system in the arm [36].

Rashtak and colleagues reported a case of AWS in a patient with an axillary furuncle. Punch biopsy of the cord showed fibroblastic proliferation around a subcutaneous lymphatic vessel. Immunohistochemical staining was positive for both CD31, a marker for all endothelial cells, and D2-40, which is reported to be a specific marker for lymphatic endothelium [13,37]. The histologic and immunohistochemical findings on biopsy support a lymphatic origin.

The evidence points to a lymphatic origin of the cords in AWS, although the exact cause of lymphatic obstruction in these patients is

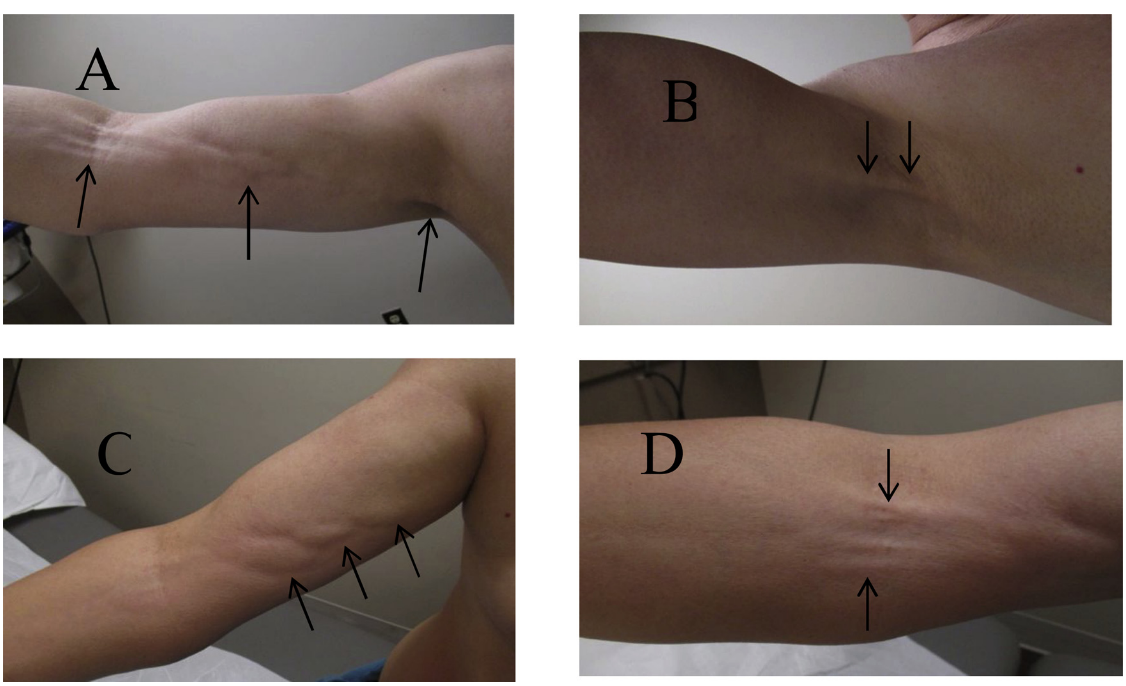

Fig. 2. 75-year-old healthy man with one-week history of right arm pain, limited range of motion, and palpable cords in the right axilla and arm. A: visible cords extend from axilla to antecubital fossa, B: thick cord in the axilla, C: cords cause puckering of skin in upper arm, D: cords cross the antecubital fossa. No history of surgery, infection, or unusual activity.

Table 1
Reported incidence of axillary web syndrome in breast cancer patients.

