



REVIEW ARTICLE

ANATOMICAL AND ANTHROPOLOGICAL VIEW OF TARGET POINTS AND LANDMARKS OF LOCAL ANESTHESIA IN THE MAXILLOFACIAL REGION: A NARRATIVE REVIEW

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ABSTRACT

Background: The anatomical-anthropological approach to local anesthesia target sites utilizes knowledge of individual anatomical variations in elderly patients to optimize conduction anesthesia efficacy while minimizing complication risks.

Aim: The aim of this study is to study the correlation of changes in anatomical and anthropological landmarks with the age of patients, finding constant points for successful anesthesia in dental practice.

Materials and Methods: The review is based on a retrospective analysis of articles on the anatomical and anthropological features of the structure of the maxillofacial region of the age group of patients, studied the location of the exit of the infraorbital, greater palatine, mental, and inferior alveolar nerves, taking into account the spatial relationships of bone structures and soft tissues in elderly patients. A systematic search was conducted in the PubMed, Wiley, Springer, eLibrary, Cyberleninka, Journals.lww.com, ResearchGate databases. The search period was from 1953 to 2024 for the following keywords: geriatric dentistry, age-related changes, infraorbital foramen, mandibular foramen, greater palatine foramen, mental foramen, trigeminal nerve, local anesthesia in Russian, English, German. More than 200 articles were reviewed, found 65 papers for the primary review, after a qualitative 38 publications were selected on age-related features inherent in patients of different age groups as the most relevant to the goals and objectives of the review. Review was conducted according to the PRISMA guidelines.

Results: A review of publications has revealed variability in anatomical-topographic parameters and the positioning of major foramina on the facial skull among elderly individuals across different geographic and chronological populations, as well as a close correlation between age-related changes in the maxillofacial region, tooth loss, and sexual dimorphism

Conclusion: To successfully achieve targeted anesthesia points and prevent complications during and after injection in elderly patients, it is essential to personalize the process of local conduction anesthesia and conduct preliminary radiographic and digital diagnostic methods.

Key words: age-related changes, infraorbital foramen, mandibular foramen, greater palatine foramen, mental foramen

INTRODUCTION

The increase in the life expectancy and quality of life of humanity has led to an increased trend of population aging. Thus, according to Russian statistic forecasts, by 2050 the number of people over 60 years of age will reach 50.0% of the total population of the country.¹ In the process of human aging, pathological and dystrophic changes develop in all organs and tissues, including the tissues of the maxillofacial region.² With age, certain areas of the facial skeleton are most prone to resorption processes, namely: the upper medial and lower lateral parts of the orbital margin, bone formations of the midface located in close proximity to the upper jaw and piriform aperture. On the lower jaw, the bigonial width and the width of the branches of the lower jaw remain unchanged, the height and length of the body of the lower jaw decrease with age, and the angles of the lower jaw increase.³ A dentist needs knowledge of age-related and individual anatomical and topographic features of the maxillofacial region to correctly perform local anesthesia, since elderly patients are more susceptible to the risk of developing complications during and after the injection, and painless dental procedures have become an integral requirement for providing dental care to people of any age.^{4,5} Individual anatomical variations in the shape, length and angle of the lower jaw show a correlation between the dose of local anesthetic for effective pain control during dental procedures.⁶ It is worth noting that the topic under consideration was actively developed already in the 20th century and does not lose its relevance at present.

The aim of this study is to study the correlation of changes in anatomical and anthropological landmarks with the age of patients, finding constant points for successful anesthesia in dental practice.

MATERIAL AND METHODS

The review is based on a retrospective analysis of articles on the anatomical and anthropological features of the structure of the maxillofacial region of the age group of patients, studied the location of the exit of the infraorbital, greater palatine, mental, and inferior alveolar nerves, taking into account the spatial relationships of bone structures and soft tissues in elderly patients.

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More than 200 articles were reviewed, found 65 papers for the primary review, after a qualitative 38 publications were selected on age-related features inherent in patients of different age groups as the most relevant to the goals and objectives of the review. The review was conducted according to the PRISMA guidelines (Figure 1).

