Original Article

Identification of the trapezius branch of the accessory nerve in adult Vietnamese cadavers

Ho Nguyen Anh Tuan[1], Le Quang Tuyen[1], Tran Dang Khoa[1], Nguyen Thanh Tu[1], Nguyen Thanh Van[2*]

[1]Faculty of Medicine, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam. [2]School of Medicine and Pharmacy, Tra Vinh University, Tra Vinh province, Vietnam.

Correspondence: Nguyen Thanh Van, School of Medicine and Pharmacy, Tra Vinh University, Tra Vinh province, Vietnam. tsbsthanhvan@tvu.edu.vn

ABSTRACT

Myofascial pain syndrome is an important health problem, in which the trapezius muscle is one of the most affected muscles in the working-age population. The study was conducted to describe the distribution of nerve points of the accessory nerve to the trapezius muscle in Vietnamese adult cadavers. A cross-sectional descriptive study was performed on 18 trapezius muscles from fresh frozen cadavers of Vietnamese adults. A total of 142 nerve entry points were identified in 18 trapezius muscles, which were grouped into 6 clusters, each with a corresponding center point. In particular, the upper part of the trapezius muscle had the presence of center points 2 and 3; the middle part of the trapezius muscle had center points 1 and 6; and the lower part of the trapezius muscle had center points 4 and 5. Comparison of these points with anatomical landmarks on the skin revealed that the nerve points entering the trapezius muscle tended to be concentrated in three main areas: about 2 cm above the upper angle of the scapula (located between the C7 spinous process and the acromion); the supraspinous fossa; between the medial border of the scapula and the T4-T6 spinous processes. This study provided important data on the distribution of nerve points entering the trapezius muscle of the accessory nerve in adult Vietnamese cadavers, contributing to providing an anatomical basis to support clinical diagnostic and treatment applications, especially in pain management and therapeutic interventions.

Keywords: Accessory nerve, Nerve points, Trapezius muscle, Vietnam

Introduction

Myofascial pain syndrome is defined as a localized hyperexcitability of muscle tissue [1]. It manifests clinically as localized pain and radiating pain after stimulation of certain areas of muscle and fascia, known as trigger points [1]. Electrophysiological analyses have shown that trigger points are associated with neuromuscular dysfunction with excessive release of acetylcholine [2, 3]. This is demonstrated histopathological by the presence of shortened myofascial units [4]. Recent investigations reveal a link between the anatomical positions of muscle belly entrance sites of motor nerve branches and the locations of clinically identified trigger points [5].

The Trapezius muscle is one of the most vulnerable muscles in the working-age population [6-8]. This is also the area most affected by trigger points, especially the upper part of the trapezius muscle [1, 9]. Trapezius trigger points not only cause pain in the shoulder area, but the pain also spreads to many other areas such as the neck, head, back, arms, and lower jaw due to the wide attachment area of the trapezius muscle [1, 10].

At present, in addition to non-pharmacological treatments, trigger point injection therapy with botulinum toxin A is an effective analgesic method in the treatment of myofascial pain syndrome [2, 11]. Recommendations suggest that if the target muscle is a superficial muscle layer such as the trapezius muscle, the injection should be based on surface anatomical landmarks instead of using electromyography [12, 13]. A comprehensive delineation of the motor nerve points' placement on the skin surface, which penetrates the muscle, not only elucidates the pathophysiology of myofascial pain syndrome but also furnishes

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Tuan HNA, Tuyen LQ, Khoa TD, Tu NT, Van NT. Identification of the trapezius branch of the accessory nerve in adult Vietnamese cadavers. J Adv Pharm Educ Res. 2025;15(1):103-9. https://doi.org/10.51847/47D0yHGoE3

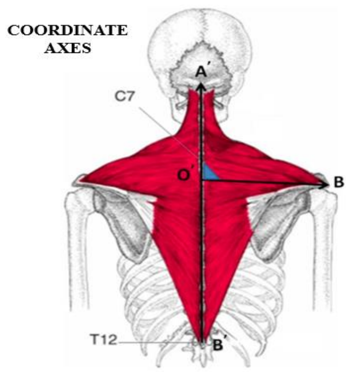
critical data that underpins diagnostic and therapeutic applications in clinical practice.

