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Clinical Oral Anatomy in Clinical Dental Practice: A Scoping Review

Anatomía Oral Clínica en la Práctica Odontológica Clínica: Una Revisión de Alcance

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SUMMARY: Medical and Surgical education and practice rely on the knowledge of clinical anatomy. In the case of the oro-facial region, there are different nervous and vascular structures labeled as "noble", due to their importance in innervating and supplying organs and tissues involved in the correct oral functions. The purpose of this scoping review is to evaluate and identify the high-risk of anatomical variations in the middle and lower third of the face, according to the current trend in recent literature about this topical research. Four different databases (Pubmed, Google Scholar, Scopus, Web of Science) were screened, to identify articles published from 2014 to 2024. Authors followed the PRISMA for Scoping Review (PRISMA-ScR) guidelines. From a total of 7954 retrieved items, 5 studies were included that investigated the anatomical variations of the mandibular canal, the mandibular incisive canal (MIC), the mandibular lingual foramina, the greater palatine nerve (GPN), the maxillary wisdom teeth, respectively. Considering the middle third of the face, the GPN and the great variability of the relationship of upper third molars with the maxillary sinus could be considered critical anatomical factors. As regards the lower third of the face, the mandibular canal, the mandibular lingual foramina and the MIC emerged as significant structures to be particularly aware of.

KEY WORDS: Maxillary bone; Mandible; Oral surgery; Anatomical variations; Vascular structures; Nervous structures.

INTRODUCTION

The anatomy of the oro-facial region serves as the core of medical education and practice in all dental branches, with particular attention to oral and maxillofacial surgery. The knowledge of the relationship between various anatomical structures, as well as their interaction with different body systems, is essential for accurately diagnosing and treating oral and facial pathologies, planning a therapeutical pathway and preventing complication (la Encina *et al*., 2022; Gerardi *et al*., 2024).

This awareness not only aids in detecting pathological signs using imaging techniques and intraoral examinations, but also highlights the significance of anatomical variations (Whyte & Boeddinghaus, 2019; Bernardi *et al*., 2024a) for managing surgical phases effectively and anticipating potential intraoperative and postoperative complications.

In the field of oral and maxillofacial surgery, specific anatomical structures are labeled as "noble" due to their critical role in maintaining vital functions, their capacity of regeneration, or contributing to the proper performance of essential physiological activities. From both a pathophysiological and surgical perspective, the term "noble" is used to describe structures whose damage could result in severe consequences for the organism's functioning or, in extreme cases, be life-threatening. These delicate structures are situated in areas where surgical access is challenging, and cause intra and post-operative complications, which can be foreseen during the preoperative planning (Pellegrino *et al*., 2020).

Noble anatomical structures in the oro-facial region are primarily associated with blood vessels and nerves, which play key roles in innervating and supplying the tissues involved in oral functions, such as mastication, speech, and sensation. Due to their vulnerability and critical functions, these structures require special consideration during various oral surgical procedures, such as the surgical extraction of teeth, bone regeneration procedures of the maxillary sinus or alveolar ridge, dental implant placement, and the excision of cysts and tumors (Manchisi *et al*., 2022; Rinaldi *et al*., 2023). Any disruption or injury to these anatomical landmarks can result in severe complications, such as hemorrhage, loss of sensation, or even permanent functional impairment (Auyong & Le, 2011).

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In the maxilla, several noble anatomical structures are of particular importance. These include the greater palatine-artery (GPA) and -nerve (GPN), which run along the palate (Fig 1.) and are involved in the innervation and blood supply of the palatal tissues (Herman *et al*., 2022). The nasopalatine canal, which contains the nasopalatine nerve and vessels, is another critical structure, especially during procedures such as dental implant placement in the anterior maxilla: a damage to this canal can lead to sensory disturbances and compromised vascular supply to the premaxillary region (Lake *et al*. 2018).

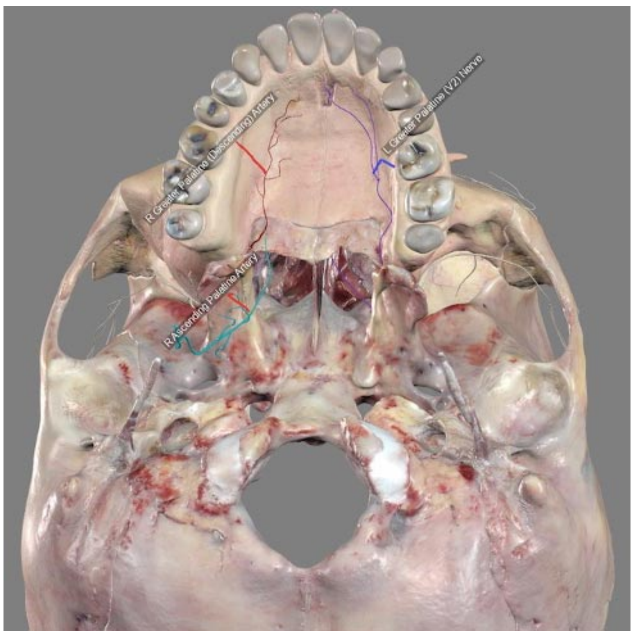

Fig. 1. Digital cadaveric sample of the course of the left GPN (violet), the right GPA (red) and the Ascending Palatine Artery, using Anatomage Inc. - Anatomage Table EDU. The 3D rendering of the donated body to science data is from Anatomage Table.

