An uncommon, unilateral motor variation of the intercostobrachial nerve

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Summary

The intercostobrachial nerve (ICBN) is commonly defined as a purely sensory nerve supplying the skin of the lateral chest wall, axilla, and medial arm. However, numerous branching patterns and distributions, including motor, have been reported. This report describes an uncommon variant of the right ICBN observed in both an 86-year-old white female cadaver and a 77-year-old white male cadaver. In both cases the ICBN presented with an additional muscular branch, termed the "medial pectoral branch", piercing and therefore innervating the pectoralis major and minor muscles. Clinically, the ICBN is relevant during surgical access to the axilla and can result in sensory deficits (persistent pain/loss of sensory function) to this region following injury. However, damage to the variation observed in these cadavers may result in additional partial motor loss to pectoralis major and minor.

Keywords

intercostobrachial nerve; lateral cutaneous branch; second intercostal nerve; medial pectoral branch; mastectomy; pectoralis minor

Introduction

The intercostobrachial nerve (ICBN) generally originates from the second intercostal nerve (T2) as its non-dividing, lateral cutaneous branch. As the ICBN travels to the medial arm, it first pierces the intercostal muscles of the second intercostal space and the serratus anterior in the midaxillary line [1]. It then courses through the axilla where it most often joins the medial cutaneous nerve of the arm, to innervate the skin of the superior half of the posterior and

medial aspects of the arm [2]. It is along its axillary course that the nerve is most vulnerable to iatrogenic injury during surgical procedures, such as axillary lymph node resection or mastectomy [3–6]. During these procedures, surgeons most often choose to sacrifice the ICBN due to the technical difficulties involved in its dissection and preservation [7,8]. However, this is a controversial topic among the surgical community with some surgeons believing this sacrifice somewhat unnecessary [7–9]. In brachial plexus blocks specifically the lateral and medial infraclavicular approach, that targets the ICBN potentially provides the patients with better torniquet [10], however a success of only 77-87% has been reported with this procedure [11]. Regardless of the current methods employed by surgeons in this field, it is important to note possible variations in the course and distribution of the ICBN for those seeking to preserve or block it. It is also relevant for those cases where the implications of its possible aberrant motor or even sensory supply to the pectoralis muscles is not yet fully understood. Therefore, we present two cases in which the right medial pectoral branch of the ICBN was found to pierce and possibly provide innervation to the pectoralis major and minor muscles.

Case Reports

The variation was discovered during a routine prosection of the thoracic and axillary area in the Gross Anatomy Instructional Studio at Khalifa University, College of Medicine and Health Sciences, Abu Dhabi, during the spring term of 2021(Ethics clearance: H21-004). The variation was found in both an 86-year-old white female who had died from acute hypoxic respiratory failure, and a 77-year-old white male who had died from nutritional deficiency and senile degeneration of the brain. These cadavers were part of the body donation program of Science Care, Phoenix, Arizona, USA, and had been fixed with “Kelspecial 35 Arterial Fluid” solution (Kelco Supply Company, Item No 5122). No evidence of previous surgeries or pathologies pertaining to the thoracic and axillary regions were noted.

While exposing the lateral thoracic wall and the contents of the axilla, the ICBN was observed to arise from the second intercostal space bilaterally. However, a large additional branch was noted to immediately arise from the right ICBN at the second intercostal space exit, which coursed towards and pierced the pectoralis minor (Figure 1 and 2). Despite taking great care in dissecting the contralateral (left) side, this variation was not observed on this side in either of the two cadavers. This additional branch has been previously described and named by Loukas et al. (2006) as the “medial pectoral branch” of the ICBN. For consistency

and clarity this uncommon nerve will be referred to as the medial pectoral **branch**, as termed by Loukas et al. (2006), throughout the rest of the paper, distinguishing its nomenclature from the lateral and medial pectoral **nerves**.

