Letter to the Editor

Cite as: Damjanovic M, Damjanovic I, Quigg J, Lee R, Bale L: The atlantomastoid: a muscle variant relevant to point-of-care ultrasound? J Ultrason 2024; 24: 21. doi: 10.15557/JoU.2024.0021.

Submitted: 29.09.2023
Accepted: 29.01.2024
Published: 27.06.2024

The atlantomastoid: a muscle variant relevant to point-of-care ultrasound?

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Keywords
anatomy; ultrasonography; muscles; diagnostic imaging; point-of-care

DOI: 10.15557/JoU.2024.0021

The atlantomastoid is a variant muscle of the suboccipital region, originating from the transverse process of the atlas (C1) and inserting on the posterior aspect of the mastoid process of the temporal bone (Fig. 1 A). The atlantomastoid is supplied by the occipital artery and innervated by the suboccipital nerve[(1)]; the former is a branch of the external carotid artery and the latter is formed by the dorsal ramus of C1. A recent study determined the muscle's prevalence to be 15%[(2)]. Because of the atlantomastoid's proximity to the four typical suboccipital muscles and certain neurovascular structures of the posterior cervical region, detection of the atlantomastoid muscle using ultrasound may be beneficial for clinicians performing interventional procedures in the suboccipital region, and for manual therapists that manipulate the cervical spine. Summarized in this letter is a point-of-care ultrasound (POCUS) simulation that was conducted on a cadaveric specimen, whereby the mastoid process, the transverse process of C1, and the obliquus capitis inferior served as anatomical landmarks to aid in the imaging of the muscle. This letter aims to bring attention to the atlantomastoid variant and highlight its potential clinical importance for POCUS practitioners.

The right suboccipital region of a fresh frozen cadaveric specimen featured an atlantomastoid muscle that measured approximately 2.5 cm in length and 0.5 cm in width (Fig. 1 B). After completing dissection, the donor was placed prone with the neck in neutral position and the head oriented slightly to the right. The reflected superficial muscle layers and overlying skin were re-approximated. The SonoSite Edge II portable ultrasound system was used, and a linear transducer 13-6 MHz probe was placed in the sagittal plane, starting from the origin of the obliquus capitis inferior on the spinous process of the second cervical vertebra. Scanning was done superolaterally until the atlantomastoid muscle could be visualized in long axis spanning between the transverse process of C1 and the mastoid process (Fig. 1 C, Fig. 1 D). To confirm the sonographic identification of the atlantomastoid, the overlying muscles and skin flap were reflected laterally to allow access to the suboccipital region. The tip of an 18-gauge needle was placed into the muscle belly. The needle was held in place, while the tissue layers on the right side of the neck were re-approximated to confirm that the scanned image was in fact the variant muscle. After sonographic images were recorded, the tissue layers were again reflected laterally to confirm that the needle tip was still placed appropriately in the muscle belly. The atlantomastoid appeared as a hypoechoic structure with some internal white signals due to the presence of collagen fibers. After the POCUS simulation was complete, the muscle was excised from the donor and histological slides were prepared.

Relevance to point-of-care ultrasound

Atrophy of the suboccipital muscles has been observed in patients who experience headaches following whiplash-type injuries and tension-type headaches[(3)]. Needle electromyography (EMG) is a diagnostic technique that can be used to determine the underlying cause of muscle atrophy. The EMG procedure involves inserting a needle electrode into each suboccipital muscle to record and analyze electrical signals, allowing clinicians to differentiate between atrophy from disuse versus atrophy from denervation – an important factor in determining course of treatment. Each muscle is identified using anatomical landmarks prior to needle insertion[(3)]. The atlantomastoid is thought to contribute to head extension if present bilaterally and lateral flexion and/or rotation of the head if present unilaterally[(1,4)]; thus, the variant muscle shares common functions with the typical suboccipital muscles. The authors suggest that the atlantomastoid, when present and identified by ultrasound, should be considered for EMG analysis.

