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Bilateral Extraosseous Course of the Mandibular Incisive Neurovascular Bundle: A Multimodal Imaging Case Report

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Case Report

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Abstract

Background

We present an exceptionally rare bilateral extraosseous course of the mandibular incisive neurovascular bundle, identified incidentally during dental implant planning. This case highlights the novelty and complementary diagnostic value of combining cone-beam computed tomography (CBCT) and real-time color Doppler ultrasonography to comprehensively characterize this clinically relevant, atypical anatomical variation.

Case presentation:

A 61-year-old systemically healthy man underwent CBCT for preoperative implant planning in the posterior mandible. During radiological evaluation, an incidental discontinuity of the labial cortical plate in the anterior mandible was detected bilaterally, raising suspicion of an extraosseous course of the mandibular incisive neurovascular bundle. To characterize the soft-tissue structure and assess vascularity, real-time B-mode and color Doppler ultrasonography were performed. CBCT demonstrated perforation of the labial cortical plate by the mandibular incisive canal bilaterally. B-mode ultrasonography identified a superficial linear hypoechoic structure closely related to the mandibular cortex, while color Doppler imaging confirmed pulsatile motion and internal arterial flow. Dynamic tracing successfully confirmed the vascular structure's continuity from the mental foramen toward the anterior mandible.

Conclusions

This rare anatomical variation challenges the traditional concept of the anterior mandible as a safe surgical zone. Combining CBCT with dynamic color Doppler ultrasonography provides a comprehensive evaluation of both the osseous and vascular components of complex neurovascular variations, which is crucial for preventing intraoperative complications during surgical procedures in the anterior mandible.

Background

The anterior mandible has traditionally been considered a relatively safe surgical zone for dental implant placement and other invasive procedures.[1] Nevertheless, this region contains the mandibular incisive canal (MIC), which carries the mandibular incisive nerve and its accompanying vessels.[2] Accurate preoperative identification of the MIC is clinically important, because injury to its neurovascular contents during procedures involving the interforaminal region may result in neurosensory disturbances or hemorrhagic complications.[3]

The MIC usually follows an intraosseous course within the anterior mandible and is visualized on cone-beam computed tomography (CBCT) as a radiolucent canal surrounded by a cortical border. However, anatomical variations may occur. An extraosseous (extracortical) course, in which the neurovascular bundle perforates the labial cortical plate and extends into the adjacent soft tissue, has been infrequently described. Such a variation may increase the risk of inadvertent neurovascular injury during surgical procedures involving the anterior mandible.[4] The closest previously reported finding is the short extraosseous course of the mental nerve described by Serman, in which the nerve exits and subsequently re-enters the mandible through a separate foramen.[5]

CBCT is the reference imaging modality for evaluating osseous anatomy, but it provides limited information on soft-tissue structures and vascular flow.[4] In contrast, color Doppler ultrasonography enables real-time visualization of superficial neurovascular structures and assessment of blood flow. Although ultrasonography has increasingly been used to evaluate superficial maxillofacial soft tissues and neurovascular structures, its application to anatomical variations of the mandibular incisive neurovascular bundle remains limited.[6]

This report presents an incidental finding, identified during implant planning, of a bilateral extraosseous course of the mandibular incisive neurovascular bundle and highlights the complementary role of CBCT and real-time color Doppler ultrasonography in the evaluation of atypical neurovascular variations.

Case Presentation

A 61-year-old systemically healthy man who was a smoker was referred for dental implant placement in the right and left posterior mandible. CBCT of the mandible was acquired for preoperative planning with a ProMax 3D Max unit (Planmeca Oy, Helsinki, Finland) using the manufacturer's standard protocol (96 kV, 5.6 mA, 12.1 s; dose–area product 807 mGy cm²), with a field of view of 10 × 6 cm and a voxel size of 200 µm. The images were reconstructed and evaluated using Romexis 6.2.1.19 software (Planmeca Oy, Helsinki, Finland).