First author	Year	Study design[1]	Number in study	Patients with AWS	ALND%	SLNB%	Combined
Moskovitz	2001	R	750	44	6%	4 patients	
Leidenius	2003	P	85	36	72%	20%	
Laurisden	2005	P	139	86	unknown	unknown	62%
Severeid	2007	R	214	63	unknown	unknown	29.4%
Torres Lacomba	2009	P	116	56	48.3%	excluded	
Bergmann	2012	P	193	54	36%	11.7%	28.1%
Wernicke	2013	R	226	6	5.2%	0.9%	
O'Toole	2013	P	308	97	54%	27%	31.5%
Nevola Teixeira	2014	P	88	32	40.8%	30.7%	36%
Koehler	2015	P	36	17	71%	41%	47.2%
Fukushima	2015	P	97	28	25.8%	3.1%	28.86%
Huang	2017	P	81	40	50.8%	45%	49%
Wariss	2017	P	964	346	unknown	unknown	35.9%
Figueira	2017	P	173	157	unknown	unknown	90.9%
Baggi	2018	P	370	186	unknown	unknown	51.1%
Koehler	2018	P	36	18	75%	43%	50%

[1] R = retrospective, P = prospective.

unclear. It is unknown why AWS occurs in some patients after axillary surgery, but not others. The mechanism for AWS in axillary infection or inflammation or in idiopathic cases is also unknown.

8. Clinical course and treatment

The time course from detection to resolution of AWS is variable. Early reports suggested that the cords are self- limited and resolve without treatment within 3 months [1]. However, more recent studies suggest that the cords can persist for 18–24 months or longer. In addition, cords can appear after many months, or can recur after initial resolution [25,33].

Because AWS is often associated with lymph node surgery and/or lymphatic dysfunction, one could expect an increased incidence of arm lymphedema in this population. The literature results are mixed on this subject. Lacomba and colleagues prospectively followed 160 breast cancer patients for 3 years, and found that women with AWS developed lymphedema 2.2 more often than women without AWS, suggesting that AWS may be a risk factor for lymphedema [38]. However, a 2017 retrospective review of 964 breast cancer patients showed no association between AWS and development of lymphedema after 10 year follow up [39].

Physical therapy can help stretch the cords and restore arm motion; treatment includes manual therapy, tissue mobilization, stretching and strengthening exercises. There is no consensus in the physical therapy literature regarding the optimal treatment or timing of treatment [19,40–45].

9. Reports of imaging

There is very limited literature describing imaging of AWS. In a 2013 case report, ultrasound of an axillary cord showed a vein with blood flow, felt to correspond to the palpable cord [7]. However, additional cords in the breast and thoracoabdominal wall in the same patient were not visible by ultrasound, suggesting that the imaged vein may not have represented a correlate for the subcutaneous cord.

In 2014, two studies describing imaging of AWS were published in the journal Lymphology. In one study, Koehler and colleagues evaluated ultrasound to characterize AWS and try to determine the structure(s) responsible for cording. In their study, 17 patients with cording underwent ultrasound by a technologist, using an 18 MHz transducer. Both axillae were scanned, and the radiologist was blinded to the side of the abnormality. No consistent abnormality could be identified to correlate with the cords. There was no difference in skin thickness, subcutaneous tissue echogenicity, or subcutaneous tissue reflectors. An unblinded review of the images showed no consistent findings, but multiple different findings were described at the dermal/ subdermal junction or in the subcutaneous fat. The authors concluded that lack of a specific structure corresponding to the cord excluded vein thrombosis and fascial abnormality as etiologies [30,46].

In the other study, Leduc and colleagues compared ultrasound and MRI for identification of cords in 15 AWS patients. For the ultrasound protocol, the cord was palpated and marked, using a dynamic abduction maneuver to locate the cord. Liquid gel and a gel pad were placed on the skin. Both transverse and longitudinal images were obtained with a 17 MHz probe. For the MRI protocol, a catheter filled with gel was placed on the skin over the cord, and multiple sequences were obtained through the region of the cord in the coronal and axial plane.