The anterior and posterior superior alveolar arteries are small vital vessels that provide blood supply to the upper dentition and surrounding bone structures: understanding their course and potential anatomical variations is essential to avoid severe bleeding during procedures such as sinus lifting or implant placement (de Oliveira-Neto *et al*., 2023). Additionally, the maxillary sinus (Fig 2.), a large cavity within the maxillary bone that communicates with the nasal cavity, is frequently involved in oral and maxillofacial surgical interventions (Lupi *et al*., 2024). The maxillary antrum hosts several significant structures, including the alveolar-antral artery and Underwood's bony septa. The alveolar-antral artery, which is often encountered during sinus lift surgeries, poses a risk of profuse bleeding if damaged, while Underwood's septa, bony partitions within the sinus, can complicate sinus elevation procedures if not identified and managed appropriately (Bernardi *et al*., 2024b).

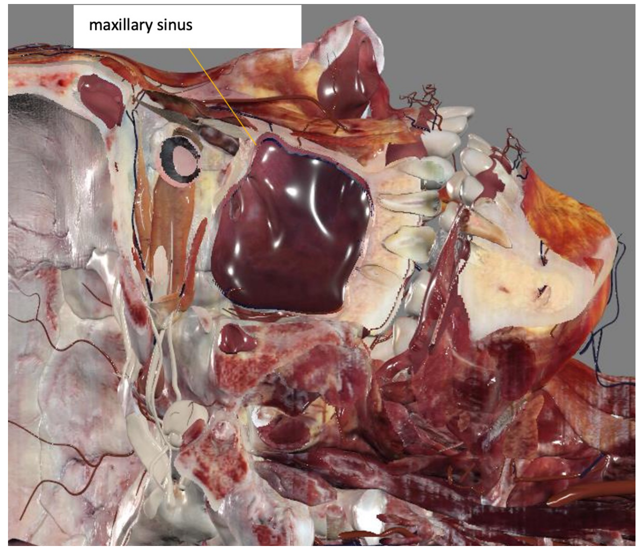

Fig. 2. Digital cadaveric sample of the right maxillary sinus, using Anatomage ® table, high resolution regions. It is possible to appreciate the anatomical features of the maxillary sinus and the nasal mucosa which lines the walls of the antrum. "Anatomage Inc. - Anatomage Table EDU The Image sets were provided by Dr. Jin Seo Park, Department of Anatomy, Dongguk University College of Medicine and Dr. Min Suk Chung, Department of Anatomy, Ajou University School of Medicine."

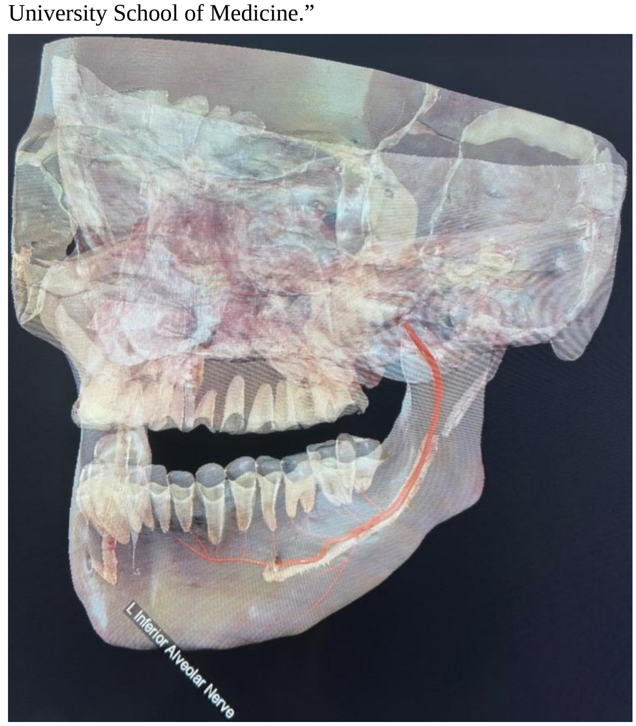

Fig. 3. Digital cadaveric sample of the left inferior alveolar nerve (red). Image obtained from Anatomage®, high-resolution regions. It is possible to appreciate the course of the inferior alveolar nerve which runs the mandibular canal until its emergency from the mandibular foramina, while it continues in the anterior portion of the mandible through the mandibular incisive canal. Using Anatomage Inc. - Anatomage Table EDU. The 3D rendering of the donated body to science data is from Anatomage Table.

As regards the mandible, the body contains several noble structures that are equally critical for surgical planning and intervention. The inferior alveolar nerve and the relative vessels (Fig 3.) run through the mandibular canal and provide sensation and blood supply, respectively, to the lower teeth and adjacent tissues (Kushnerev & Yates, 2015). The mental foramen, located on the external surface of the mandible body, allows the emergence the mental nerve, a branch of the inferior alveolar nerve, to emerge, supplying sensation to the lower lip and chin (Figs. 4).