A detailed radiological evaluation of the scan revealed an incidental finding in the anterior mandible. A distinct discontinuity of the labial cortical bone was observed bilaterally between the mental foramina (Fig. 1). Because an extraosseous course of the mandibular incisive neurovascular bundle was suspected, an ultrasonographic examination was performed for further soft-tissue assessment.

A dentomaxillofacial radiologist with 14 years of clinical experience performed ultrasonography using a LOGIQ P9 system (GE Healthcare, Chicago, IL, USA) equipped with a wideband linear transducer (L3-12t; 3–12 MHz). Dynamic assessment included tracing the vascular structure from the mental foramen region and evaluating its positional relationship to the mandibular cortex during lower lip movements.

On B-mode imaging, the labial cortical border of the mandible appeared as a hyperechoic linear interface, and a superficial hypoechoic linear structure was identified bilaterally immediately above it. Real-time imaging demonstrated active pulsation within this structure [see Additional file 1]. Color

Doppler imaging demonstrated blood flow within it, with a pulsatile pattern consistent with an arterial vessel (Fig. 2). To characterize the anatomical origin and course of this vascular structure, dynamic tracing was initiated at the mental foramen region rather than along the expected course of the facial artery and its inferior labial branch. The structure could be followed continuously from the mental foramen region toward the anterior mandible while maintaining a close spatial relationship with the underlying mandibular cortex. During dynamic assessment, the patient was asked to perform lower lip movements, including protrusion and retraction. Throughout these movements, the structure remained closely apposed to the mandibular cortical surface, with no appreciable displacement relative to the underlying cortex. These dynamic ultrasonographic findings were observed bilaterally and corresponded to labial cortical perforations identified on CBCT.

Discussion and Conclusions

The anterior mandible has traditionally been regarded as a relatively safe region for surgical procedures. Nevertheless, the presence of the MIC and its neurovascular bundle warrants careful preoperative evaluation. The MIC is a common anatomical structure, although its reported visualization rates vary considerably depending on the imaging modality and study population, with CBCT consistently demonstrating higher detection rates than conventional radiography.[2,4,7] The mandibular incisive neurovascular bundle generally follows an intraosseous course.[8] Although some authors have suggested that the bundle traverses the intertrabecular spaces of cancellous bone rather than a true cortical canal,[9] these descriptions still confine its course within bone. In contrast, reports of a true extraosseous course associated with cortical perforation remain exceptionally uncommon.

The closest counterpart in the literature is the “mental foramen complex” hypothesis proposed by Serman, in which the mental nerve follows a short extraosseous course before re-entering the mandible through a separate anterior foramen. However, this concept remains controversial and has been described for the bifid mental nerve/foramen rather than for the mandibular incisive nerve. The mandibular incisive foramen, also described by Serman,[5] represents another uncommon variation, and Rusu and Stoenescu similarly emphasized that anatomical variations in this region remain insufficiently documented.[10,11]

To the best of our knowledge, this is the first reported case demonstrating a bilateral extraosseous course of the mandibular incisive neurovascular bundle associated with bilateral labial cortical perforation, characterized using complementary CBCT and real-time color Doppler ultrasonography. The present case therefore expands the currently recognized spectrum of anatomical variations involving the mandibular incisive neurovascular bundle and provides in vivo documentation of both its osseous and vascular components.

The embryological basis of this variation remains uncertain. Normally, the development of the mandibular canal involves the fusion of nerve branches that are subsequently corticalized and enveloped by the developing bone via intramembranous ossification.[12] While incomplete fusion or ossification in

this stage is known to result in accessory intraosseous canals,[13] one possible explanation for our finding is a more severe developmental alteration in the relationship between the developing mandibular neurovascular bundle and the ossification pattern of the surrounding mandibular bone. Such an alteration could prevent complete incorporation within the developing bone, possibly resulting in the persistence of an extraosseous pathway. However, this hypothesis remains speculative, and further anatomical and developmental investigations are required to clarify the underlying mechanism.