Ultrasound demonstrated a finding correlating with the cord in 12/15 patients. MRI showed the cords in 7/15 patients, but all 7 cords were also detected by ultrasound. Thus, ultrasound was found to be more effective than MRI for imaging the cords. Ultrasound of the cords showed deformation of the dermis with shoulder abduction, an anechoic cord with hyperechoic edge, likely the lumen of a vessel and vessel wall, and hyperechoic structures thought to represent fibrosis. There was no flow on Doppler images. Echogenic infiltration of surrounding fat was described. With MRI, some of the cords were visible as low signal subcutaneous linear bands or dots, but positioning and identification of the cords was challenging. The authors discuss that US may be more effective because of better spatial resolution, ability to palpate cords while imaging, ability to obtain a dynamic study, and a technically easier and shorter study, thus allowing the patient to fully cooperate. Four different ultrasound appearances were described: hypoechoic or anechoic lumen with echogenic walls, a hyperechoic structure, a hypoechoic structure, and a hypoechoic structure with hyperechoic internal material thought to be thrombus. The authors conclude that the appearance of the cords suggests occlusion of lymphatic vessels [46].

In 2015, a pilot study evaluated ultrasound in 5 women with cording after breast cancer surgery. Ultrasound of the palpable axillary cords was performed with a 9 MHz linear probe. Ultrasound showed "honeycomb-like structures" in the transverse plane and striated/linear structures in the longitudinal plane. The authors concluded that the cords could not be reliably identified, and that ultrasound was not useful in determining the pathophysiology of cording [47].

An educational exhibit presented at the American Roentgen Ray Society 2018 Annual Meeting described physical exam and ultrasound findings in several patients with AWS [48]. The authors report that patient history and limited physical exam of the axilla can alert the radiologist to the possibility of AWS. Careful ultrasound by the