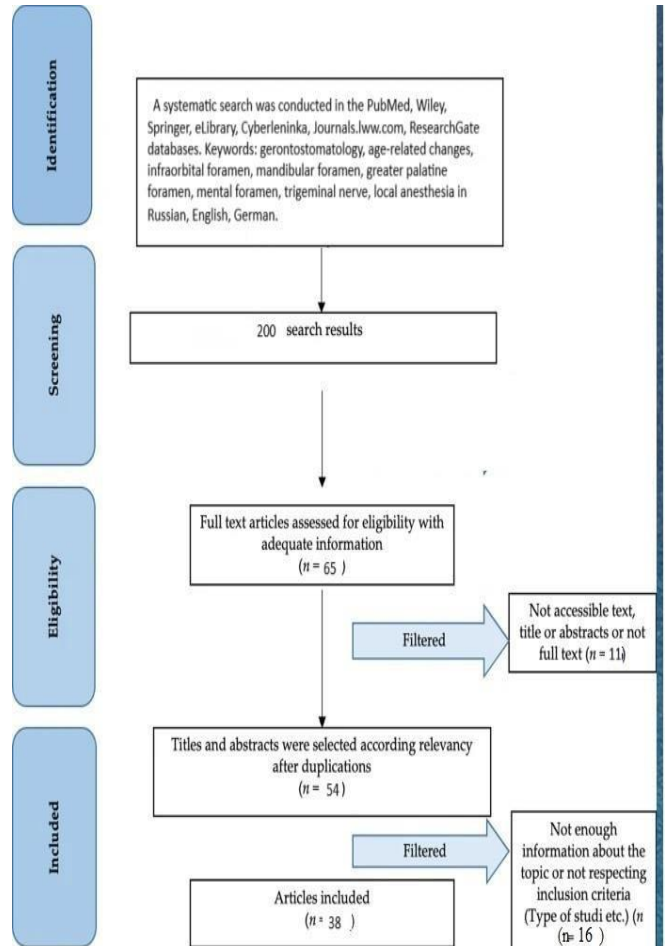


Figure 1. PRISMA flow chart

RESULTS

Analysis revealed significant geographical and temporal variations in craniofacial foramina positioning among elderly populations. Strong correlations emerged between maxillofacial aging patterns, tooth loss, and sexual dimorphism. Studies conducted among individuals of Caucasian descent of different genders and ages have revealed that the cause of age-related changes in the position of ligaments, muscles, subcutaneous adipose tissue, and facial shape is the reduction of interbrow, orbital, maxillary, and piriform angles.⁷ Research on the human facial skeleton from a medieval European osteological collection confirmed multiple age-related resorptive changes in the craniofacial region. The most active resorption occurs at the edges of the orbits

and piriform aperture, leading to an increase in their surface area and a decrease in the vertical height of the maxilla.⁸

Another study conducted on an Asian population corroborated these findings, although changes in the orbital and maxillary angles were less pronounced, while the piriform angle demonstrated more significant changes compared to European populations.⁹

The problem of atrophy in the maxillary alveolar process leads to functional impairments and disproportionality in the maxillofacial region, as well as shifts in the localization of anatomical landmarks: elements of the muscular system, neurovascular bundles passing through the palatal and incisive canals, and dental arch asymmetry. A reduction in the vertical dimension of the maxilla is accompanied by decreased fat tissue and collagen content in the skin, causing sagging of the soft tissues in the midface. After the age of 40–45, thinning of the bony walls of the maxillary sinuses is observed, eventually leading to increased pneumatization of the skull bones. Against the backdrop of age-related alveolar process atrophy, elderly individuals face an elevated risk of vascular damage and significant bleeding during dental procedures.¹⁰

Progressive bone loss, alveolar bone atrophy and osteoporosis, facial structural changes, altered appearance, and issues with chewing and speech are observed in elderly edentulous patients. Alveolar bone atrophy is more extensive and progresses faster in the mandible than in the maxilla.¹¹ A correlation has been established between secondary edentulism in the elderly and reduced vertical parameters of the mandible, mandibular ramus height, and an increased gonial angle. The mandibular angle increases with age—from 97 to 135 degrees—due to resorption of the lower border of the angle near the junction of the body and ramus. It has been found that with age, the chin becomes more prominent and shorter in both men and women. The reduction in vertical dimensions of the mandibular ramus is associated with an increased distance between the mandibular angle and the hyoid bone, likely due to condylar process resorption or osteoarthritis.¹²

In a cross-sectional group analysis of 160 skulls, Bartlett et al. observed that facial width, depth, and height either increase or remain unchanged in the elderly. These findings support the theory that the skull continues to grow, albeit at varying rates from infancy to old age. Changes in craniofacial morphology closely correlate with tooth loss and are sex-dependent. In women, nearly all transverse

cranial dimensions increase with age, whereas no such changes occur in men.¹³ A study by Daniela Garib et al. provided further evidence that the craniofacial complex continues to change from early to mature adulthood during aging, acquiring anatomical and morphological differences between men and women.¹⁴

Facial muscles in young individuals exhibit broad, convex contours, which flatten with age due to restructuring of the subcutaneous adipose tissue in the Bichat's fat pad region. Additionally, in cases of partial or complete secondary edentulism—common in the elderly—the function of masticatory muscles, particularly the masseter and temporalis, declines.¹⁵ Hypofunction of the masticatory muscles and subsequent changes in muscular engrams lead to distal displacement of the mandible and loss of lower facial height.¹⁶ All patients experience age-related changes characterized by reduced overall muscle mass.¹⁷ With aging, skeletal muscles atrophy by an average of 50%, unlike facial muscles, which maintain constant tension, undergo elongation, increased tone, and reduced amplitude.¹⁸