The clinical relevance of this variation lies in its potential to increase the risk of iatrogenic injury if it is not recognized before surgery. Although the anterior mandible is generally considered a predictable surgical region, unexpected neurovascular variations may contribute to intraoperative complications. Because an extraosseous mandibular incisive neurovascular bundle lacks the protection normally provided by cortical bone, it may be particularly vulnerable during procedures involving the anterior mandible, including flap reflection, implant placement, guided bone regeneration, symphyseal bone harvesting. Injury to this superficially located neurovascular structure may result in hemorrhagic complications, postoperative neurosensory disturbances, or both. Recognition of such variations may therefore contribute to safer surgical planning and help minimize the risk of neurovascular injury.

Diagnostically, while CBCT accurately depicted the cortical discontinuity, color Doppler ultrasonography was essential to confirm the pulsatile arterial flow and to dynamically trace the extraosseous structure from the mental foramen. Combining these modalities provided a comprehensive characterization of this atypical finding.

An important diagnostic consideration in the present case is the potential resemblance of the observed arterial structure to the inferior labial artery. On color Doppler ultrasonography, both structures may present as superficial vessels in the lower anterior facial region, demonstration of arterial-type flow alone cannot establish their anatomical identity. In the present case, the vascular structure was traced dynamically from the mental foramen region toward the anterior mandible rather than being approached along the course of the facial artery. It also maintained a close spatial relationship with the mandibular cortical surface and corresponded to the region of cortical perforation identified on CBCT. During lower lip movement, no appreciable displacement of the structure relative to the underlying mandibular cortex was observed. An additional distinguishing feature was the observed vessel's distinct relationship to the tissue planes. The inferior labial artery is generally described in the soft tissues of the lower lip, most commonly in the submucosal or intramuscular planes, by contrast, the structure observed in the present case was located immediately superficial to the mandibular cortical surface, without an intervening substantial soft-tissue layer. This close apposition to the mandibular cortex, its continuity from the mental foramen region and its correspondence with the cortical perforation, further favored an extraosseous continuation of the mandibular incisive neurovascular bundle. These findings favored an extraosseous continuation of the mandibular incisive neurovascular bundle rather than an isolated inferior labial artery. Nevertheless, because ultrasonography cannot independently establish the precise anatomical identity of an arterial vessel in the absence of direct anatomical or surgical confirmation, a contribution from an adjacent arterial branch cannot be entirely excluded. The interpretation in the

present case therefore relies on the concordance of CBCT anatomy, vascularity, dynamic tracing, and spatial correspondence rather than on Doppler findings alone.

The major strength of this report is the multimodal evaluation of an exceptionally rare anatomical variation with complementary CBCT, real-time B-mode ultrasonography, and color Doppler imaging, which allowed in vivo characterization of both its osseous and vascular components. Nevertheless, this report is limited to a single case and lacks surgical or histological confirmation, since no surgical intervention was clinically indicated. Two further limitations should be emphasized. First, spectral (pulsed-wave) Doppler waveform analysis was not performed. Color Doppler encodes the direction of flow rather than vessel type, therefore, the arterial nature of the structure was inferred from its pulsatility and flow pattern rather than definitively established. Second, ultrasonography at the frequencies used does not resolve a nerve of this caliber, so only the vascular component was directly visualized; the designation “neurovascular bundle” therefore rests on the canal anatomy demonstrated on CBCT. Although dynamic tracing and positional assessment during lower lip movement supported the proposed interpretation, ultrasonography alone cannot definitively exclude a contribution from, or anastomosis with, adjacent facial arterial branches. Additional well-documented cases are required to better define the prevalence, anatomical characteristics, and clinical significance of this variation, and future multicenter studies incorporating multimodal imaging may further clarify its anatomical spectrum.