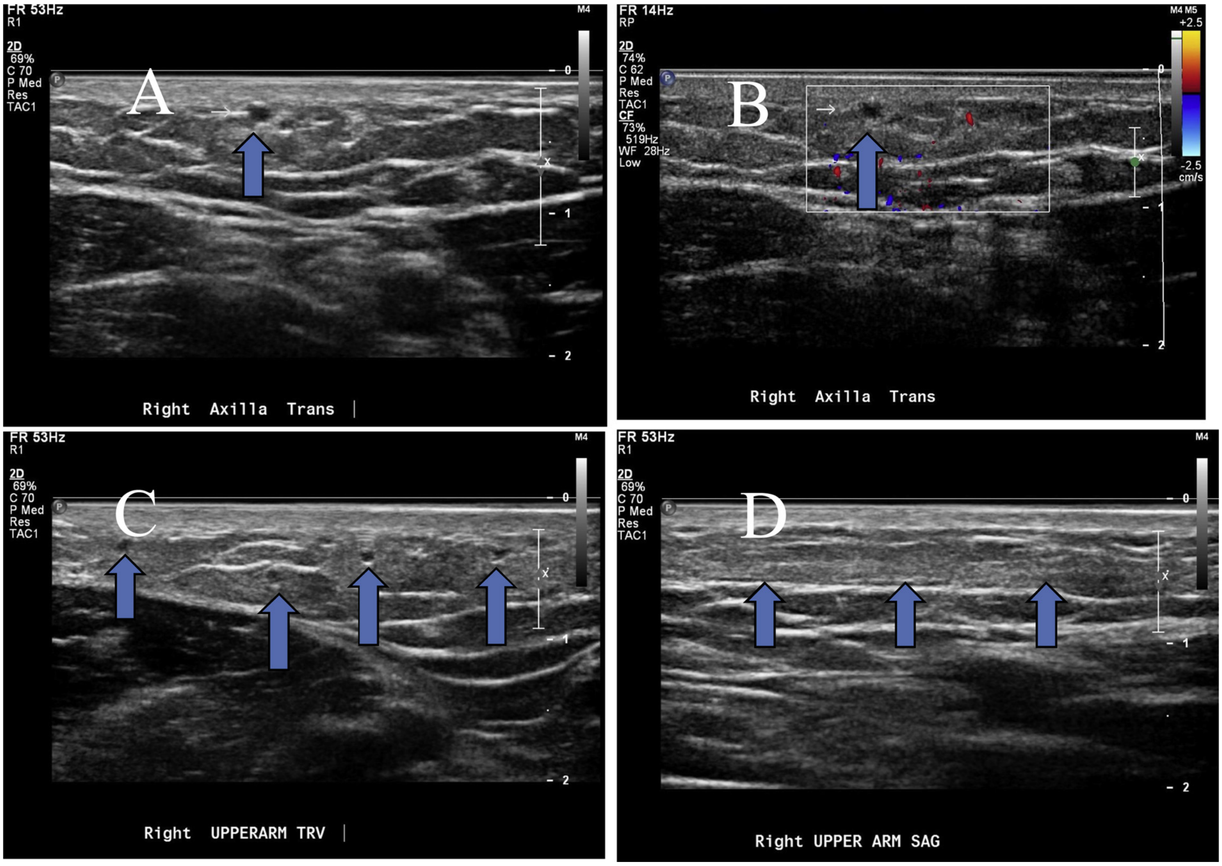

Fig. 3. Ultrasound images of the 75-year-old man in Fig. 2. A: transverse view of cord in axilla, B: color Doppler image shows no flow in cord, C: transverse image of multiple cords in the upper arm, D: increased echogenicity of subcutaneous fat.

