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ORIGINAL ARTICLE

Denervation point for neuromuscular blockade on lateral pectoral nerves: a cadaver study

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Abstract

Purpose The objective of our study was to clarify the topography of the medial and lateral pectoral nerves (LPNs) and the vascularity in the infraclavicular fossa and to propose an ideal injection point for neuromuscular blockade of the pectoralis major (PM) muscle.

Methods The pectoral muscles and their nerves were examined bilaterally on 10 formalin-fixed cadavers. The PM muscle was dissected from its clavicular origin and sternocostal attachments. It was reflected superolaterally to expose the pectoralis minor muscle and neurovascular bundle at the infraclavicular fossa. We took the measurements to identify a landmark point and reach the neurovascular bundle from an overlying point on the skin.

Results The LPN was closely related to the thoracoacromial artery and veins on the lower surface of the PM muscle and was visible under the muscle fascia as a neurovascular bundle. The point where the pM line (perpendicular to midsternal line beginning from the inferior border of the jugular notch) transects the neurovascular bundle was sufficiently close to the point at which the neurovascular bundle enters the PM muscle. Hence, this point was determined as the denervation point in all cadaveric dissections. This denervation point is 2.81 ± 0.33 cm distant vertically from the 1/3 medial part of the clavicle and 8.12 ± 1.09 cm distant horizontally from the midsternal line.

Conclusions We have identified an injection point which may be and suitable and safe location to administer neuromuscular motor blockade of the pectoralis muscles with a percutaneous local anesthetic agent in some clinical pathologies requiring elective denervation.

Keywords Pectoral nerves · Denervation point · Neuromuscular blockade · Cadaver

Introduction

Lateral pectoral nerve (LPN) may arise from the anterior divisions of the upper and middle trunks or from a single root from the lateral cord of the brachial plexus. It receives nerve fibers mostly from C7, some from C6 and much less from C5 [5, 7, 13]. It crosses anterior to the axillary artery and vein and splits into two branches. The upper branch pierces the clavipectoral fascia, and innervates the clavicular head of the pectoralis major (PM) muscle, whereas the lower branch innervates the medial portion of the clavicular head and superior portion of the sternal head of the PM [2, 8, 13].

The medial pectoral nerve (MPN) arises from the medial cord of the brachial plexus, deriving from the ventral rami of C8 and T1. Then, it curves forward between the axillary artery and vein. It is joined by a branch of the LPN to form a plexiform loop around the artery. This connection, the

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ansa pectoralis, is a loop of the lateral and MPNs. It can be composed of nerve bundles from C7 or from C5, C6 and C7 according to the level of its formation. Two or three branches of the MPN pierce the pectoralis minor (Pm) muscle and others may pass round its inferior border to end in the PM [2, 6, 8, 13].

To date, there has been little surgical interest in the anatomy of the pectoral nerves and anatomy textbooks usually provide only a scant description of these nerves [1, 12]. During the surgical interventions involving pectoral muscles, detailed knowledge of the anatomy of the pectoral nerves may be useful in their identification. Currently, neuromuscular blockade of pectoralis muscles is being used in breast surgery and orthopedic procedures, such as shoulder dislocation to obtain better cosmetic results and pain relief by decreasing the muscle tonus [1, 3, 9, 10]. Therefore, the objective of our study was to analyze the topography of the nerve supply to the PM and to propose landmarks to identify the ideal injection point for local nerve blockade in the cadaver model and to highlight its clinical use.

Materials and methods

The anatomical study was performed bilaterally on 10 formalin-preserved cadavers (age ranging from 55 to 88 years). The dissections were performed to identify the neurovascular bundle (NVB) of the PM.

First, the skin and subcutaneous tissues were removed from the pectoral region to expose the sternum and the PM and deltoid muscles. The PM was dissected from its clavicular origin and sternocostal attachments. It was reflected superolaterally to expose the Pm and NVB in which the LPN passes together with pectoral branches of the thoracoacromial artery at the infraclavicular fossa. The NVB was exposed within the fascia beneath the inferior surface of the PM (Fig. 1). The clavicle was disarticulated to expose the brachial plexus. The pectoral nerves were traced proximally toward their origin. The Pm was released from the coracoid process and reflected medially.

The pectoral nerves were identified at the levels of the medial and lateral cords of the brachial plexus. The branching patterns of these nerves and their relationship to the PM and Pm were evaluated to determine their course (Fig. 2). Then, we planned to identify a point to reach the NVB from an overlying point on the skin. A needle was placed over the NVB. Then, the dissected skin flap was replaced its original position. The skin projection point of the needle was named the denervation point (DP). The following landmarks were determined to identify this point over the skin.