The lingual nerve is also of concern during oral surgical procedures, since its location near the mandibular molar roots, is at high risk during lower third molar extractions. Damage to the lingual nerve can result in altered sensation or complete loss of function in the tongue and adjacent tissues, posing a significant challenge for oral surgeons (Pippi *et al*., 2017).

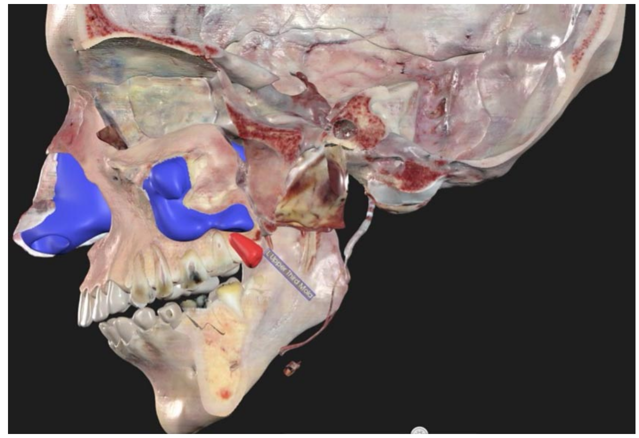

Fig. 4. Left upper third molar (red), characterized by a distal inclination of the crown, and its relationship with the nasal mucosa of the right maxillary sinus (blue). Image obtained from Anatomage®, high-resolution regions. "Anatomage Inc. - Anatomage Table EDU The Image sets were provided by Dr. Jin Seo Park, Department of Anatomy, Dongguk University College of Medicine and Dr. Min Suk Chung, Department of Anatomy, Ajou University School of Medicine."

The arterial vascularization of the anterior portion of the oral cavity floor is also very important due to possible accidental hematomas in this area (Katsumi *et al*., 2021). The vessels are hosted in lingual mandibular foramina on the midline above and below the genial tubercle (Alqutaibi *et al*., 2022).

The literature is rich in original studies, reviews and reports on orofacial anatomical variants; however, this abundance of studies might confuse professionals who must work daily on live patients.

The aim of this scoping review is to assess the extent of the literature concerning the evaluation and identification of high-risk anatomical variations in the middle and lower third of the face, to understand the current trends in this topical research and provide essential information to clinicians. According to the scoping review guidelines (Peters *et al*. 2021) we included the following review questions and keywords.

Review questions

1. "What does "noble anatomical structures" mean in the context of oral and maxillofacial surgery?": This question helps to establish a clear conceptual framework for the review and determine how the term "noble" is used in the literature.

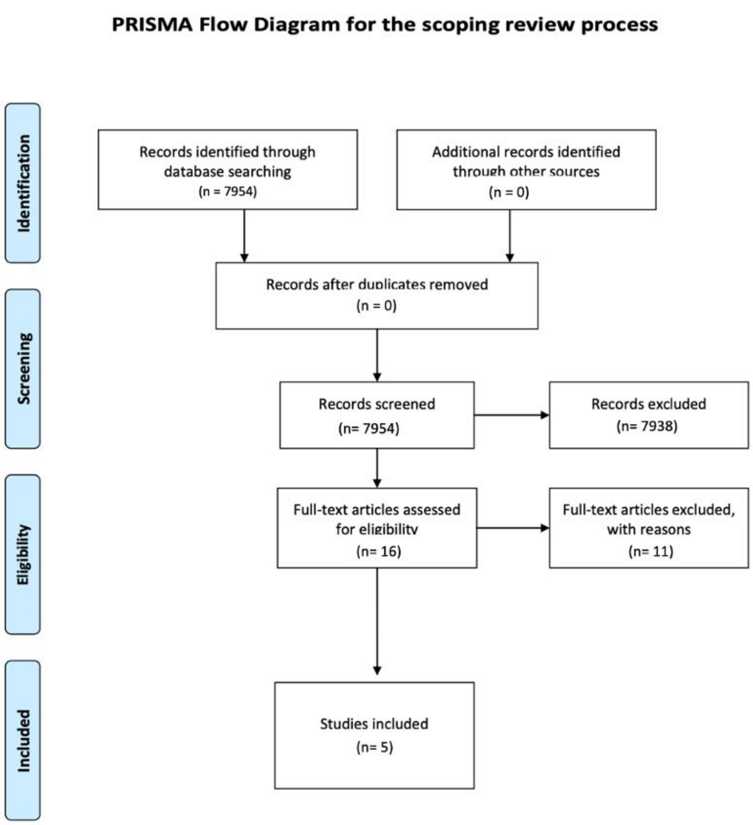

Fig. 5. PRISMA flowchart illustrating the experimental study search and selection process (Moher *et al*. 200).

2. "What are the main bony, nervous, and vascular structures considered noble in the oro-facial region?": Identifying the most frequently studied and discussed noble structures is a fundamental step in mapping the field.