The imaging findings in this case support an extraosseous course of the mandibular incisive neurovascular bundle, representing an exceptionally rare anatomical variation with important implications for surgery of the anterior mandible. This finding challenges the view that the anterior mandible is generally a safe surgical region and emphasizes the value of evaluating the entire CBCT volume rather than limiting the assessment to the primary region of interest. CBCT demonstrates cortical discontinuities and osseous anatomy, whereas real-time color Doppler ultrasonography provides complementary information on the superficial vascular structure, its flow characteristics, and its relationship with the mandibular cortex. Accurate preoperative recognition of such variations may help to prevent intraoperative complications, including hemorrhage and neurosensory disturbance.

Abbreviations

CBCT
Cone-beam computed tomography
MIC
Mandibular incisive canal
MC
Mandibular cortex (Fig. 2)

Declarations

Ethics approval and consent to participate

According to the institutional policy of Dokuz Eylül University, formal ethics committee approval is not required for single case reports, provided that informed consent is obtained. The study was conducted in accordance with the Declaration of Helsinki. Informed consent to participate was obtained from the patient.

Consent for publication

Written informed consent for publication of their clinical details and clinical images was obtained from the patient. A copy of the consent form is available for review by the Editor of this journal.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

DO contributed to conceptualization, data curation, formal analysis, visualization, and wrote the original draft. MR contributed to data curation, formal analysis, visualization, and writing – review and editing. MO contributed to conceptualization, investigation, methodology, supervision, validation, and writing – review and editing. All authors read and approved the final manuscript.

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Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

References

1. Miller RJ, Edwards WC, Boudet C, Cohen JH. Maxillofacial anatomy: the mandibular symphysis. J Oral Implantol. 2011;37(6):745–53.

2. Safı Y, Azizi Z, Rahimian S, Dehghanian T, Heydarzadeh B. Morphometric analysis of the mandibular incisive canal using cone-beam computed tomography images. Head Face Med. 2026;22(1):25.
3. Caughey JA, Do Q, Shen D, Ohyama H, He P, Tubbs RS, et al. Comprehensive review of the incisive branch of the inferior alveolar nerve. Anat Cell Biol. 2021;54(4):409–16.
4. Pereira-Maciel P, Tavares-de-Sousa E, Oliveira-Sales MA. The mandibular incisive canal and its anatomical relationships: a cone-beam computed tomography study. Med Oral Patol Oral Cir Bucal. 2015;20(6):e723–8.
5. Serman NJ. The mandibular incisive foramen. J Anat. 1989;167:195.
6. Gold L, Nazarian LN, Johar AS, Rao VM. Characterization of maxillofacial soft tissue vascular anomalies by ultrasound and color Doppler imaging: an adjuvant to computed tomography and magnetic resonance imaging. J Oral Maxillofac Surg. 2003;61(1):19–31.
7. Borghesi A, Di Salvo D, Ciolli P, Falcone T, Ravanelli M, Farina D, et al. Detection rate and variability in measurement of mandibular incisive canal on cone-beam computed tomography: a study of 220 dentate hemi-mandibles from Italy. J Imaging. 2022;8(6):161.
8. De Andrade E, Otomo-Corgel J, Pucher J, Ranganath KA, St George N Jr. The intraosseous course of the mandibular incisive nerve in the mandibular symphysis. Int J Periodontics Restor Dent. 2001;21(6):591–7.
9. Eliades AN, Manta KH, Tsirlis AT. Neurovascular content of the mandibular canal and its clinical relevance: a literature review of the related anatomical and radiological studies. Balkan J Dent Med. 2014;18(3):124–32.
10. Rosenquist B. Is there an anterior loop of the inferior alveolar nerve? Int J Periodontics Restor Dent. 1996;16(1):40–5.
11. Rusu MC, Stoenescu MD. The mandibular incisive foramen, a false mental foramen. Morphologie. 2020;104(347):293–6.
12. Chávez-Lomeli ME, Mansilla Lory J, Pompa JA, Kjaer I. The human mandibular canal arises from three separate canals innervating different tooth groups. J Dent Res. 1996;75(8):1540–4.
13. Auluck A, Pai KM. Trifid mandibular nerve canal. Dentomaxillofac Radiol. 2005;34(4):259.