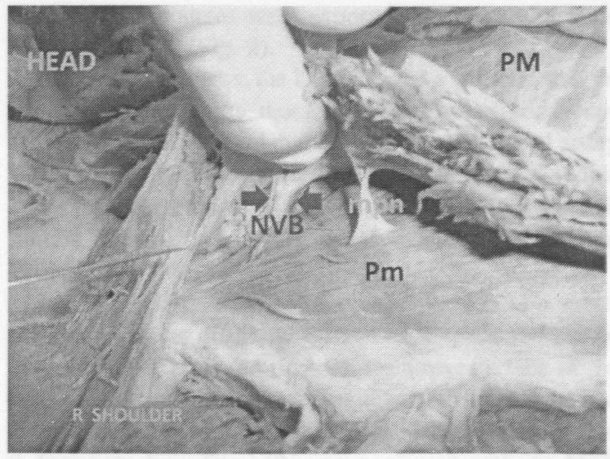

Fig. 1 The pectoralis major muscle (*PM*) is elevated. Medial pectoral nerve (*mpn*) piercing the pectoralis minor muscle (*Pm*). *NVB* neurovascular bundle

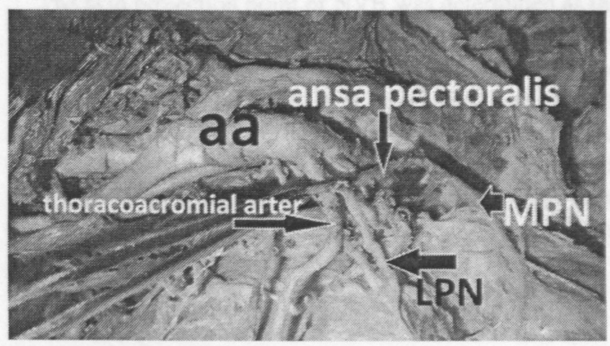

Fig. 2 View of the dissected left clavipectoral triangle. *aa* Axillary artery, *MPN* medial pectoral nerve, *LPN* lateral pectoral nerve

The C line was defined as the longitudinal length of the clavicle between the sternoclavicular and the acromioclavicular joints, and was measured with a flexible ruler. A midsternal line was drawn from the suprasternal notch to the xyphoid process (M line). A line perpendicular to the M line beginning from the inferior border of the jugular notch was also drawn (pM line). The skin projection point of the needle was located sufficiently close to pM line in all cadaveric dissections. A secondary line was required to describe the DP point. Beginning from the DP point, we drew lines perpendicular to the longitudinal axis of the clavicle in all cadavers (pC line). These lines intersected the clavicle approximately at the junction of the 1/3 medial and 2/3 lateral part of the clavicle.

After determining the denervation point, perpendicular distances of this point to the sternum and the clavicle were measured with a flexible ruler and are shown in Table 1. After cadaveric measurements had been performed, a topographic point for neuromuscular blockade was located on the anterior thoracic wall of a living subject (Fig. 3).

Table 1 Measurements between anatomical landmarks

Specimen	Length of clavicle (cm)	Distance of DP to C line (cm)	Distance of DP to M line (cm)
1R	15.00	3.50	9.00
1L	15.00	3.50	9.00
2R	15.00	3.00	7.50
2L	15.00	3.00	7.50
3R	18.00	3.00	11.00
3L	18.00	3.00	11.00
4R	15.00	2.50	7.00
4L	15.00	2.50	7.50
5R	15.00	2.50	7.50
5L	16.00	2.50	7.50
6R	15.80	2.60	8.00
6L	15.60	2.60	8.00
7R	15.60	2.50	8.00
7L	16.00	2.50	8.00
8R	16.00	3.00	7.50
8L	16.00	3.00	7.50
9R	15.40	2.50	8.00
9L	15.40	2.50	8.00
10R	16.00	3.00	7.50
10L	16.00	3.00	7.50
SD	15.74 ± 0.88	2.81 ± 0.33	8.12 ± 1.09

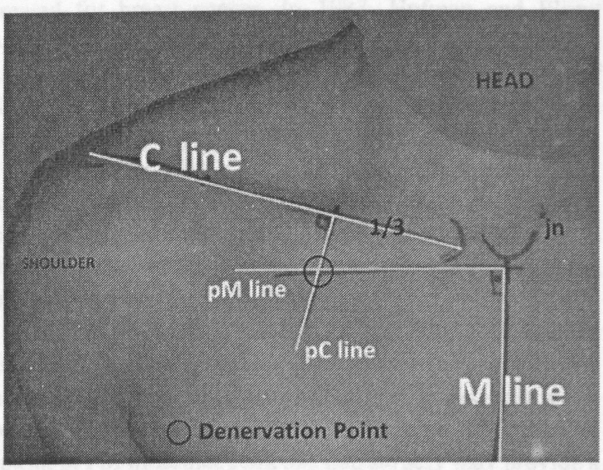

Fig. 3 A diagrammatic drawing of denervation point (DP) on thoracic wall. *C line* drawing line as the longitudinal length of the clavicula, *M line* median line through the sternum, *pM line* the line passing through the most inferior point of the jugular notch perpendicularly to M line, *pC line* the line passing through the medial 1/3 clavicle perpendicularly to C line, *jn* jugular notch

Results

The pectoral nerves were identified at the levels of the medial and lateral cords of the brachial plexus. The branches of these nerves and their relationship to the PM and Pm and their courses were exposed to constitute a landmark for the DP (Fig. 2).