Initial research on this issue has been conducted globally; however, they mostly focused on the superior region of the trapezius muscle and did not include the other parts of the muscle [14-16]. No study has been undertaken in Vietnam on the location of nerve points of the accessory nerve inside the trapezius muscle. Consequently, we undertook this investigation to delineate the distribution of nerve sites of the accessory nerve inside the trapezius muscle in the cadavers of Vietnamese adults.

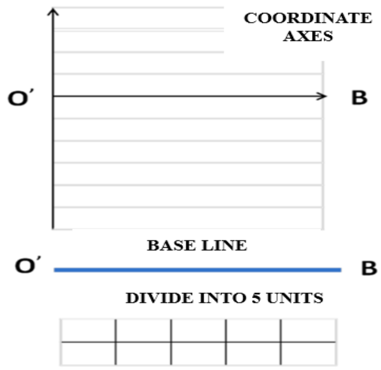
Materials and Methods

The current research was performed from May to October 2024 at the Department of Anatomy, Basic Sciences - Basic Medicine, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam. The research was performed on nine adult Vietnamese cadavers that had been cryopreserved. The cadavers included 5 men and 4 females, with a mean age of 71.8 ± 15.7 years (spanning from 53 to 99 years). The chosen samples exhibited intact neck, shoulder, and back regions, devoid of abnormalities from trauma or congenital anomalies, and had no surgical history in these areas. The investigation included the dissection of a total of 18 trapezius muscles, including 9 samples from the right side and 9 samples from the left side.

The study employed a coordinate system to ascertain the distribution of nerve points on the skin surface, comprising: Horizontal axis O'B (where B denotes the midpoint of the lateral edge of the acromion and O' represents the perpendicular projection of B onto the vertical axis); Vertical axis A'B' (with A' indicating the lateral occipital protuberance and B' signifying the T12 spinous process); and the coordinate origin O' as the perpendicular projection of B onto the vertical axis. The positions of nerve points were established by measuring the abscissa and ordinate of each point inside the coordinate system. The points were evaluated to determine their position relative to the abscissa. In addition, the O'B segment was divided into 05 unit intervals according to the method of author Yi KH [16], and then the distribution ratio of nerve points in each interval was determined **(Figure 1)**.



a)



b)

Figure 1. The coordinate system of the trapezoidal axis and how to divide the unit interval on the coordinate system

Clustering method of nerve points

To investigate the relationship between the locations of nerve points entering the muscles in human cadavers and the trigger points of the trapezius muscle in clinical practice, it is necessary to identify a system of points that represent the study sample. Therefore, we grouped these nerve points into clusters, in which each cluster has a corresponding center point, also known as the centroid point.

The clustering procedure is performed with the k-means clustering technique. The k-means algorithm utilizes the Elbow Method to ascertain the appropriate number of clusters. This approach computes the sum of squared distances of the component points inside each cluster to their respective centroid. As the quantity of clusters escalates, the aggregate of squared distances will diminish. Nonetheless, above a certain threshold, as the quantity of clusters escalates, the total squared distances remain relatively constant. This point is known as the Elbow Point and represents the ideal number of clusters for grouping **(Figure 2)**.

Upon establishing the number of clusters, we input the coordinates of the surveyed nerve sites into SPSS software and executed the k-means clustering procedure. The program will provide the outcomes for each cluster, including the component points and the respective centroid of each cluster.

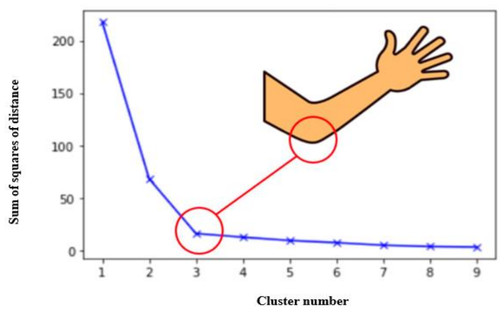
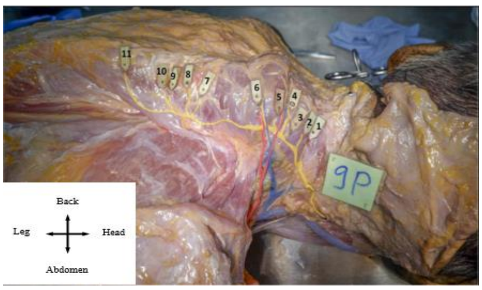