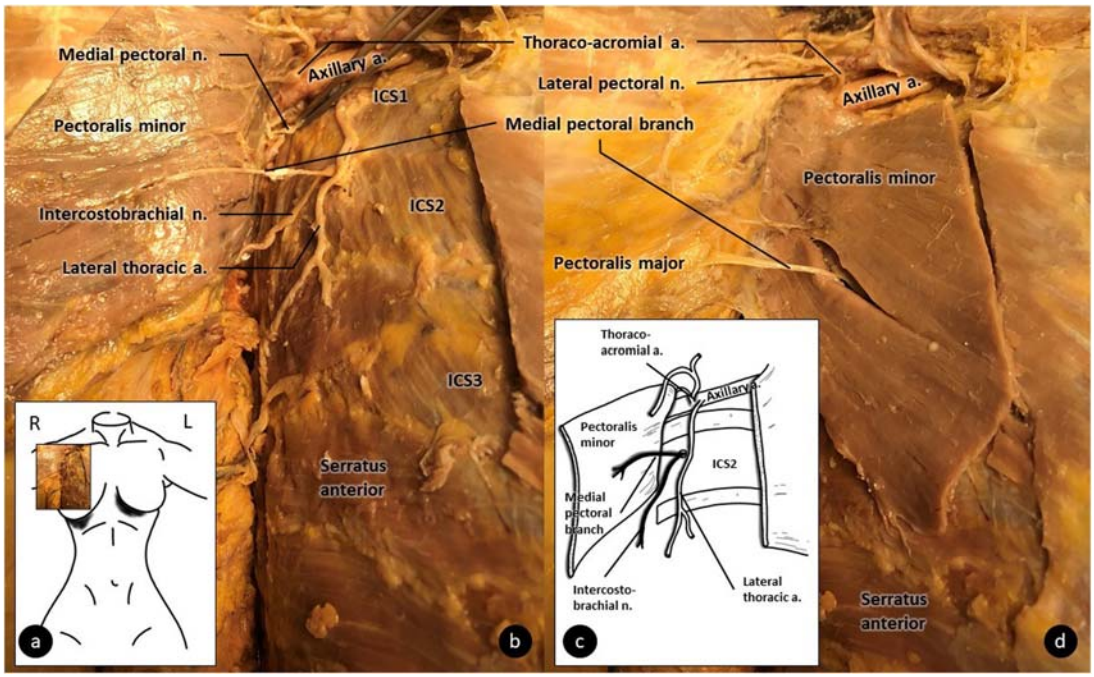

Figure 1. Image of the right axilla of an 86-year-old female illustrating the variant branch of the intercostobrachial nerve (ICBN). a: Schematic orientation of the dissected area. b: Photograph demonstrating the exposed medial pectoral branch after reflection of the pectoralis minor. It originates in the second intercostal space (ICS2) from the ICBN, a branch of the second intercostal nerve, and pierces the pectoralis minor. c: Line diagram of (b), depicting the medial pectoral branch originating from the ICBN in the ICS2 and piercing the pectoralis minor. d: Photograph of the course of the medial pectoral branch after reflection of the pectoralis major. It pierces the pectoralis minor muscle and terminates in the pectoralis major. a.= artery; *n*.= nerve.