Figures

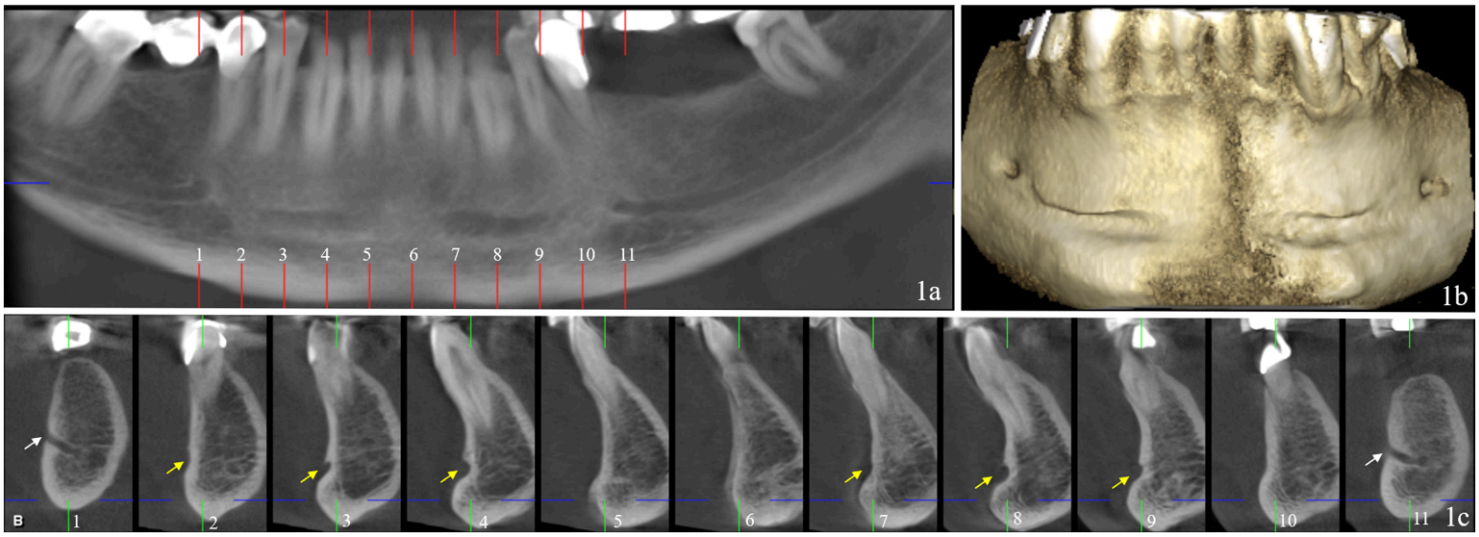


Figure 1

Multiplanar and three-dimensional assessment of the anterior mandible. (a) Panoramic reformation showing the reference lines (1–11) for the sequential cross-sectional images in (c), spanning the interforaminal region between the right and left mental foramina. (b) Three-dimensional volume-rendered image demonstrating bilateral discontinuity of the labial cortical plate. (c) Sequential cross-sectional images (slices 1–11) corresponding to the reference lines in (a). White arrows in slices 1 and 11 indicate the right and left mental foramina, respectively. Yellow arrows in slices 2–4 and 7–9 indicate bilateral discontinuity of the labial cortical plate at the level of the mandibular incisive canal.