3. "What are the primary anatomical variations of noble structures reported in the existing literature?": This question allows for an understanding of how anatomical variability may influence the planning and execution of surgical procedures.

4. "What are the clinical implications of anatomical variability and risk factors in the planning and execution of oro-facial surgical procedures?": This question focuses on the practical impact of anatomical variation in surgery

METHODS

Scoping review registration:

This project is registered as DOI: https://doi.org/10.17605/OSF.IO/MXPCU (Scoping Review)

Search strategy

This scoping review screened four different databases, thus Pubmed, Google Scholar, Scopus, Web of Science, to identify articles on the topic, published from 2014 to 2024. Authors adhered to the PRISMA for Scoping Review (PRISMA-ScR) (Tricco *et al*., 2018).

Search terms

An electronic search was conducted using the following search terms: "mandibular bone" AND "upper maxilla" AND "anatomical variations". OR "clinical anatomy" AND "vascular structure" AND nervous structure AND "high risk" OR "risk management" AND "Oral surgery" OR "Maxillo-facial surgery" OR "Facial esthetic minor procedure". The search strategy was adapted for each included database.

The proposed scoping review will follow the JBI methodology for scoping reviews (Peters *et al*. 2021).

The PCC (Population, Concept, Context) method was used to develop this scoping review, defining the following parameters (Pollock *et al*., 2023):
P: population of living humans and cadavers
C: anatomical variations of noble structures
C: middle and lower third of the face

Inclusion criteria

Studies were included if they met the following inclusion criteria, original article, retrospective study, systematic review and meta-analysis which assess the presence of anatomical variations of the middle and lower third of the face, publications of the last 10 years in vivo on living humans or cadavers, studies in English.

Exclusion criteria:

Studies were excluded if they met the following exclusion criteria:
abstracts, chapters of book, non-peer-reviewed article, conference proceedings, proceeding paper, absence of investigation of anatomical variations, comprehensive review, narrative review, studies not in English

Study selection:

Two independent authors (D.G. and F.A.) faced primary literature research. The same operators conducted a second re-evaluation of the selected titles and the studies not suitable according to the established eligibility and inclusion criteria were excluded. Afterwards the left items were intensely screened in their full text for final inclusion (Fig. 5). In case of disagreements between the authors after independent evaluation, a consensus was reached by re-evaluation and discussion. In the event of discrepancies in the data, reference paper authors were contacted by email for further explanation when possible. The remaining studies were finally reviewed for qualitative synthesis.

RESULTS

Mandibular canal and its variants

In the systematic review and meta-analysis of Asghar *et al*. (2023), 32 articles were included to investigate the characteristics of variants of the mandibular canal, focusing on the bifid and trifid variants. The authors evaluated the frequency of bifid mandibular canal (BMC) and trifid mandibular canal (TMC), the prevalence of subtype of BMC, the length and diameter of BMC and the ethnicity, sec, and laterality distribution. A TMC was detected in just 1.3 %. Authors showed a prevalence rate of BMC was 18.87 % in the total of 19,284 hemimandibles. Regarding the distribution of BMC in the North American, European, South America and Asian populations included, the prevalence of BMC was 24 % in 1088 North American hemimandibles, 22 % in 1086 European hemimandibles, 19 % in 1154 South American hemimandibles, 18 % in 15,640 Asian hemimandibles. Regarding sex distribution,

Table I. General description of the included studies and related anatomical structure.

Authors (year)	Title	Type of study	Anatomical structures investigated
Asghar et al. (2022)	An evaluation of mandibular canal variations: a systematic review and meta-analysis.	Systematic review and Meta-analysis.	Mandibular canal.
Barbosa et al. (2018)	Imaging aspects of the mandibular incisive canal: a PROSPERO-registered systematic review and meta-analysis of	Systematic review and Meta-Analysis.	Mandibular incisive canal (MIC)..
Bernardi et al. (2017)	Frequency and anatomical features of the mandibular lingual foramina: systematic review and meta-analysis.	Systematic review and Meta-Analysis.	Mandibular lingual foramina.
Hafeez et al. (2015)	Anatomical Variations of the Greater Palatine Nerve in the Greater Palatine Canal.	Original article (study on cadaveric head).	Greater Palatine Nerve (GPN).
Lanzer et al. (2015)	Anatomic (positional) variation of maxillary wisdom teeth with special regard to the maxillary sinus.	Retrospective study.	Maxillary wisdom teeth.

Table II. Summary of the methods of the included studies.