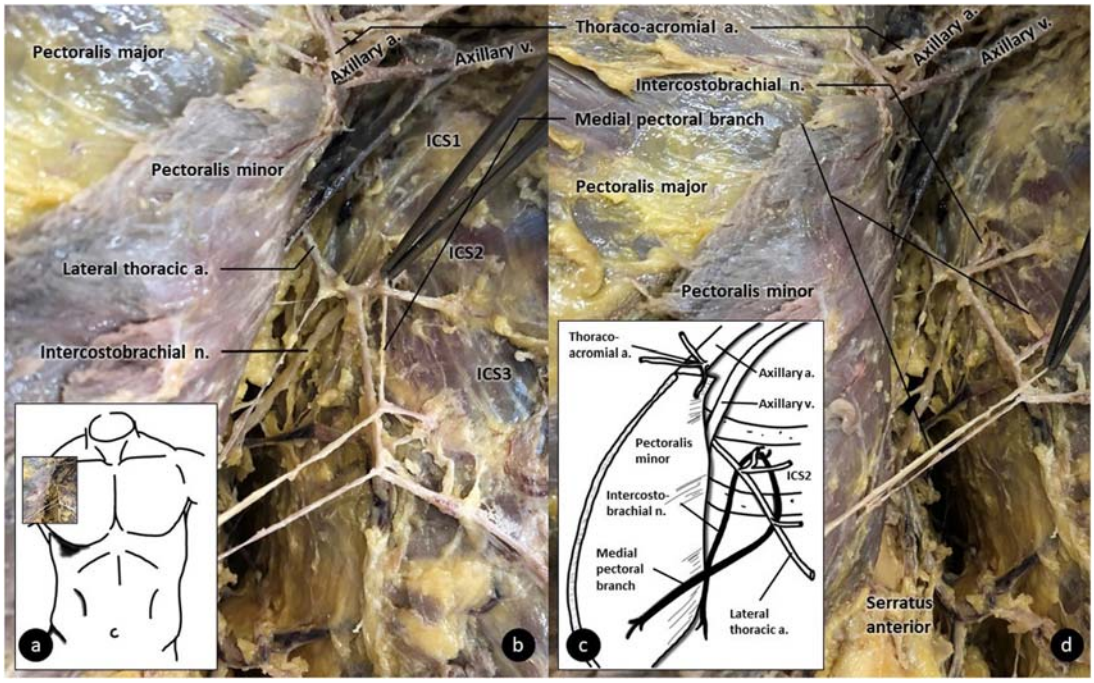

Figure 2. Image of the right axilla of a 77-year-old male illustrating the variant branch of the intercostobrachial nerve (ICBN). a: Schematic orientation of the dissected area. b: Photograph demonstrating the exposed medial pectoral branch after reflection of the pectoralis minor. It originates in the second intercostal space (ICS2) from the ICBN, a branch of the second intercostal nerve, and pierces the pectoralis minor. c: Line diagram of (b and d), depicting the medial pectoral branch originating from the ICBN in the ICS2 and piercing the pectoralis minor. d: Photograph of the course of the medial pectoral branch as it descends with the lateral thoracic artery, and then project towards the pectoralis minor muscle. a.= artery; *n*.= nerve; v.=vein.

The medial pectoral branch pierced the pectoralis minor and continued its course to the abdominal head of the pectoralis major muscle, where it was firmly attached to the underlying muscle fibers without piercing the muscle completely. Based on its course and fiber termination, it can be assumed that the medial pectoral branch contributed to the motor supply of pectoralis minor and abdominal head of pectoralis major in these two cases. This assumption was further supported by the sparse fiber distribution noted from the medial and lateral pectoral nerves, which were both present. In both cases, the lateral pectoral nerve followed the course described in current textbooks as well as the literature; it ran from the lateral cord of the brachial plexus to pierce the clavicular and sternal heads of the pectoralis major. The medial pectoral nerve, although small, was noted along the superior pole of pectoralis minor in the male cadaver. In the female cadaver however, the medial pectoral nerve did not contribute branches to pectoralis minor, as it followed an unusual course towards the inferior border of pectoralis minor, completely bypassing the muscle, where it

terminated into the overlying pectoralis major. In contrast to the female cadaver, the medial pectoral nerve in the male cadaver did pierce the pectoralis minor, as is its usual course, to continue to the pectoralis major. The ansa pectoralis, the communicating branch between the medial and lateral pectoral nerves, was also observed in both cadavers and no communications between the medial pectoral branch and the medial or lateral pectoral nerves, or any other related nerves were observed.