Figure 2. Elbow method to determine the optimal number of clusters

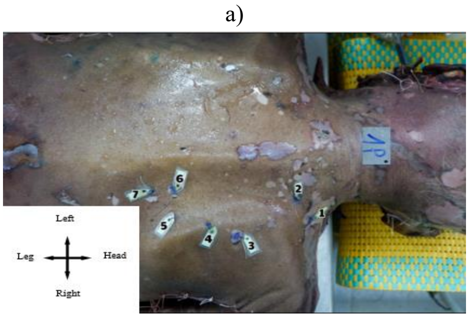
Research process

After thawing at room temperature, the cadavers that met the sampling criteria were placed in a prone position on the dissection table. On the skin surface, the horizontal and vertical axes of the coordinate system were marked with colored tape, and the dimensions of the coordinate axes were measured. The dissection was performed using two main skin incisions. The anterior incision started from the sternal notch, ran along the midline to the chin condyle, and continued toward the angle of the mandible and mastoid process; at the same time, another incision extended from the sternal notch along the clavicle to the acromioclavicular joint. The posterior incision started from the spinous process of T12, ran horizontally along the posterior axillary line, ascended to the acromioclavicular process, and advanced toward the acromioclavicular joint. When the two incisions met, the skin and subcutaneous tissue were dissected until the anterior and inferior borders of the trapezius muscle were exposed. The trapezius attachment was then dissected at the posterior 1/3 of the clavicle border, the acromioclavicular process, and the scapula, and the muscle was turned toward the midline of the back to continue the process of nerve identification.

The main trunk of the accessory nerve was located on the ventral surface of the trapezius muscle, and the nerve entry points were identified as the places where the primary branches branched off the main trunk and entered the muscle. At each of these points, a threaded needle was inserted perpendicularly from the ventral surface of the trapezius muscle through the skin, and the two ends of the thread were fixed to a numbered tag on both the skin and the ventral surface of the trapezius muscle to mark the exact location. After marking was completed, the trapezius muscle was returned to its original position. On the skin surface, each marked point was projected onto the coordinate system by using a set square to lower it perpendicularly onto the horizontal and vertical axes. The distance from the origin of the coordinates to each marked point on the two axes was precisely measured to determine the distribution of the nerve entry points into the muscle **(Figure 3)**.



a)



b)

Figure 3. Marking of primary branches on the muscle surface (a) and on the skin surface (b)

Research ethics

The study was approved by the Ethics Council in Biomedical Research of Pham Ngoc Thach University of Medicine under Decision No. 1079/TĐHYKPNT-HDDD dated March 12, 2024.

Results and Discussion

Characteristics of nerve point distribution on the coordinate system

The study found that 100% of cases (18/18 trapezius muscles) had the presence of primary branches that separated from the main trunk of the accessory nerve and entered the ventral surface of the trapezius muscle. The average number of primary nerve branches was 7.9 ± 2.5. In total, the study recorded 142 primary nerve branches, distributed in all three parts of the trapezius muscle. Of which, the middle part had the highest proportion with 54.9%, followed by the upper part 24.6% and the lower part 20.4%. With 142 primary nerve branches, we identified 142 nerve points entering the corresponding muscles. The results showed that the nerve points on the skin surface were mainly distributed below the horizontal axis with a rate of 75.4% (107/142 nerve points), while above the horizontal axis accounted for 24.7% (35/142 nerve points). When dividing the O'B segment into 05-unit intervals, **Figure 4** shows that the nerve points are mainly concentrated from interval 01 to interval 03 with a total ratio of 99.3%. **Figure 5** illustrates the limited range of the nerve points, which are encircled in a rectangle with a width equal to 1 unit interval of the horizontal axis (the second interval) and a length equal to 4/10 of the vertical axis.