In all the specimens, the LPN showed a constant straight course, parallel to the thoracoacromial artery and veins. The LPN was closely related to the thoracoacromial artery and veins on the lower surface of the PM and was visible under the muscle fascia as a neurovascular bundle. Then, it formed five to six branches to the clavicular and sternal heads of the PM.

In ten specimens, the MPN pierced the Pm as a single trunk at the level of the third intercostal space and one or more branches emerged to reach the lower surface of the PM. In the remaining ten specimens, the MPN passed around the lower border of the Pm to end in the PM as two to four branches. The LPN communicated with the MPN via a branch that passed in front of the axillary artery. This loop formation between the LPN and MPN was observed in all specimens.

The skin projection point of NVB was determined as the DP point in all cadaveric dissections. The distances from the main structures (clavicle, jugular notch, sternum) of the skin projection of the NVB were measured. The average measurement of the length of the clavicle (C line) was 15.74 ± 0.88 cm in the specimens. This ideal DP point is 2.81 ± 0.33 cm distant vertically from the one-third medial part of the clavicle and 8.12 ± 1.09 cm distant horizontally from the midsternal line (Table 1).

Discussion

Neurovascular blockade of the LPN and MPN is of interest in some clinical conditions, such as mastectomy or shoulder dislocations to reduce chronic postoperative pain or muscle spasm [3, 4, 12]. Therefore, it is important to clarify the topography of the medial and LPNs and the vascularity in the infraclavicular fossa.

In the study by Moosman et al. [10], the MPN coursed through the Pm in 62% of the dissections, whereas in the remaining 38%, the nerve exited around the lateral aspect of the Pm in 100 cadaver dissections. In the study by Macchi et al. [8], the LPN showed a constant straight course, parallel to the thoracoacromial artery and veins. It gave rise to four to seven branches that entered the PM. In nine specimens, the MPN pierced the Pm as a single trunk and one or more branches emerged to reach the lower surface of the PM. In the other seven specimens, the nerve formed a lateral branch, which always coursed on the lower surface of the Pm and passed round its lower border to end in the PM. Branching patterns of LPN and MPN in our study were consistent with the study performed by Macchi et al.

We observed that the course of the LPN with upper and lower branches was constant, running with the thoracoacromial vessels, and it was always identifiable as the NVB lying within the fascia beneath the inferior surface of the PM. It gave rise to five to six branches that entered the PM. The MPN pierced the Pm as a single trunk at the level of the third intercostal space and one or more branches emerged to reach the lower surface of the PM in ten specimens; in the remaining ten, the nerve exited around the lateral aspect of the Pm and entered the PM as two to four branches.

The skin projection point of NVB represents DP point in all cadaveric dissections. We believe that this landmark may be a guide for local anesthetic applications for PM denervation. Currently, neuromuscular blockade of pectoralis muscles is being used in some clinical conditions. There have been anecdotal case reports of botulinum toxin use to paralyze the muscles for pain relief [11]. Rakhshanda et al. [4] stated that routine botulinum toxin infiltration of the chest wall musculature at the time of mastectomy and immediate reconstruction with a subpectoral tissue expander would paralyze the muscles and reduce the postoperative pain caused by muscle spasm. In breast cancer surgery, postoperative pain may be followed by chronic neuropathic pain, particularly after the dissection of axillary lymph nodes and injury of the brachial plexus. In fact, postoperative pain may influence the development of chronic postmastectomy pain. This pain may substantially affect the quality of life of patients treated for breast cancer. In 1987, Hofman and Elliott suggested that partial denervation is of value because a slight weakening of the lower half of the PM in itself allows a better projection and a better cosmetic result in breast reconstruction with implant [3].

The shoulder joint is the most unstable joint in the body, and is easily dislocated. Irreducible shoulder dislocation causes spasm of the PM and severe pain. Amit et al. [12] studied the use of botulinum toxin to relieve a PM spasm in irreducible shoulder dislocation.

The PM myocutaneous flap is one of the flaps most frequently used in head and neck reconstruction. Pectoral nerve denervation may also be helpful in decreasing the pain and spasm in head and neck surgery. The relief of spasm in PM musculocutaneous flap surgery may provide a better and safe closure of the defect and better vascularisation with less tension [1].

By making four lines using palpable anatomic landmarks, we found an intersection point which seems to be suitable for denervation of pectoral nerves through injection of a local anesthetic agent at this point.

In the case of anatomical variations, such as an aberrant course of pectoral nerves or the presence of a different route of pectoral muscles, denervation applications may be unsuccessful or may result in undesirable side effects. Loukas et al. reported an unusual innervation of pectoralis minor and major muscles from a branch of the intercostobrachial nerve. Clinical consequences of such a variation may include motor losses, in addition to the commonly reported sensory losses, resulting from accidental or intentional dissection of the intercostobrachial nerve [7].

Conclusion

We propose an injection point which may be an ideal and safe location to administer neuromuscular motor blockade of the pectoralis muscles with a percutaneous local anesthetic agent in some clinical pathologies requiring elective denervation. More clinical studies should be performed to contribute to our knowledge on this topic.

Conflict of interest We do not have a financial relationship with any organization that sponsored the research. We have no conflict of interest.

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