Discussion

This study reports on a rare variation of the ICBN, where one additional motor branch, the medial pectoral branch arises from the ICBN at its exit from the second intercostal space to course towards and supply both the pectoralis minor and major. This singular branch, to the authors knowledge, has only been described twice before by Loukas et al. (2006) and Shetty & Nayak (2015).

Several authors have reported on the anatomy and variations of the ICBN [6,9,12–16], but only Loukas et al. and Shetty & Nayak have reported on a motor variation as reported in these cases. Before Loukas et al. (2006), a paper by Murakami et al. (2002) reported on a variation of the ICBN, in which the authors noted two separate branches arising from the ICBN penetrating, but not innervating, the pectoralis major and minor muscles. Other major variations with regard to the origin, course and distribution of the ICBN have been reported over the years, which include; communications between the ICBN and different components of the brachial plexus [1,12,16–18], contributing branches from the T1 and T3 intercostal nerves [12,18], various branching patterns of the ICBN [9,17,19] and, variations in the ICBNs relation to the lateral thoracic vein [12]. Although motor variations of the ICBN are rare, it remains important to report all variations related to the course and distribution of the ICBN, to minimize the risk of iatrogenic injury and to improve the understanding of the anatomy of this region.

Preserving the ICBN has been a topic of interest in the surgical community for more than 45 years, with the first mention of possibly preserving this nerve by Assa in 1974 [20]. Since then, efforts have been made to clinically assess the advantages and disadvantages of preserving the ICBN for postoperative pain management, and several authors have recommended preserving the ICBN as this approach greatly reduces the patients' postoperative pain and sensory deficits [3,4,7,8,15,21–26]. The ICBN was reported in 2021 to

be the most commonly injured nerve [27], and is most often damaged during axillary lymph node resection or other surgical procedures relating to this region, such as mastectomies [5,6]. Postmastectomy pain syndrome (PMPS) is one of the sensory deficit disorders arising from damage to the sensory nerves in this region, specifically the ICBN [6], and is observed in 20-68% of cases [28]. These postoperative pain syndromes can have a debilitating effect on the patient, especially when pain is elicited with movement [6], leading to a reduction in health-related quality of life. Transaxillary breast augmentation is an additional procedure in which the ICBN can be severely damaged. Tebbetts in 1984 [29] found that the ICBN was damaged in 20% of transaxillary breast augmentation procedures, which resulted in sensory loss of the medial surface of the brachium [27]. It may also be speculated that the medial pectoral branch could be the cause of unexplained pain in the pectoral region following surgery or upper arm compression, which warrants further studies to precisely determine the root value of the medial pectoral branch. Understanding the motor and/or sensory contribution of this unusual variation via histological methods is also an avenue that requires further investigation. Although histology was not the focus of this paper, the authors followed Hilton's law that states if a nerve pierces a muscle, it will supply it with motor innervation [30].

Although, to the authors knowledge this is only the third time this type of variation is described, this unusual distribution pattern of the medial pectoral branch highlights the importance of this branch as a possible variant motor nerve, which may innervate pectoralis major and minor [31,32]. Currently, the consequences of damage to this aberrant motor branch are clinically unknown, but may lead to muscle weakness and possible paralysis if inadvertently injured. The ability to preserve the ICBN is only possible if the surgeon is aware of all the potential variations in its course [9,14,16].

Conclusion

Despite the fact that the clinical significance of this variation and the consequences of injury to this motor branch are unknown, this variation and that of Loukas *et al.* (2006) and Shetty & Nayak (2015) indicate sensory as well as potential motor innervation originating from the ICBN. This variation further supports the notion of preserving the ICBN during axillary procedures.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Author Contributions

All the authors had substantial contributions to the conception of the work, analysis, or interpretation of data for the work. This included drafting the work or revising it critically for important intellectual content. The final version of this document was approved by all authors before submission. Additionally, all the authors agreed to be 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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