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CASE REPORT

Pterygoideus proprius muscle: stuck between the greater wing and lateral pterygoid plate

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ABSTRACT

The muscles of mastication derive from a common embryological source, and the presence of accessory muscles in the infratemporal fossa (ITF) is uncommon. Here, we present findings from postmortem dissection of the ITF revealing a unilaterally present muscle extending from the greater wing of the sphenoid to blend inferiorly with the medial and lateral pterygoid muscles before attaching to the lateral pterygoid plate. This muscle is most consistent with the pterygoideus proprius muscle initially described in 1858. Though the exact embryological origin and function of this muscle remain speculative, these topics are nonetheless worth investigating as it may provide insight regarding the ontogeny of muscles descending from the first pharyngeal arch. Additionally, presence of the pterygoideus proprius muscle may have clinical implications and impact surrounding structures such as the mandibular division of the trigeminal nerve, maxillary artery, pterygoid venous plexus, masticatory muscles, and temporomandibular joint (TMJ).

Keywords: muscles of mastication, dissection, infratemporal fossa, temporomandibular joint

INTRODUCTION

The infratemporal fossa (ITF) is located deep and inferior to the zygomatic arch and contains several muscles of mastication, branches from the mandibular division of the trigeminal nerve, maxillary artery, and pterygoid venous plexus. Four muscles of mastication are typically found bilaterally: the temporalis muscle, masseter muscle, and medial and lateral pterygoid muscles. The two pterygoid muscles are found within the ITF while the temporalis and masseter muscles are found laterally. Likely owing to a common developmental lineage, accessory muscles have been identified in the ITF. The present case describes an accessory muscle that fits prior descriptions of pterygoideus proprius muscle; however, several variations have been described in terms of attachment, innervation, size, and laterality. Pterygoideus proprius muscle was initially described as a vertically oriented fibrous band attaching from the infratemporal crest of the sphenoid to the lateral pterygoid plate [4]. In 1981, Barker noted a pterygoideus proprius muscle running from the greater wing to the lateral pterygoid plate and palatine bone. Interestingly, fibers mingled with those of the inferior head of the lateral pterygoid muscle and superficial head of the medial pterygoid muscle [2]. Later, Penhall et al. identified three individuals with unilateral pterygoideus proprius muscles out of 150 donors (2% incidence). In the three cases, the muscle attached to the infratemporal crest and ran inferiorly toward the lateral pterygoid plate. Each case yielded varying degrees of interdigitation with the pterygoid muscles — one weaved with the attachment of lateral pterygoid muscle, the second was found to overlap the inferior portion of lateral pterygoid muscle with minimal fiber mixing, and the last example appeared to blend with fibers of both medial and lateral pterygoid muscles [6]. In 2001, Akita et al. found three pterygoideus proprius muscle examples from dissection of 66 ITFs (4.5% incidence). All three of these cases were unilateral, appeared to receive innervation from anterior deep temporal nerves, and attached superiorly to the medial surface of the temporalis muscle. Although in one of these instances the pterygoideus proprius muscle had additional attachment to the infratemporal crest, this was the first report of this muscle attaching to the temporalis muscle. For two of these muscles, the inferior attachment was noted to blend with the inferior head of the lateral pterygoid muscle and continue to the lateral pterygoid plate [1]. In 2007, Tubbs et al. described a pterygoideus proprius muscle running from the infratemporal crest down to blend with fibers of medial pterygoid muscle and ultimately attaching to the pyramidal process of the palatine bone. In this case, the pterygoideus proprius muscle was more tendinous than prior

reports [8]. Lastly, a 2010 report utilized magnetic resonance imaging (MRI) to investigate the incidence of the pterygoideus proprius muscle. This modality provided for in-vivo exploration of the ITF without the challenges of dissection. Researchers identified ten examples of suspected pterygoideus proprius muscles out of 78 half heads, a frequency of 12.8%. Of the examples, six were unilateral and four (two pairs) bilateral. Exact attachments were not described due to the visualization modality [7]. Historical reports of pterygoideus proprius muscle indicate fairly consistent inferior attachments to the palatine bone or lateral pterygoid plate with varying degrees of interdigitation with surrounding muscles of mastication. Superior attachments display more variation — the majority originate from the infratemporal crest [2, 6, 8] or the medial surface of temporalis muscle [1]. Indeed, knowledge and understanding of accessory muscles of mastication is essential for proper interpretation of medical imaging, effective diagnosis and treatment of dysfunction associated with ITF structures.