Authors	Methods
Asghar et al. (2022)	**Search strategy** MeSH terms: "Mandible, mandibular canal, man- dibular foramen, inferior alveolar canal, retromolar canal, inferior alveolar foramen, and inferior dental nerve canal." Databases: The Cochrane Library, PubMed, Google Scholar, Web of Science. **Inclusion criteria:** Primary study dealt with MC variation. Study on Cadaver or living subject. CBCT or CT data. Cross-sectional design. Prevalence studies. Human studies. **Exclusion criteria** Literature reviews; Case reports or series, letters, or communications; Panoramic radiological studies; Data from dry skull or isolated dry mandible; Post-surgical or post-reconstruction data of mandible; Congenital anomalies of bone or soft tissue of oral cavity or facial deformity; Tumor or pressure effect on mandible or bony infiltration or metastasis of mandible. Animal studies.
Barbosa et al. (2018)	**Databases**: PubMed's Medline and Scopus *{[(Interforaminal region) OR (mandibular incisive canal) OR (mandibular incisive nerve) OR (mental nerve) OR (anterior mandible)] + (cone beam computed tomography)]}* **Inclusion criteria:** Articles without language or year of publication restrictions, Evaluated by CBCT Involving human beings. **Exclusion criteria**: Case reports; case series; literature reviews; editor's notes; and studies performed on imaging exams other than CBCT.
Bernardi et al. (2017)	**Databases:** PubMed, EMBASE, Google Scholar, EBSCO HOST, Science Direct, Scopus, Web of Science, and Cochrane Library **Search terms**: mandibular lingual foramina, genial spine, alveolar process, mandible, computed tomography, CT, accessory foramina, computer- assisted three-dimensional imaging, mandible, and helical computed tomography. **Inclusion criteria:** cadaveric and tridimensional radiological studies; only data regarding the anterior lingual mandibular foramina. **Exclusion criteria:** case reports, abstracts, oral communications, and conference proceedings.
Hafeez *et al*. (2015)	Dissection of 20 cadaveric hemisectioned heads.
Lanzer et al. (2015)	**Inclusion criteria:** CBCT scans of maxillary third molars. Images recorded from 2008 to 2013. **Exclusion criteria:** Insufficient image quality from a radiological point of view.

the prevalence of BMC was 25 % higher in male than females, while the investigation based on the laterality distribution demonstrated a 21 % higher prevalence on the right side than the left in 10,552 hemimandibles; furthermore, BMC was three times more often unilateral than bilateral.

The retromolar BMC was the most prevalent variant in 10,151 hemimandibles, followed by the forward, dental, and buccolingual types. The forward type of BMC joined the main canal at 18 % and the rest proceeded towards the mental foramen. The prevalence of termination in first, second, and third molar roots were 24 %, 13 %, and 63 %, respectively. Finally, the buccolingual type of BMC terminated as a buccal canal in 49 % and a lingual canal in 51 %.

Regarding the dimension of BMC, the mean length of the BMC was 13.62 mm, while the mean diameter was 1.63 mm.

The mandibular incisive canal (MIC)

Ferreira Barbosa *et al*. (2019) performed a systematic review and meta-analysis including 25 observational studies on a total of 3421 CBCT exams and panoramic radiographs as additional data. The authors showed a mean prevalence of MIC of 89.6±15.08 %. Regarding the laterality distribution, the bilateral mean prevalence of MICs was 74.5 ± 21.7 %. Furthermore, authors assessed the geographic distribution, showing a statistically significant prevalence of MIC of studies from South and North America (91.33±9.288) and Asia (88.77±20.25, while Europe studies did not show a statistically significant prevalence of MIC (89.67±4.08). Regarding the detection of MIC depending on voxel size lower than 0.3 mm or higher than 0.3 mm, the mean prevalence of MIC was 93.88 % and 89.33 %, respectively.

The diameter of MIC was measured as a range between 0.45 and 4.12 mm, in particular the mean diameter of the right side ranged from 1.49 to 1.91 mm, while the left side was between 1.44 and 1.94 mm. Regarding the mean length of MIC, its value was between 6.6 mm to 18.5 mm: on the right side, it varied from 7.1 mm to 17.73 mm, on the left side was between 6.6 and 17.84 mm.

Mandibular lingual foramina

Bernardi *et al*. (2017) evaluated the incidence of lingual foramina performing considering five cadaveric studies reporting the presence of lingual foramina associated with bony canals and a vascular plexus of the anterior region of the mandible composing of branches of mylohyoid nerve and submental/sublingual artery and vein, above the genial spine. In particular, the incidence of the midline lingual foramina was between 97 % and 100 % and it was associated with accessory lingual foramina of the anterior region. Regarding the dimension of lingual foramina, its diameters ranged from 0.1 to 1.5 mm.

Furthermore, three CT studies of cadavers and seven ones of living patients were included: the frequency of lingual foramina varied from 96.2 to 100 % with a diameter width ranged from 0.25 to 1.91 mm.

Greater palatine nerve (GPN)

Hafeez *et al*. (2015) dissected twenty cadaveric hemi-sectioned heads in order to evaluate the emergence of the greater palatine nerve: in 12 of 20 samples, the GPN emerged as a single trunk and proceeded anteriorly within the mucosal tissue and medial to the maxillary premolar, split into main 2 or 3 branches which finally divided into smaller branches which reached the nasopalatine nerves.

In the last 8 samples, the variations of the greater palatine nerve were represented by its emergency as 2 or more trunks whose course varied, showing lateral branches which proceeded more laterally and medial.