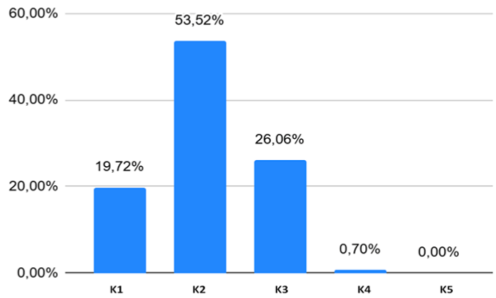


Figure 4. Proportion of nerve points on the coordinate system in each unit interval

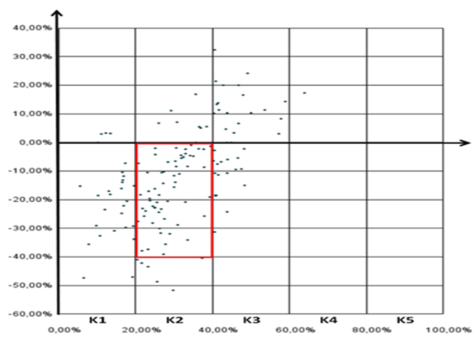
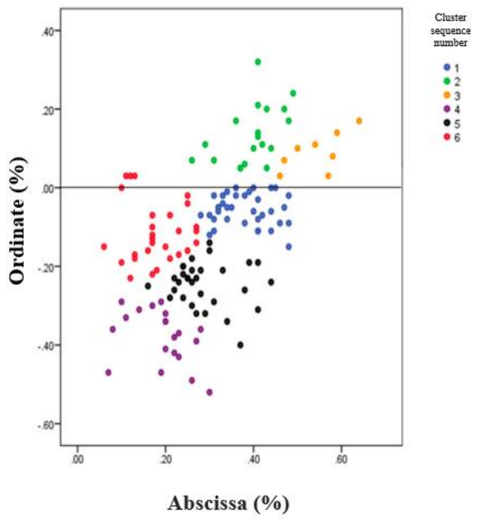


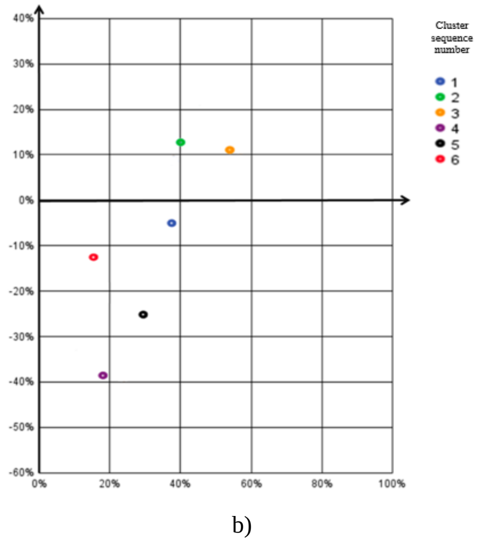
Figure 5. Location of nerve points on the coordinate system according to the division of 05-unit intervals

Distribution of nerve points into clusters using a k-means clustering algorithm

Based on the elbow method of the k-means algorithm, the study determined the optimal number of clusters to group 142 nerve points as 6 clusters. Although at point 10, the total distance between the component points and the center point reached the smallest level, from point 6 onwards, when continuing to increase the number of clusters, the total distance changed insignificantly. In each cluster, the study determined a corresponding center point (called a centroid) **(Figure 6)**.



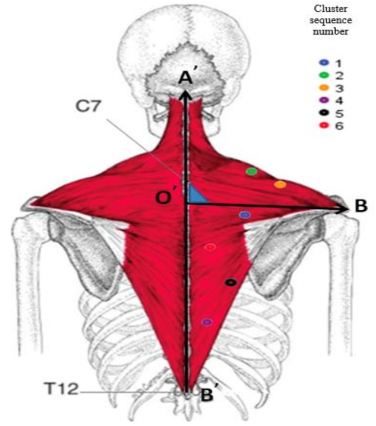
a)



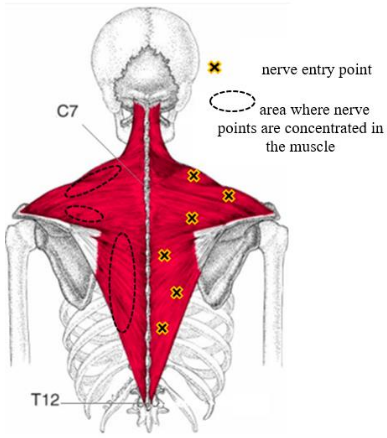
b)

Figure 6. Distribution of 142 nerve points in 06 clusters (a) and Distribution position of 06 center points of the clusters on the coordinate system (b)