CASE REPORT

During a routine dissection of the infratemporal fossa (ITF) and maxillary artery in a 90-year-old male anatomical donor, an additional muscle was identified (Fig. 1). To better visualize the ITF, the coronoid process of mandible was removed along with the inferior attachment of temporalis muscle. Anterior portions of the mandibular ramus and the zygomatic arch were also removed. The identified accessory muscle most closely resembled the pterygoideus proprius muscle initially described by Henle in 1858 [4]. Inferior fibers of temporalis muscle were trimmed for enhanced visibility. The pterygoideus proprius muscle was found only on the donor's right; dissection of the donor's left revealed no anomalies of the ITF. The muscle was seen running in a vertical fashion originating deep to the temporalis muscle from the greater wing. It then traveled inferomedially, deep to the maxillary artery, before blending with muscle fibers of the inferior head of lateral pterygoid muscle and the superficial head of medial pterygoid muscle. It then appeared to attach near the inferior part of the lateral pterygoid plate. Several structures were seen in close proximity to this muscle: the superior head of the lateral pterygoid muscle ran posterior to the pterygoideus proprius muscle while the inferior head of the lateral pterygoid muscle mingled with fibers of pterygoideus proprius muscle before attaching to the lateral pterygoid plate; anterior and posterior deep temporal arteries appeared to run in the plane between temporalis and pterygoideus proprius muscles. Additionally, the lingual and inferior

alveolar nerve branches of the trigeminal nerve displayed typical anatomical patterns. No nervous contribution was observed directly supplying the pterygoideus proprius muscle. Compared to previous reports, the present pterygoideus proprius muscle was large and rivaled the size of the lateral pterygoid muscle. Rather than attaching to the infratemporal crest, it extended further superiorly to the greater wing and measured approximately 4.5 × 2 cm in total. The muscle did not appear atrophied, and though attaching to different regions of the sphenoid and not crossing any articulations, the muscle appeared otherwise healthy and functional. In fact, along the superior posterior border of pterygoideus proprius muscle, a ridge of abnormal bony growth was observed.

DISCUSSION

In the present case study, we describe an accessory muscle located within the ITF best resembling pterygoideus proprius muscle. In this subject, the muscle coursed vertically from the greater wing to the lateral pterygoid plate, and inferior fibers interdigitated with fibers from medial and lateral pterygoid muscles. Accessory muscles in the ITF have been periodically documented — origins can likely be traced to embryonic development [3]. Muscles of mastication begin developing from mesenchyme of the first pharyngeal arch and eventually migrate to acquire attachment. These attachments undergo constant remodeling as their corresponding bony attachments continue to develop. Additionally, evidence indicates muscle constituents may develop first and induce development of osteogenic counterparts [6]. Two hypotheses offer insight into the existence of the pterygoideus proprius muscle in the ITF. This muscle may result from improper fusion of early temporalis muscle condensations due to the relatively later development of the coronoid process. Without an existing coronoid process, muscle fibers from the developing temporalis muscle may improperly attach to the lateral pterygoid plate and be prevented from rejoining the primary muscle belly. Another hypothesis describes the failure of a portion of the lateral pterygoid muscle to attach to the temporomandibular joint disc. Via differential growth, these fibers eventually elongate and attach to the lateral pterygoid plate [8]. The vertical orientation of fibers coupled with two prior reports of pterygoideus proprius muscle originating from the medial border of temporalis itself [1] are more consistent with a temporalis muscle lineage. A recent cadaveric study of the temporalis muscle supported the existence of a superficial and deep head. The superficial head attached

from the temporal fossa to the coronoid process; the deep head typically attached from the infratemporal crest to the medial surface of the coronoid process and mandibular ramus [10]. Pterygoideus proprius muscle may represent a vestige of the deep head of temporalis muscle that gained precocious attachment to the lateral pterygoid plate before the coronoid process had fully formed. Another mystery surrounding the pterygoideus proprius muscle is its function. Because it attaches to two parts of the same bone, the typical function associated with muscle (movement) is unlikely. Though, a small bony ridge of growth was observed along the superior posterior border of the pterygoideus proprius muscle. Abnormal bony changes are typically produced by mechanical forces of attached muscles; therefore, the presence of bone growth indicates the exertion of force via muscle contraction. Historical reports of pterygoideus proprius muscle speculate regarding its function in propelling relatively cooler venous blood from the pterygoid venous plexus toward the cavernous sinus. Because the internal carotid artery traverses the cavernous sinus before delivering arterial blood to the majority of the cerebrum, the movement of blood from the pterygoid venous plexus toward the cavernous sinus may serve a thermoregulatory purpose as blood equalizes along the temperature gradient [6, 8]. Though no nerve branches were identified piercing the pterygoideus proprius muscle in the present case, a prior report indicated innervation via anterior deep temporal nerves [1]. These nerves provide innervation to the temporalis muscle, and as such, it is possible contraction of temporalis muscle also produces isometric contraction of the pterygoideus proprius muscle. Presence of pterygoideus proprius muscle may also have clinical implications. The ITF is complex with many important neurovascular structures. The presence of pterygoideus proprius muscle could affect branches of the trigeminal nerve and/or maxillary artery [8]. Additionally, with the blending of muscle fibers from the pterygoideus proprius, lateral pterygoid, and medial pterygoid muscles it is possible the actions of the latter muscles were impacted [6]. Effects of altered muscle trajectory may be especially apparent because pterygoideus proprius muscle tends to occur unilaterally, and this could produce asymmetric movements of the mandible and temporomandibular disc. Though no differences were visible in the donor’s occlusion or TMJ, temporomandibular joint disorders (TMJD) affect approximately 31% of the adult population [9]. Symptoms of dysfunction include muscle and joint pain, limited mandibular range of motion, and jaw deviation during opening and closing. TMJD is a complex pathology with many potential contributors: injury, hormonal changes, and muscle of mastication parafunction.