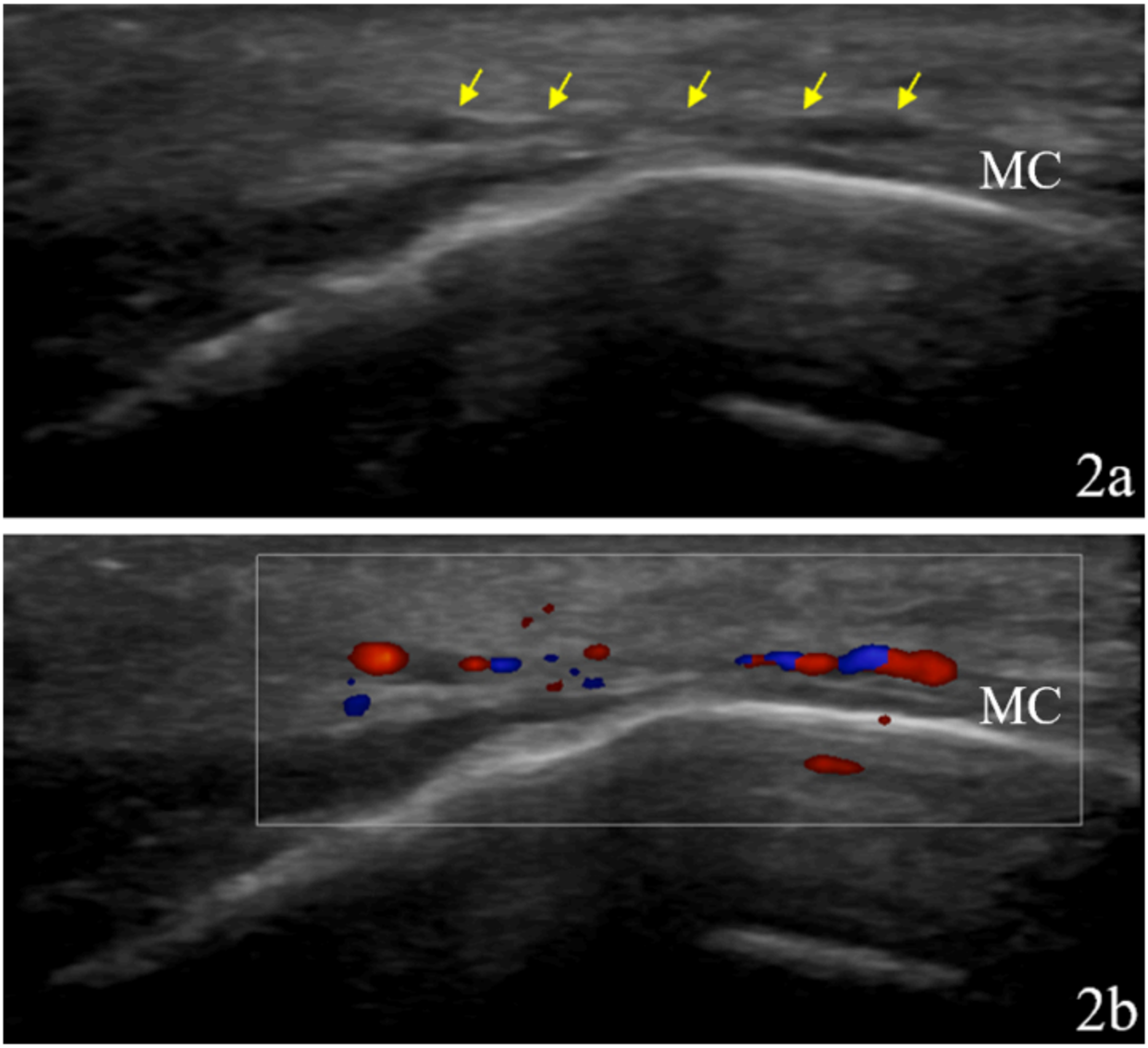


Figure 2

Ultrasonographic characterization of the superficial structure corresponding to the extraosseous course. (a) B-mode image of the left side showing a hypoechoic linear structure (yellow arrows) immediately superficial to the hyperechoic labial cortical border. Real-time imaging demonstrated pulsatile motion and a persistent spatial relationship with the mandibular cortex during lower lip movement. (b) Color Doppler image of the same region, with the sampling box outlined in white, demonstrating vascular flow within the structure with an arterial pattern. MC: mandibular cortex.

Supplementary Files

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