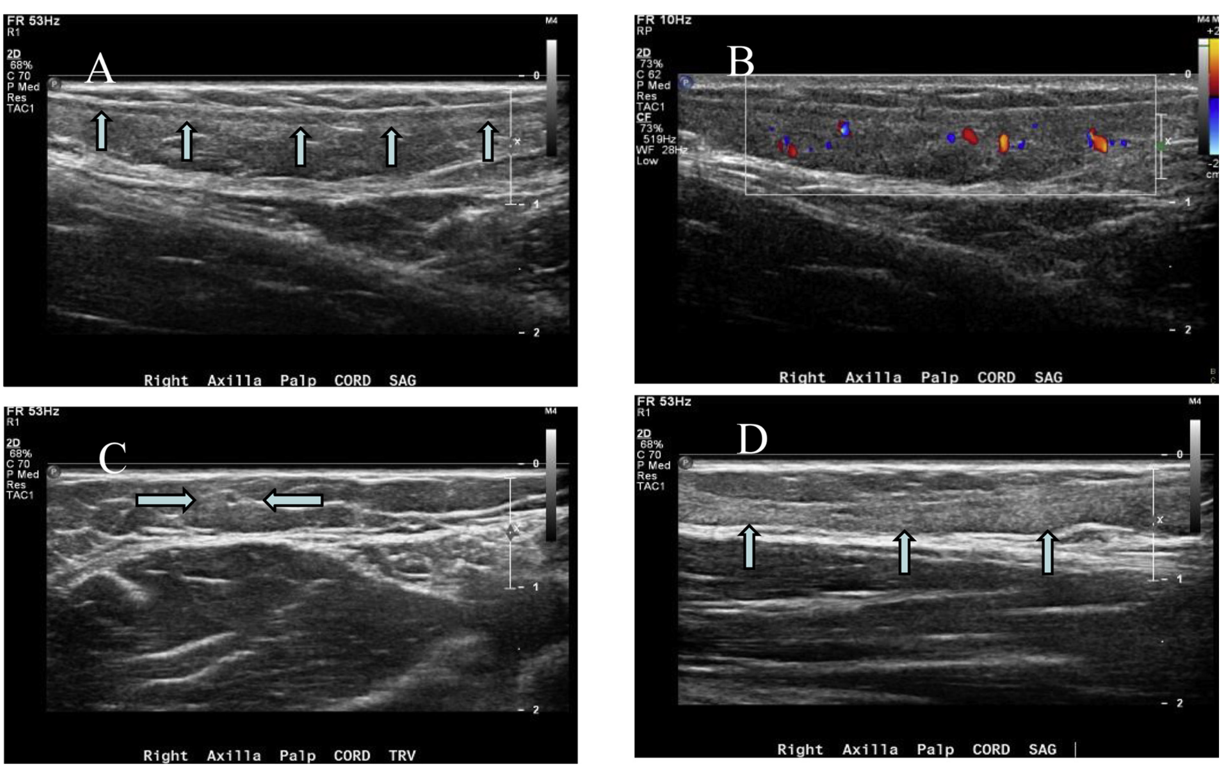

Fig. 4. 43-year-old woman one week after core needle biopsy of right breast cancer and a right axillary lymph node, presents with a palpable cord in the right axilla, arm pain and limited shoulder abduction. A: sagittal ultrasound image of palpable right axillary cord, B: color Doppler image of the cord showing no flow, C: transverse view of cord, D: increased echogenicity in surrounding subcutaneous fat.

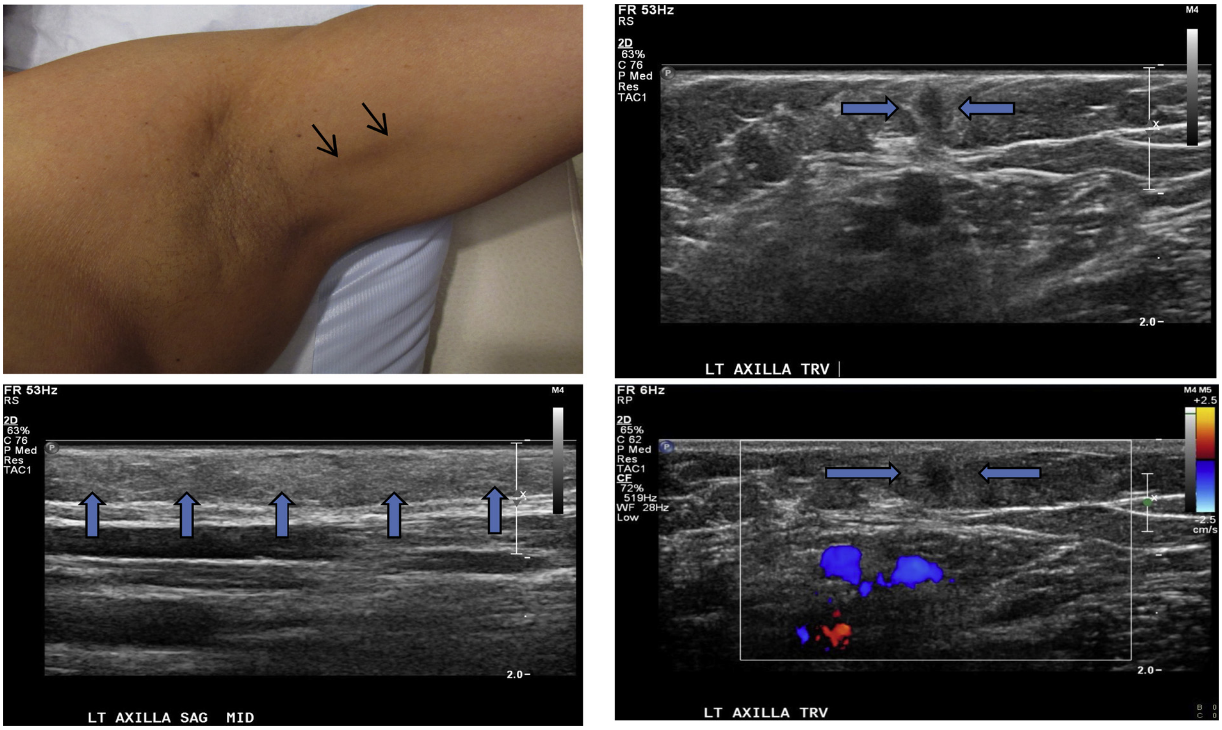

Fig. 5. 50-year-old woman with visible and palpable cord in the left axilla, 3 months after lumpectomy and sentinel lymph node biopsy for treatment of breast cancer. A: clinical appearance of cord in the axilla, B: transverse ultrasound of cord, showing central hypoechogenicity and increased echogenicity of surrounding subcutaneous fat, C: sagittal view of cord, showing increased echogenicity of surrounding fat, D: color Doppler image showing no flow in cord.