Furthermore, the authors observed 4 patterns of intracanalicular branching, while in 2 specimens, 2 distinct trunks were noted within the canal, both providing 2 branches close to the greater palatine foramen; another variation within the canal was identified with the presence of 2 trunks, each providing 2 branches resulting in 4 final branches merging from the greater palatine foramen. In 4 specimens, the GPN is divided into 2 trunks within the canal emerging as thick lateral trunk and a slender medial trunk. In another case, the anatomical variation was represented by the presence of 3 trunks before emerging from the sphenopalatine ganglion. The most common variation, belonging to 4 samples, was characterized by the emergency of GPN in the form of a lateral and medial trunk, each proceeding within the mucosa of the hard palate. Regarding the GPA, unlike the GPN, non-consistent variations were detected: the most common pattern was represented by the vessel distributing superiorly related to the nerve and closely adhered to hard palate bone. In 2 specimens, the artery emerged inferiorly and parallel, respectively, to the nerve, in the other specimen, the vessel ran parallel to the medial trunk of the nerve.

Relationship between maxillary wisdom teeth and maxillary sinus

In the retrospective study of Lanzer *et al*. (2015) 713 third molars from 430 patients were evaluated. The position of the wisdom teeth varied in the sagittal plane: 220 teeth

Table III. Summary of the results of the included studies.

Authors	Results
Asghar et al. (2022)	**Prevalence rate of TMC:** 1.3%. Prevalence rate of BMC: 18.87% in the total of 19,284 hemimandibles. **Geographic distribution of BMC:** 24% in 1088 North American hemimandibles 22% in 1086 European hemimandibles 19% in 1154 South American hemimandibles 18% in 15,640 Asian hemimandibles. **Sex distribution of BMC:** 25% higher in male than females, **Laterality distribution of BMC:** 21% higher prevalence on the right side than the left in 10,552 hemimandibles; BMC was three times more often unilateral than bilateral.
Barbosa et al. (2018)	25 observational study on a total of 3421 CBCT exams **Prevalence of MIC**: 89.6±15.08 %. **Laterality distribution:** **Prevalence of bilateral MICs**: 74.5 ± 21.7%. Geographic distribution of MIC: South and North America: (91.33±9.288) Asia (88.77±20.25) Europe (89.67±4.08): no statistically significant **Detection of MIC depending on voxel size:** < 0.3 mm 93.88% ≥0.3 mm: 89.33%. **Diameter of MIC**: Range: 0.45-4.12 mm, Right side: range 1.49-1.91 mm Left side: range 1.44-1.94 mm. **Length of MIC:** Range: 6.6-18.5 mm Right side: 7.1 mm-17.73 mm, Left side: 6.6-17.84 mm.
Bernardi et al. (2017)	<u>Five cadaveric studies reporting:</u> Presence of lingual foramina associated with bony canals and a vascular plexus of branches of mylohyoid nerve and submental/sublingual artery and vein **Midline lingual foramina**: Prevalence: 97%-100% Associated with accessory lingual foramina of the anterior region. **Dimension of lingual foramina** Diameters range: 0.1-1.5 mm. <u>3 CT studies of cadavers and 7 ones of living patients reporting:</u> Prevalence of lingual foramina: range 96.2%-100% Diameter: range 0.25-1.91mm.
Hafeez et al. (2015)	Twenty cadaveric hemi-sectioned heads <u>Emergence of the greater palatine nerve:</u> in 12 of 20 samples: as a single trunk, splitted into main 2 or 3 branches, divided into smaller branches which reached the nasopalatine nerves. 8 samples: as 2 or more trunks with lateral branches which proceeded more laterally and medial. Detection of 4 patterns of intracanalicular branching <u>2 specimens:</u> 2 distinct trunks within the canal, both providing 2 branches close to the greater palatine foramen; <u>1 specimen:</u> 2 trunks within the canal, each providing 2 branches resulting in 4 final branches merging from the greater palatine foramen. <u>4 specimens:</u> 2 trunks within the canal emerging as thick lateral trunk and a medial trunk. Another anatomical variation: 3 trunks before emerging from the sphenopalatine ganglion. <u>4 specimens:</u> The most common variationà emergency of GPN in the form of a lateral and medial trunk, **GPA**: non-consistent variations detected: most common pattern à vessel distributing superiorly realted to the nerve and closely adhered to hard palate bone. <u>2 specimen:</u> the artery emerged inferiorly and parallel, respectively, to the nerve. <u>Another specimen:</u> artery ran parallel to the medial trunk of the nerve.
Lanzer et al. (2015)	713 third molars from 430 patients were evaluated. **Variations**: <u>Sagittal plane:</u> 220 teeth had not inclination 91 were mesially inclined 402 were distally inclined. the predominant inclination was of -10°. <u>Transversal plane:</u> 469 teeth had a vestibular inclination 86 teeth palatal inclination. About 50%: of the mesially inclined third molars had a direct connection to the maxillary sinus. 45.5% of palatally inclined teeth revealed a more direct contact with the sinus than the vestibular inclined third molars. <u>Protrusion into the sinus:</u> 25.1% did not protrude into the antrum 39.8% protruded up to 2 mm 15.4% had half of the root protruded into the sinus. 5.9% entire protrusion of root in the antrum 13.7% entire protrusion of crown in the antrum <u>Presence or not of a bony barrier between the maxillary sinus and the third molars:</u> 45.6% absence