When clustering the nerve points, the study noted the presence of center points 2 and 3 in the upper part of the trapezius muscle; the presence of center points 1 and 6 in the middle part of the trapezius muscle; and the presence of center points 4 and 5 in the lower part of the trapezius muscle. In addition, when determining the location of the nerve points relative to the bone landmarks on the skin surface, the results showed that the nerve points were concentrated in three main areas, including about 2 cm above the upper corner of the scapula (located between the spinous process of C7 and the acromion); the supraspinous fossa; and the area between the medial border of the scapula and the spinous processes of T4-T6 **(Figure 7)**.



a)



b)

Figure 7. Location distribution of the 06 central points of the clusters on the trapezius muscle (a) and the area where the nerve points concentrate in the muscle compared to the bone landmarks on the skin surface (b)

Myofascial trigger points (MTPs) are considered a pathophysiological model of pain of various etiologies [17]. These points, also known as muscle knots, are hyperirritable areas within the muscle, associated with contractile nodules and dysfunctional motor endplates [1]. Trigger points can theoretically occur anywhere in skeletal muscle, but are most commonly found near the neuromuscular junction [1, 17, 18]. A nerve entry point is defined as the location where a motor nerve branch enters the epimysium of a muscle belly [19]. Akamatsu FE [20, 21] found that the nerve points entering the muscle and the myofascial trigger points have anatomical overlap, suggesting a potential relationship between the innervation and the formation of pain points. Many neck and thoracic pain syndromes are associated with trigger points in the trapezius muscle. Therefore, understanding the relationship between the nerve points entering the trapezius muscle and the clinical location of trigger points not only contributes to elucidating the pathogenesis but also brings important application value in clinical diagnosis and treatment.

The nerve distribution in the trapezius muscle is very diverse in each individual. Therefore, in order to help clinicians easily apply it in practice, this study conducted a clustering of motor nerve points using the k-means algorithm and identified 142 nerve points divided into 06 main clusters, in which: in the upper part of the trapezius muscle, the central points 2 and 3 are present; in the middle part of the trapezius muscle, the central point's 1 and 6 are present; and in the lower part of the trapezius muscle, the central point's 4 and 5 are present. This result shows a significant overlap between the motor nerve point clusters and the fascial trigger points described in previous studies.

Center points 2 and 3 in this study are similar to TrP 1 and TrP 2 of Travell JG [1]. Akamatsu FE's study also noted the presence of MTP1 located in the middle of the anterior border of the upper part of the trapezius muscle (on the fibers going from the superior nuchal line, then running longitudinally to the clavicle attachment), and MTP 2 located near MTP 1, slightly deviated (on the fibers going from the nuchal ligament, running horizontally, converging forward and attaching to the clavicle) [20, 22]. The locations of center points 1 and 6 in the middle part of the trapezius muscle in this study are similar to TrP 5 of Travell [1] and MTP 5.1 and MTP 5.2 of Akamatsu [20]. Center points 4 and 5 in the lower part of the trapezius muscle correspond to TrP 3 of Travell [1] and MTP 3 and MTP 3.1 of Akamatsu [20].

When comparing the results of this study with the studies on trigger points in living people by the authors Fernandez-de-las-Penas C [10] and Ge HY [23, 24], because the subjects of the two studies above were living people, while this study was conducted on cadavers, we only focused on comparing the locations of motor nerve points with clinically significant pain points. The study by Fernandez-de-las-Penas C [10, 25] examined the pain pressure threshold at 11 locations in the shoulder area, the upper part of the trapezius muscle had a point of 4 (between the spinous process of C7 and the acromion) corresponding to the center points 2 and 3 in our study; the middle part of the trapezius muscle had a point of 5 (the angle of the scapula) and a point of 10 (between the spinous process of T4 and the medial border of the scapula) corresponding to the center points 1 and 6; The lower part has a score of 11 (between the T6 spinous process and the medial border of the scapula) corresponding to the central point's 4 and 5. In Ge HY's study [23, 26, 27], upper parts of the trapezius muscle had scores of 3, 4, and 5 corresponding to points 2 and 3 in our study; the middle part of the trapezius muscle had scores of 8, 9 corresponding to the central point 1 in this study.