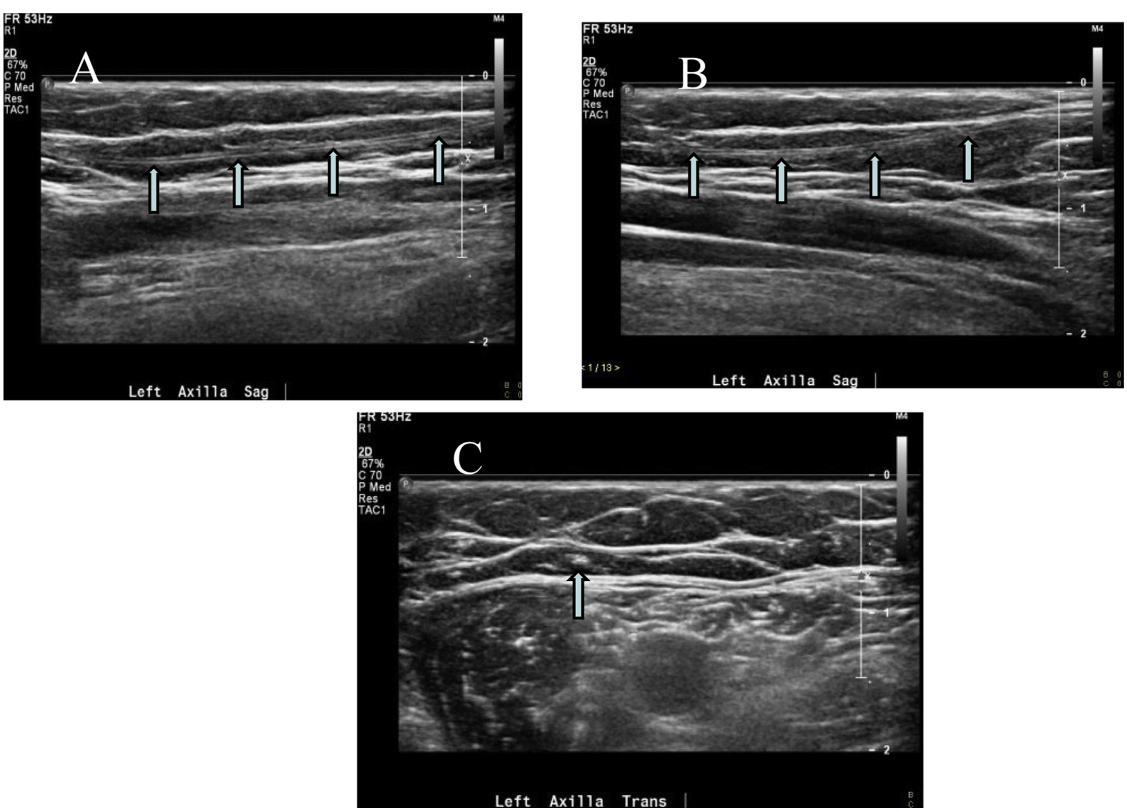

Fig. 6. 44-year-old woman 10 months after mastectomy and SLNB for treatment of breast cancer, with chronic palpable axillary cords. A: sagittal ultrasound of a cord in the axilla with trilaminar appearance, B: a second axillary cord, sagittal view, C: transverse view of an axillary cord.

technologist and the radiologist, with attention to the palpable cord or cords, can demonstrate findings similar to those described by Leduc et al. The palpable cord or cords should be evaluated with a high frequency ultrasound transducer (17 MHz), in the transverse and longitudinal planes, imaging directly over the cord [46].