had not inclination, 91 were mesial inclined and 402 were distal inclined; the predominant inclination was of -10°. In relation to the transversal plane, 469 teeth had a vestibular inclination, and 86 teeth were palatal inclined. The statistical analysis showed a significant association between the inclination of the third molars and the maxillary sinus: The mesial and distal inclination made a larger position of third molars closer to the maxillary sinus; about 50 % of the mesial inclined third molars, had a direct connection to the maxillary sinus. Besides, 45.5 % of palatal inclined teeth revealed a more direct contact with the sinus than the vestibular inclined third molars.

Regarding the protrusion into the sinus, 25.1 % of the teeth did not protrude into the antrum, while 39.8 % protruded up to 2 mm and 15.4 % had half of the root protruded into the sinus; the entire protrusion of root and crown was present in the 5.9 % and 13.7 % of cases, respectively.

Regarding the presence or not, of a bony barrier between the maxillary sinus and the third molars, its absence was detected in 45.6 % of teeth; the superior bony covering of third molars increased with the vestibular inclination, while the distal inclination was related to a thicker barrier. Finally, in the case of palatal inclination, the absence of a bony barrier was detected in 75 % of cases.

DISCUSSION

The term “noble structures” mainly refers to nerves, blood vessels, and essential organs whose role is critical in maintaining the proper function of the body. Their importance lies not only in their functions, but also in their potential damage caused by pathological iatrogenic condition: in particular, the damage of a nerve could lead to loss of function (Phillips & Essick, 2011), and the damage of a particular artery can result in life-threatening conditions (Valente, 2016). Therefore, understanding clinical anatomy enables specialists to determine the best treatment approach for the patient.

Our research showed the mandibular canal exhibits significant anatomical variations in the course, length, and branching patterns of the canal which can affect the location of the inferior alveolar nerve and associated blood vessels (Varvara *et al*., 2022); these deviations may include bifid or trifid canals, accessory mental foramina, or unusual curvature and positioning: Ashgar *et al*. (Ashgar *et al*., 2022) highlighted the major prevalence of the bifid variant of the mandibular canal, whose course and shape is mainly identified in 4 different types, as described in the Naitoh’s classification (Naitoh *et al*., 2009), thus the retromolar canal, the dental canal, the forward and anterior canal and the buccolingual canal. The bifid retromolar canal emerged as the most prevalent variant, and its course could be important clinical implication during the surgical procedures of wisdom tooth extractions (Kumar Potu *et al*., 2013). Injury to the inferior alveolar nerve which runs within the mandibular canal, during surgical treatments such as wisdom tooth extraction or implant placement, can lead to paresthesia, anesthesia, or even permanent nerve damage, significantly impacting the patient’s quality of life (Pelé *et al*., 2021).

The mandibular canal ends with the mandibular foramen, continuing with the mandibular incisive canal which runs within the anterior portion of the mandible, extending from the mental foramen towards the midline.

This canal is often smaller and less defined than the mandibular canal, and its presence can vary between individuals. However, Ferreira Barbosa *et al*. (2019) showed a mean prevalence of MIC of 89.6 % and a great variant in its dimension, demonstrating a diameter and a length which ranged 0.45-4.12 and 6.6-18.5 mm, respectively. These data could reflect the importance of detecting the mandibular incisive canal in the anterior portion of the mandible, which is considered a safe zone because it could have clinical implication during procedures involving the anterior mandible, such as implant placement, to avoid nerve injury and a consequent paresthesia (Vyas & Tadinada, 2023).

Regarding the anterior portion of the mandible, it is crucial to identify the mandibular lingual foramina represented by small openings on the lingual side, typically near the midline: the main variants related to the mandibular foramina are the number, size, and exact position: Bernardi *et al*. (2017) reported an high prevalence of the mandibular lingual foramina, near to the 100 %, associated with accessory smaller foramina, and a mean diameter ranging between 0.5 and s 1.5 mm as reported in five cadaveric study. The awareness of the lingual foramina is important during surgical procedures, such as implant placement, to avoid unexpected bleeding or nerve damage (He *et al*., 2017).

At level of the maxilla, the variants that arise from this scoping review are the greater palatine nerve and artery and the relationship between the upper third molar and the antrum of the maxillary sinus. Hafeez *et al*. (2015) in their cadaveric study described the course of the greater palatine nerve, demonstrating several variants in the emergence of its canal which could split in 2 or 3 trunks which could run in different direction at the level of the palatine mucosa: These variants represent essential considerations in dental procedures, such as palatal surgery, local anesthesia administration, and implant placement due to the consequent of the injury to these structures which can result in significant bleeding (Harris *et al*. 2005), or loss of palatal sensation, complicating surgical procedures like palatal surgery or local anesthesia administration (Tavelli *et al*., 2019).