Although the use of coordinate systems helps to locate nerve points on the skin surface scientifically, this method is quite complicated to remember in clinical practice. Therefore, we propose a simpler and more intuitive method by describing the concentration of nerve points in the muscle based on palpable bony landmarks under the skin, specifically the scapula. The results of the study showed that the nerve points into the trapezius muscle tend to concentrate in three main areas: about 2 cm above the upper angle of the scapula (located between the C7 spinous process and the acromion); the supraspinatus fossa; and between the medial border of the scapula and the T4-T6 spinous processes. This bony landmark-based description method has the advantage of being simple, intuitive, and easy for clinicians to apply in practice. However, it should be noted that these areas have spatial overlap between the trapezius muscle (superficial muscle) and the underlying muscles such as the supraspinatus, rhomboid, and levator scapulae. Therefore, more in-depth studies are needed to examine the relationship between the trigger points of these muscles clinically and the location of the motor nerve points entering the muscles, to help distinguish the system of pain points characteristic of the trapezius muscle from those of neighboring muscles.

Conclusion

The findings in this study contribute to providing an important anatomical basis, supporting orientation in the diagnosis and treatment of pain syndromes related to the trapezius muscle in clinical practice. The results show that the 142 nerve points surveyed can be grouped into 6 clusters, with each cluster having a corresponding central point distributed in all three parts of the trapezius muscle. When describing the distribution area of these points compared to bone landmarks on the skin surface for convenient clinical application, the results show that the nerve points entering the trapezius muscle tend to be concentrated in three main areas: about 2 cm above the upper angle of the scapula (or between the C7 spinous process and the acromion); the supraspinous fossa; between the medial border of the scapula and the T4-T6 spinous processes.

Acknowledgments: We would like to express our heartfelt gratitude to Pham Ngoc Thach University of Medicine for providing the necessary tools and equipment that facilitated the successful completion of this study. Our deepest appreciation goes to the volunteers and their families who selflessly donated their bodies to medical science. Their invaluable contribution has significantly advanced our understanding of human anatomy and will continue to benefit medical education and research for years to come.

Conflict of interest: None

Financial support: None

Ethics statement: The study was reviewed and approved by the Ethics Committee of Pham Ngoc Thach University of Medicine. No identifiable information was collected. All data used in the study were anonymized and securely stored in accordance with the institutional regulations.

References

1. Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Vol 2. Lippincott Williams & Wilkins; 1992.
2. Zhuang X, Tan S, Huang Q. Understanding of myofascial trigger points. Chin Med J. 2014;127(24):4271-7.