Depending on the etiology, minimally invasive treatments include pain medication, physical therapy, and intramuscular relaxants [5]. Considering the prevalence of TMJD, clinicians must consider the possibility of accessory muscles of mastication — such as the pterygoideus proprius muscle — when evaluating and treating this condition. Knowledge of typical and variant anatomy associated with the ITF are key for surgical planning and should be considered when treating patients for TMJ-related dysfunction.

CONCLUSIONS

In conclusion, this case study describes an accessory pterygoideus proprius muscle identified during routine dissection of the ITF. Because muscles of mastication descend from the common source of first arch mesenchyme, accessory muscles are periodically found in the ITF and likely represent a consolidation of muscle tissue that failed to fuse with the temporalis or lateral pterygoid muscles. Considering the structural complexity and clinical significance of the ITF, knowledge of possible variations may be crucial for successful diagnosis and treatment.

Article information and declarations

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Conflict of interest: None declared.

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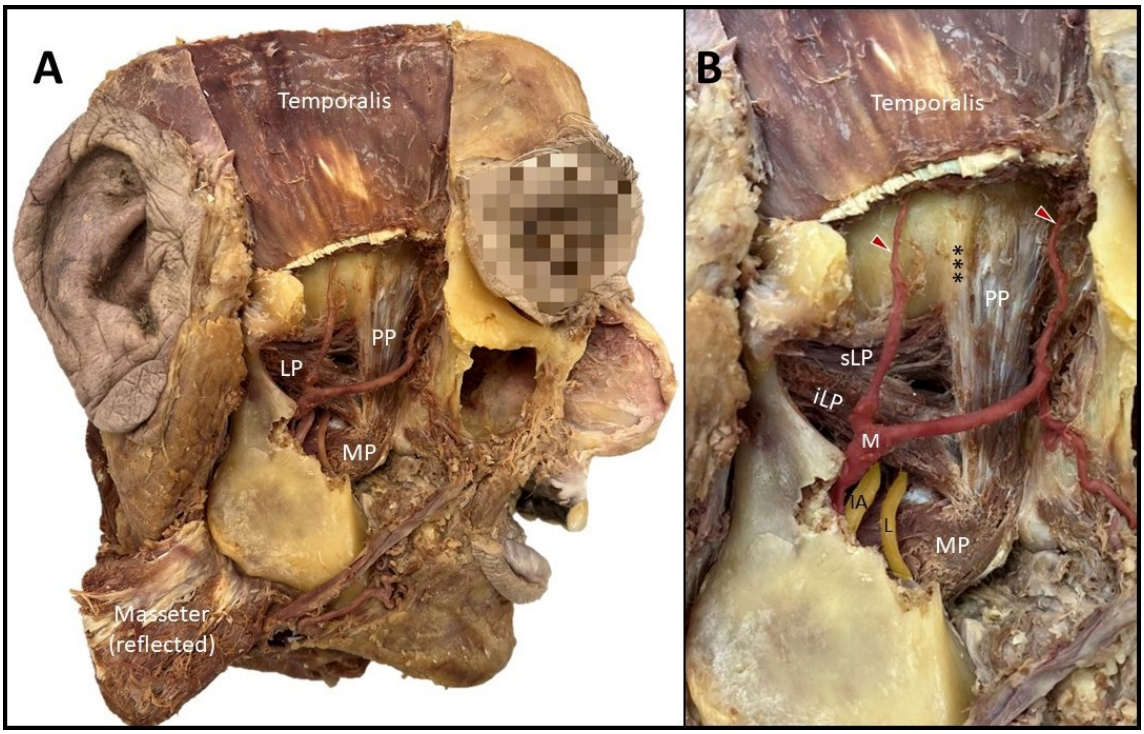

Figure 1A. The right side of the donor's face displaying the infratemporal fossa. The muscles of mastication are observed: masseter, temporalis, lateral pterygoid (LP), and medial pterygoid (MP). The anomalous pterygoideus proprius muscle (PP) is seen running vertically. **B.** A closer view of the infratemporal fossa is shown, and structures were pseudo-colored using PowerPoint for clarity. The maxillary artery (M, colored red) traverses the region and gives rise to deep temporal arteries (red arrowheads) that appear to travel superiorly between the temporalis and pterygoideus proprius muscles. In the region, the superior head (sLP) and inferior head (iLP) of the lateral pterygoid muscles, inferior alveolar (IA) and lingual (L) nerves, and a ridge of bony growth (***) are observed.