Manual therapists may use an invasive technique known as dry needling; a method of pain relief involving the insertion of solid filament needles into specific myofascial trigger points[(5)]. Dry needling of the suboccipital muscles is used to treat cervicogenic headache and often results in positive outcomes including increased range of motion and significant reductions in local and widespread pain[(5)]. If variant muscles like the atlantomastoid have the potential to play an etiological role in chronic pain, detection using POCUS prior

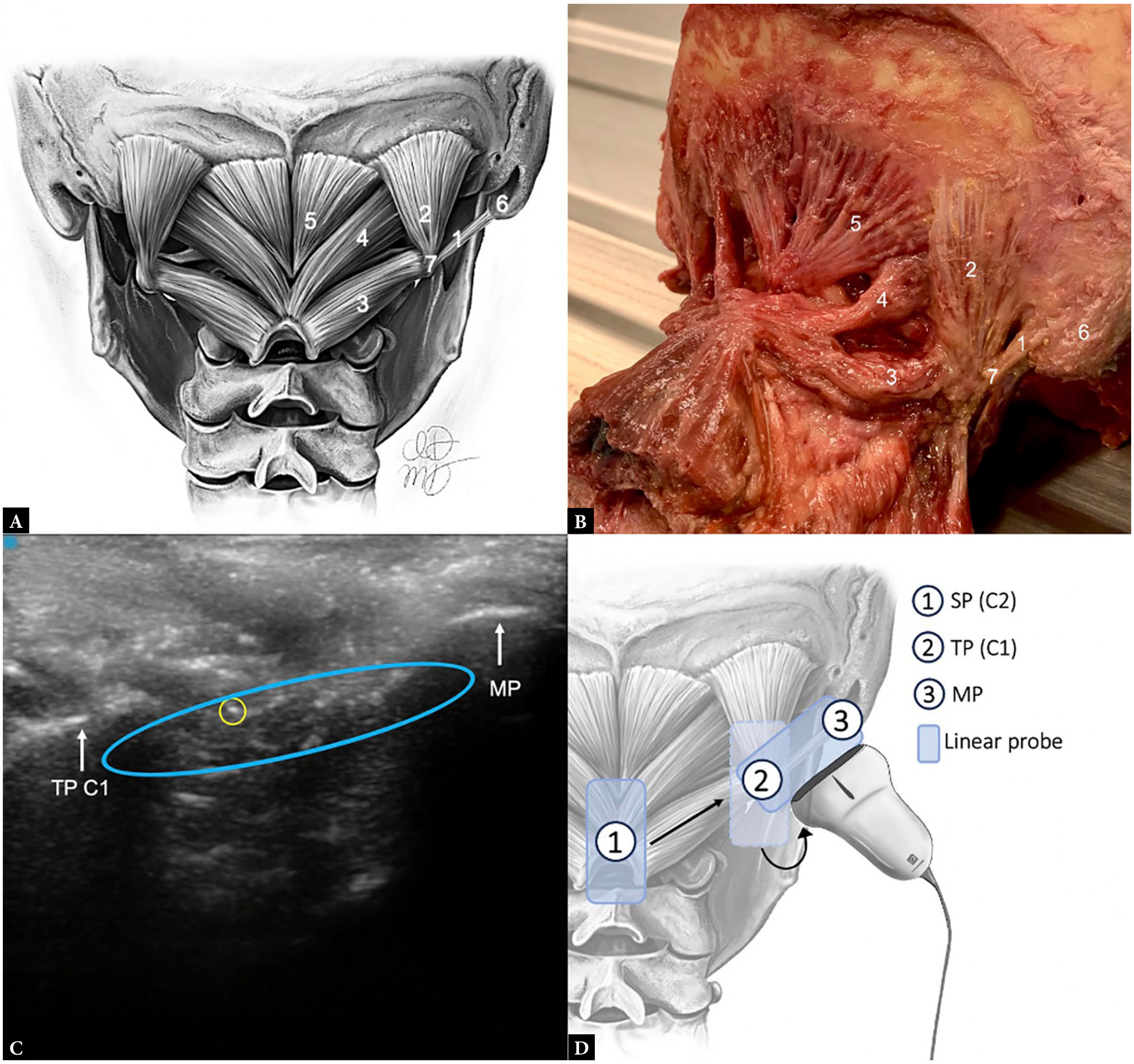

Fig. 1. A. *Illustration of the atlantomastoid and typical suboccipital musculature – based on the THIEME Atlas of Anatomy (1 – atlantomastoid; 2 – obliquus capitis superior; 3 – obliquus capitis inferior; 4 – rectus capitis posterior major; 5 – rectus capitis posterior minor; 6 – mastoid process; 7 – transverse process of C1).* **B.** *Suboccipital region of a fresh frozen donor with the atlantomastoid muscle present on the right side (posterolateral view).* **C.** *Annotated ultrasound image of the atlantomastoid with a yellow circle indicating the 18-gauge needle tip out of plane on the surface of the muscle, and a blue oval indicating the muscle belly of the atlantomastoid – long axis view (MP – mastoid process; TP C1 – transverse process of the first cervical vertebra).* **D.** *Graphic schematic of ultrasound examination with relevant anatomical landmarks and probe positioning (SP C2 – spinous process of the second cervical vertebra; TP C1– transverse process of the first cervical vertebra; MP – mastoid process)*

to intervention could result in a new target in pain management. Furthermore, treatment for chronic tension-type headache involves a variety of modalities primarily focused on the suboccipital region[(6)]. One of the most common treatment methods is suboccipital release, a non-invasive osteopathic manipulation technique that targets the suboccipital musculature[(7)]. It is recommended that patients undergo a complete musculoskeletal exam of the neck prior to a suboccipital release, as concern for neurovascular compromise is a contraindication for the procedure[(8)]. Since variations in suboccipital musculature are closely associated with compression of neurovascular structures such as the vertebral artery and the greater and third occipital nerves[(2)], POCUS evaluation during the initial exam may be beneficial in determining patient suitability prior to cervical manipulation. If present, the atlantomastoid lies in close proximity to certain neurovascular structures of the posterior cervical region. The occipital artery courses between the lateral border of the obliquus capitis superior and the medial border of the atlantomastoid prior to ascending obliquely towards the external occipital protuberance[(2)]. The greater, lesser, and third occipital nerves travel medially relative to the atlantomastoid to innervate the posterior scalp. At the current time, the relationships between