3. Shah JP, Gilliams EA. Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: an application of muscle pain concepts to myofascial pain syndrome. J Bodyw Mov Ther. 2008;12(4):371-84.
4. Jin F, Guo Y, Wang Z, Badughaish A, Pan X, Zhang L, et al. The pathophysiological nature of sarcomeres in trigger points in patients with myofascial pain syndrome: a preliminary study. Eur J Pain. 2020;24(10):1968-78.
5. Ziembicki T. Nerve entry points – the anatomy beneath trigger points. J Bodyw Mov Ther. 2023;35:121-3. doi:10.1016/j.jbmt.2023.04.083
6. Steingrímsdóttir OA, Køpke Vøllestad N, Knardahl S. A prospective study of the relationship between musculoskeletal or psychological complaints and muscular responses to standardized cognitive and motor tasks in a working population. Eur J Pain. 2005;9(3):311-24. doi:10.1016/j.ejpain.2004.08.001
7. Richter JM, Mathiassen SE, Slijper HP, Over EA, Frens MA. Differences in muscle load between computer and non-computer work among office workers. Ergonomics. 2009;52(12):1540-55. doi:10.1080/00140130903199905
8. Cagnie B, Dhooge F, Van Akeleyen J, Cools A, Cambier D, Danneels L. Changes in the microcirculation of the trapezius muscle during a prolonged computer task. Eur J Appl Physiol. 2012;112(9):3305-12. doi:10.1007/s00421-012-2322-z
9. Ricci V, Mezian K, Chang KV, Tarantino D, Güvener O, Gervasoni F, et al. Ultrasound imaging and guidance for cervical myofascial pain: a narrative review. Int J Environ Res Public Health. 2023;20(5):3838. doi:10.3390/ijerph20053838
10. Fernández-de-las-Peñas C, Madeleine P, Caminero AB, Cuadrado ML, Arendt-Nielsen L, Pareja JA. Generalized neck-shoulder hyperalgesia in chronic tension-type headache and unilateral migraine assessed by pressure pain sensitivity topographical maps of the trapezius muscle. Cephalalgia. 2010; 30(1):77-86. doi:10.1111/j.1468-2982.2009.01901.x
11. Urits I, Charipova K, Gress K, Schaaf AL, Gupta S, Kiernan HC, et al. Treatment and management of myofascial pain syndrome. Best Pract Res Clin Anaesthesiol. 2020;34(3):427-48.
12. Schnitzler A, Roche N, Denormandie P, Lautridou C, Parratte B, Genet F. Manual needle placement: accuracy of botulinum toxin A injections. Muscle Nerve. 2012;46(4):531-4.
13. Lee JH, Lee KY, Kim JY, Son WH, Jeong JH, Gil Jeong Y, et al. Botulinum toxin injection-site selection for a smooth shoulder line: an anatomical study. Biomed Res Int. 2017;2017(1):3092720. doi:10.1155/2017/3092720
14. Barbero M, Cescon C, Tettamanti A, Leggero V, Macmillan F, Coutts F, et al. Myofascial trigger points and innervation zone locations in upper trapezius muscles. BMC Musculoskelet Disord. 2013;14:1-9.
15. Bae JH, Lee JS, Choi DY, Suhk J, Kim ST. Accessory nerve distribution for aesthetic botulinum toxin injections into the upper trapezius muscle: anatomical study and clinical trial: reproducible BoNT injection sites for upper trapezius. Surg Radiol Anat. 2018;40:1253-9.
16. Yi KH, Lee HJ, Choi YJ, Lee K, Lee JH, Kim HJ. Anatomical guide for botulinum neurotoxin injection: Application to cosmetic shoulder contouring, pain syndromes, and cervical dystonia. Clin Anat. 2021;34(6):822-8.
17. Hong CZ. Myofascial trigger points: pathophysiology and correlation with acupuncture points. Acupunct Med. 2000;18(1):41-7. doi:10.1136/aim.18.1.41
18. Joseph KA, Ahuja S, Zaheer S. Secondary ovarian malignancy in an imatinib treated chronic myeloid leukemia patient diagnosed on fluid cytology. Clin Cancer Investig J. 2023;12(4):10-3. doi:10.51847/y7ma3YBrbY
19. Safwat MD, Abdel-Meguid EM. Distribution of terminal nerve entry points to the flexor and extensor groups of forearm muscles: an anatomical study. Folia Morphol (Warsz). 2007;66(2):83-93.
20. Akamatsu FE, Ayres BR, Saleh SO, Hojaij F, Andrade M, Hsing WT, et al. Trigger points: an anatomical substratum. Biomed Res Int. 2015;2015(1):623287. doi:10.1155/2015/623287
21. Gioia G, Freeman J, Sipka A, Santisteban C, Wieland M, Gallardo VA, et al. Study of bacterial contamination of house flies in different environments. Entomol Appl Sci Lett. 2023;10(4):56-61. doi:10.51847/Rb6CEz672N
22. Aburas M. Characterization and identification of pantoea calida from contaminated soil and its biocontrol by streptomyces coeruleorubidus. World J Environ Biosci. 2022;11(3):50-6. doi:10.51847/JxVBFGWSn1
23. Ge HY, Nie H, Madeleine P, Danneskiold-Samsøe B, Graven-Nielsen T, Arendt-Nielsen L. Contribution of the local and referred pain from active myofascial trigger points in fibromyalgia syndrome. Pain. 2009;147(1-3):233-40. doi:10.1016/j.pain.2009.09.019
24. Alqahatani S. Study on machine learning and deep learning in medical imaging emphasizes MRI: a systematic literature review. Int J Pharm Res Allied Sci. 2023;12(2):70-8. doi:10.51847/kj4hoW5tIZ
25. Choudhary V, Sharma S, Vashishtha S, Malik A. Recent findings, application and future direction of natural extracts: mucilage. Int J Pharm Phytopharmacol Res. 2023;13(1):33-43. doi:10.51847/EAUqALnIHP
26. Al-Twaijri SA, AlKharboush GH, Alohali MA, Arab IF, Alqarni RH, Alharbi MS. Application of lasers for soft tissues in orthodontic treatment: a narrative review. Bull Pioneer Res Med Clin Sci. 2024;3(1):1-6.
27. Uzun K, Karataş Z. Investigating the role of metacognitive beliefs, ambiguity tolerance, and emotion processing in predicting nurses' generalized anxiety disorder. J Integr Nurs Palliat Care. 2022;3:36-42. doi:10.51847/mXbCbDAVpU