In some patients, the cords appear as thin isoechoic or hypoechoic

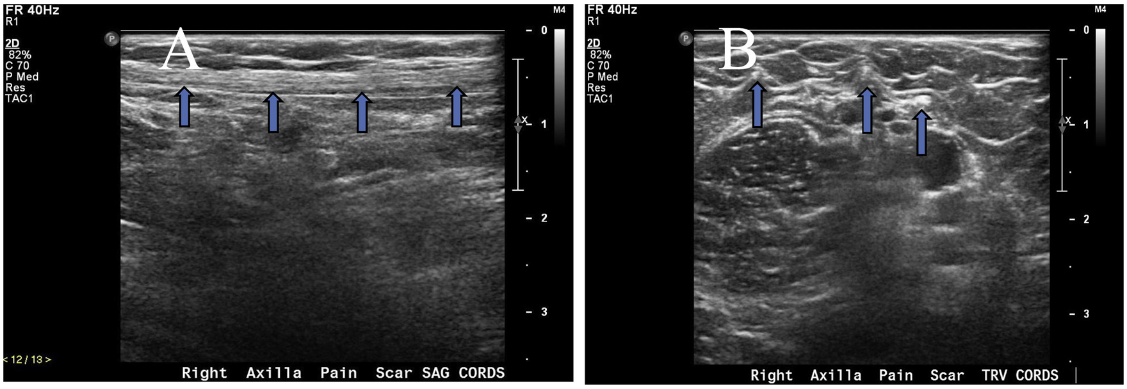

Fig. 7. 73-year-old woman with history of lumpectomy and axillary node dissection 3 years ago, with a chronic palpable cord in the right axilla. A: sagittal ultrasound of the axillary cord shows an echogenic linear structure corresponding to the palpable cord, B: transverse ultrasound of 3 echogenic cords.

linear bands within the subcutaneous fat, with no visible wall or with a thin echogenic wall (Fig. 3–5). In other patients, the palpable cords correspond to one or more thin echogenic bands in the subcutaneous fat, with no internal color flow. The cords may be trilaminar (echogenic/hypoechoic/echogenic), suggesting a vessel (Fig. 6), or may be more homogeneously echogenic, suggesting fibrosis (Fig. 7). The cords measure 1–3 mm in transverse dimension. The surrounding subcutaneous fat may be echogenic (Figs. 3–5). There is no color flow within the cord (Figs. 3–5) [48].

10. Future directions

Further research is needed to better define the ultrasound imaging findings in AWS, determine whether the cords can always be identified by ultrasound, and study whether the cords have a different ultrasound appearance depending on whether they are acute or chronic. It would also be useful to improve clinician awareness and better understand the etiology of AWS. More research on the treatment and possible prevention of AWS is also needed.

11. Conclusion

Many patients are at risk for axillary web syndrome, including a large number of breast cancer patients who have undergone axillary node surgery. AWS is usually a clinical diagnosis, but if the clinician is unaware of the syndrome and the patient has a new area of pain and/or palpable concern, the patient may present to radiology for evaluation. Therefore, it is important for radiologists to be aware of this entity, so that they are knowledgeable about the clinical examination and ultrasound findings. Although the ultrasound findings are subtle, it is possible to recognize axillary cords with ultrasound and confidently make the diagnosis of axillary web syndrome.

Note

Figs. 1,4,5,6, and 7 are reprinted with permission form the American Roentgen Ray Society (ARRS) [48]. Original details of the source of the figures were anonymized. Permission was obtained from the ARRS (American Roentgen Ray Society) to reprint the images.

Disclosures

Lisa Mullen, MD has no disclosure of possible conflict of interest and/or commercial involvement. Susan Harvey, MD is on the scientific advisory board for Hologic, Inc. and IBM Watson Imaging.

Funding

This work did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

The authors would like to acknowledge medical librarian Katie Lobner for her assistance with our literature search and our clinical colleagues Lisa K. Jacobs, MD, Melissa S. Camp, MD, Fariba Asrari, MD, and Heather Prender, PT, for sharing their patients and knowledge of axillary web syndrome.

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