these nerves and the atlantomastoid have not been discussed in the literature, however the authors postulate that the lesser occipital nerve in particular could be in close proximity to the atlantomastoid. Additionally, the third segment of the vertebral artery lies in close relationship to three bony landmarks: the transverse process of C1, the posterior tubercle of C1, and the tip of the mastoid process. As the atlantomastoid originates from the transverse process of C1 and inserts on the mastoid process, it would lie in close proximity to the third segment of the vertebral artery.

Clinicians performing interventional procedures in the suboccipital region, like ultrasound-guided greater occipital nerve (GON) blocks and botulinum toxin injection into the suboccipital muscles to treat pain related to compressed nerves, muscle spasm, occipital neuralgia, and chronic tension-type headache, could benefit from knowledge of the atlantomastoid muscle because of its relationships to key anatomical landmarks and neurovascular structures in the region[4]. The procedure for ultrasound-guided GON blocks typically involves the use of the obliquus capitis inferior as the primary anatomical landmark to identify the GON prior to needle injection[9]. However, muscular variations in the suboccipital region have been shown to cause alterations in the pathway of the GON[1], further illustrating the value of POCUS identification of muscular variants that may influence the treatment approach if discovered prior to performing the procedure. Ultrasound-guided injection of a local anesthetic-steroid combination into the suboccipital muscles has been shown to be an effective management strategy for post-dural puncture headache[10], again indicating the potential for the atlantomastoid to be considered a target for treatment, when present.

This cadaveric POCUS simulation indicates that the atlantomastoid muscle variant, when present, can be identified during scanning by using the obliquus capitis inferior, the transverse process of C1, and the mastoid process as landmarks. This letter aims to help foster interest in the atlantomastoid muscle and encourage POCUS practitioners to consider the muscle's relevance in the diagnosis and treatment of chronic pain conditions.

Statement of ethics approval

Ethical approval for this study was granted by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Acknowledgements

The authors are grateful for the assistance of Dr. Joseph Newbigging and Dr. Tatiana Vukadinovic for their POCUS expertise. We also thank Mitchell Doherty and the staff of the Clinical Simulation Centre at Queen's University.

Author contributions

Original concept of study: JQ, RL, LB. Writing of manuscript: MD, ID, JQ, LB. Analysis and interpretation of data: JQ. Final approval of manuscript: MD, ID, JQ, RL, LB. Collection, recording and/or compilation of data: MD, ID, JQ, LB. Critical review of manuscript: MD, ID, JQ, RL, LB.

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