Changes in the soft tissue profile of the face occur between ages 5 and 45, with earlier changes observed in females (10–15 years on average) compared to males (15–25 years).¹⁹ According to Pecora NG, Baccetti T, and McNamara JA Jr., structural changes in soft tissues—including drooping of the nasal tip and columella, elongation, and thinning of the upper lip—are defining features of craniofacial changes across age groups.²⁰ Analysis of 88 human facial scans (ages 26–90) by Windhager S, Mitteroecker P, Rupić I, Lauc T, Polašek O, and Schaefer K concluded that facial aging progresses faster in women than in men.²¹

Literature indicates that age-related musculoskeletal changes in the maxillofacial region determine the positioning of major foramina in the elderly. A retrospective analysis of morphometric characteristics of the infraorbital foramen and cone-beam computed tomography data from 125 patients (ages 18–75) by S Dağistan, Ö Miloğlu, O Altun, and EK Umar revealed that a round infraorbital foramen shape was common in the 30–39 age group, while an oval shape was more frequent in those aged 20–29, with both shapes more prevalent in females.²² The study also found the infraorbital foramen diameter to be largest in the 40–49 age group.

Data on the topography and asymmetry of the infraorbital foramen from A. Gawlikowska-Sroka et al. confirm geographical and chronological variations

among European populations, which may aid in targeting injection points for regional anesthesia.²³ However, the classical infraorbital anesthesia technique lacks precision in aligning needle insertion with the target site, as it disregards individual variations in vascular and neural anatomy. Variability in the anatomical-topographic parameters of the infraorbital foramen and facial skeletal structure necessitates personalized approaches to regional anesthesia, incorporating radiographic and digital diagnostic methods.^{24,25}

Morphometric studies of the greater palatine foramen show that the most common shapes among both sexes are oval (elongated anteroposteriorly), teardrop, and round. Less frequent shapes include crescent, triangular, rhomboid, and helical. The diameters of the greater palatine foramen and the length of its canal are larger in men, demonstrating significant sexual dimorphism.²⁶

Variability in the location and shape of the greater palatine canal—including undulating, funnel-shaped with inferior curvature, hourglass, zigzag, crescent, and straight—is independent of age and sex.²⁷

Anatomical-topographic features of the mandibular foramen, and thus the injection site for regional anesthesia, exhibit age-related differences. In 3-year-olds, the mandibular foramen is located 4.12 mm below the occlusal surface of molars, ascending with age to reach the occlusal level by age 9. In adults, it lies 4.16 mm above the occlusal surface. At age 3, the foramen is positioned at one-third the ramus height, reaching the midpoint in adulthood, with size varying from 67.8% at age 3 to 61.7% in adults.^{28,29} In individuals with reduced anterior facial height, the mandibular foramen may be even higher, located at 60% of the ramus width from its anterior edge. The vertical distance between the mandibular foramen and occlusal plane shows significant variability, particularly with aging.³⁰

Sandhya S.T. and Karpagam identified asymmetry in the position of the mandibular foramen relative to landmarks on the left and right rami, ranging from 13% to 20%, irrespective of age.³¹ According to Ditti J. Mary and Karthik Ganesh Mohanraj, a correlation exists between the gonial angle and mandibular foramen position, offering valuable insights for successful inferior alveolar nerve block and dental procedures.³² Other studies have revealed anatomical variability in the macrostructure and topography of the inferior alveolar nerve in adults and the elderly, manifested by high (4.0–11.0 mm) and low (22.0–33.0 mm) origins relative to the oval foramen, as well as variations in branching (single or dual trunks).

The number of branches to the teeth, interalveolar septa, and gums from the inferior alveolar nerve also decreases significantly with age and tooth loss.³³

The mental foramen, a bilateral opening on the anterior mandible, transmits the terminal branch of the inferior alveolar nerve (mental nerve).^{34,35,36} Its position relative to the mandibular borders remains relatively constant, aiding in nerve localization even in elderly patients. Achilandeshwari and Ranganath noted that the mental foramen is farther from anatomical landmarks in dentate jaws than in edentulous ones.³⁷ Mental foramen topography varies significantly across ethnic and age groups depending on sexual dimorphism and vertical facial dimensions (short, normal, or long face), which holds clinical relevance in dentistry.³⁸

CONCLUSION

To successfully achieve targeted anesthesia points and prevent complications during and after injection in elderly patients, it is essential to personalize the process of local conduction anesthesia and conduct preliminary radiographic and digital diagnostic methods.

DECLARATIONS

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Conflict of interest

The author declares that he has no Conflict of interest. None of the authors have relevant financial relations with a commercial interest.

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Ethical Approval

Not applicable

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