Although Hafeez *et al*. (2015) did not show significant differences in the anatomical variations of the GPA, many cadaveric studies demonstrated the variability of the distance of the GPA from the cementoenamel junctions of the upper molars and premolars, which ranges between 7 mm and 17 mm (Reiser *et al*., 1996). The reason of this disagreement would be influenced by other factors such as age, sex or alveolar bone atrophies; however, Harris *et al*. (2005) did not show a statistically significant increase of adverse events depending on these factors.

Finally, Lanzer *et al*. (2015) demonstrated the presence of a significant relationship between the upper third molar and the maxillary sinus depending on the different inclination that the third molars could have; in particular, the mesial and palatal inclination is related to a more direct contact or protrusion of the third molars in the antrum. Studying the position of third molar before clinical procedures as tooth extractions should reduce the risk of dislocating the teeth in the antrum and the related procedures of retrieving them, increasing the discomfort of the patients (Amorimm *et al*., 2015).

The study of the presence of noble structures and, above all their variations should be well considered during pre- and post-graduate training courses. Indeed, the particular attention demonstrated by the above-described data, inevitably associates the clinical anatomy to clinical practice influencing the activities, exposing surgeons and patients to intraoperative risks or post-operative complications the related handling.

Therefore, the continue and applied study of clinical anatomy plays a primary role in the psychological well-being of dental students and clinicians: Knowledge of clinical anatomy helps surgeons to better plan the treatment, reducing the state of anxiety that can alter concentration, and affecting the operator's performance (Varvara *et al*., 2021).

4.1 Limits and future perspectives

Other anatomical structures that could be considered “noble” did not arise from this scoping review, due to the criteria applied in the search strategy, such as the mandibular foramina, the lingual nerve or the canalis sinuosus: the mandibular foramina could have some variants regarding its position and one or more accessory foramina, which usually have a lower diameter than the main (Asdullah *et al*., 2018); the lingual nerve is often involved in the treatment plan of wisdom tooth extraction, due to the variability in its distance from the cortical plate of the retromolar trigone (Iwanaga *et al*., 2023) which could make the surgical phases more difficult in relationship to the dangerous risk of damage of the nerve and consequent paresthesia. Furthermore, the canalis sinuosus has been considered as a variant of the superior alveolar artery, as several studies in recent literature investigated (Aoki *et al*., 2020; Angiolani *et al*., 2023).
Finally, further research should be performed to provide a real picture of the living clinical anatomy of the lower third of the face and the most important anatomical structures to be taken into consideration before and during a surgical treatment.

CONCLUSIONS

This review emphasized the importance of recognizing and accurately identifying noble anatomical structures, as well as providing a comprehensive overview of the critical anatomical landmarks, their potential variations, and the best practices for safeguarding them during oral and maxillofacial procedures. What emerged at level of the middle third of the face were GPN, GPA and the great variability of the relationship of upper third molars with the maxillary sinus, while the mandibular canal, the mandibular lingual foramina and the MIC have developed as critical anatomical structures of the lower third of the face. A thorough understanding of these structures is crucial for minimizing complications, optimizing patient outcomes, and advancing the field of oral surgery.

GERARDI, D.; ANGIOLANI, F.; KËRPI, B.; META, E.; VARVARA, G.; BIANCHI, S.; MACCHIARELLI, G. & BERNARDI, S. Anatomía oral clínica en la práctica odontológica clínica: Una revisión de alcance. *Int. J. Morphol., 43(2)*:640-650, 2025.

RESUMEN: La educación y la práctica médica y quirúrgica se basan en el conocimiento de la anatomía clínica. En el caso de la región orofacial, existen diferentes estructuras nerviosas y vasculares etiquetadas como “nobles”, debido a su importancia en la inervación y suministro de órganos y tejidos fundamentales para las funciones orales correctas. El propósito de esta revisión exploratoria es evaluar e identificar el alto riesgo de variaciones anatómicas en el tercio medio e inferior de la cara, de acuerdo con la tendencia actual en la literatura reciente sobre esta investigación temática. Se examinaron cuatro bases de datos diferentes (Pubmed, Google Scholar, Scopus, Web of Science) para identificar artículos publicados entre 2014 y 2024. Los autores siguieron las pautas PRISMA for Scoping Review (PRISMA-ScR). De un total de 7954 artículos recuperados, se incluyeron 5 estudios que investigaron las variaciones anatómicas del canal mandibular, el canal incisivo mandibular (CMI), los forámanes linguales mandibulares, el nervio palatino mayor (NGP) y los terceros molares maxilares, respectivamente. Teniendo en consideración el tercio medio de la cara, el NGP y la gran variabilidad de la relación de los terceros molares superiores con el seno maxilar se podrían considerar factores anatómicos críticos. En cuanto al tercio inferior de la cara, el canal mandibular, los forámenes linguales mandibulares y el CMI surgieron como estructuras importantes a tener en cuenta.

PALABRAS CLAVE: Hueso maxilar; Mandíbula; Cirugía oral; Variaciones anatómicas; Estructuras vasculares; Estructuras nerviosas.

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