DOI 10.26724/2079-8334-2026-2-96-175-180
UDC 611.92-031.4+611.93-031.64

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PROJECTION FETAL ANATOMY OF THE ORGANS AND STRUCTURES OF THE LATERAL FACIAL REGION AND ADJACENT CERVICAL AREAS

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Recently, there has been an increase in the incidence of congenital and acquired pathologies affecting the organs and structures of the head and neck regions. This trend underscores investigators' heightened interest in further elucidating their anatomical variability under both normal and pathological conditions. The determination of the projection relationships among the organs, fasciomuscular, and neurovascular formations of the lateral facial region and adjacent cervical areas was conducted on 22 human fetal specimens aged 4–10 months (81.0–375.0 mm crown-rump length). It was established that the development and establishment of topographic-anatomical relationships among the constituent structures of the lateral facial region and adjacent cervical areas during the human fetal period are under the combined influence of spatiotemporal factors. These factors are associated with the dynamics and close syntopic correlation of the organs, neurovascular, fascial-cellular, and osseous structures of the given regions. Furthermore, a significant individual and age-related anatomical variability of the organs, vessels, and nerves of the lateral facial region and adjacent cervical areas was identified in human fetuses, manifesting as variations in their shape, size, and topography.

Key words: lateral facial region, deep facial region, organs and fasciae of the neck, vessels and nerves of the cervical region, sternocleidomastoid muscle, facial nerve, anatomy.

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ПРОЄКЦІЙНА ФЕТАЛЬНА АНАТОМІЯ ОРГАНІВ І СТРУКТУР БІЧНОЇ ДІЛЯНКИ ЛИЦЯ ТА СУМІЖНИХ ДІЛЯНОК ШИЇ

Останнім часом збільшилася кількість вродженої та набутої патології органів і структур ділянок голови та шиї, що зумовлює підвищену зацікавленість дослідників у подальшому з'ясуванні їхньої анатомічної мінливості за умов норми та патології. З'ясування проєкційних взаємовідношень органів, фасціально-м'язових і судинно-нервових утворень бічної ділянки лиця та суміжних ділянок шиї проведено на 22 препаратах плодів людини віком 4-10 місяців (81,0-375,0 мм тім'яно-куприкової довжини). Встановлено, що розвиток і становлення топографо-анатомічних взаємовідношень складових утворень бічної ділянки лиця та суміжних ділянок шиї у плодовому періоді розвитку людини знаходиться під сукупним впливом просторово-часових факторів, пов'язаних з динамікою та тісною синтопічною кореляцією органів, судинно-нервових, фасціально-клітковинних і кісткових структур даних ділянок. Також встановлено значну індивідуальну та вікову анатомічну мінливість органів, судин і нервів бічної ділянки лиця та суміжних ділянок шиї у плодів людини, що проявляється у різновидах їх форми, розмірів і топографії.

Ключові слова: бічна ділянка лиця, глибока ділянка лиця, органи і фасції шиї, судини і нерви шийної ділянки, груднинно-ключично-соскоподібний м'яз, лицевий нерв, анатомія.

Funding. *The study is a fragment of the research project "Sex- and age-related patterns of ontogenetic transformations and morphometric parameters of organs and structures under normal and experimental conditions. Morpho-functional and anthropometric features of the musculoskeletal system of athletes", state registration No. 0125U001531.*

The head and neck represent some of the most highly individualised regions of the human body, demanding comprehensive knowledge regarding the topography of the components within each compartment, zone, layer, and neurovascular structure [1, 4, 9, 13, 14]. A recent increase in the incidence of congenital and acquired pathologies affecting the organs and structures of the head and neck has spurred heightened scholarly interest in elucidating their anatomical variability under both normal and pathological conditions. Currently, the available scientific data on the morphology of structures within the lateral facial region, thymus, thyroid gland, trachea, oesophagus, and their adjacent vessels and nerves do not fully satisfy the clinical requirements of perinatal medicine [2, 6, 7, 16].

The major (great) vessels of the head and neck constitute a critical link within the circulatory system. Mapping the projection of the carotid arteries onto the organs of the lateral facial region and adjacent cervical zones, alongside establishing the topography of the main neurovascular bundle of the neck at various levels, holds profound applied significance in vascular surgery [3, 5, 8, 11, 20]. Consequently, insights into the anatomy of the projectional variants of organs, neurovascular complexes, and fasciomuscular structures of the lateral facial region and adjacent cervical zones in human fetuses at various gestational ages are pivotal for performing surgical interventions and interpreting angiograms. Furthermore, these data will facilitate the development of novel, minimally invasive approaches to the major vessels of the head and neck in fetal and neonatal surgery [6, 10, 18].

The purpose of the study was to establish the individual and age-related anatomical variability of organs, vessels, and nerves of the lateral facial region and adjacent zones of the neck in human fetuses.

Materials and methods. The study was conducted on 22 specimens of human fetuses aged 4–10 months, with no external signs of anatomical abnormalities or congenital malformations affecting the head and neck.

The periods of intrauterine development were categorised in accordance with the Instruction on Determining the Criteria of the Perinatal Period, Live Birth and Stillbirth, approved by Order No. 179 of the Ministry of Health of Ukraine, dated 29 March 2006. The subjects' ages were determined in obstetric months using crown-rump length (CRL) measurements. The projectional relationships of organs, fasciomuscle structures, and neurovascular complexes of the lateral facial region and adjacent cervical zones were elucidated in fetuses with a CRL ranging from 81.0 to 375.0 mm. This was achieved using macromicroscopic dissection, layer-by-layer illustration of the structures within these regions, vascular injection, and morphometry.

Human fetuses weighing over 500.0 g were examined directly at the Chernivtsi Regional Bureau of Pathology under a scientific cooperation agreement. Individual human fetal specimens were obtained from the collection of the Department of Anatomy, Clinical Anatomy and Operative Surgery at Bukovinian State Medical University, having been acquired prior to 2006 in compliance with the legislation in force at that time.

The work was performed in adherence to the core tenets of the Declaration of Helsinki of the World Medical Association on ethical principles for medical research involving human subjects (1964–2013), Order No. 690 of the Ministry of Health of Ukraine dated 23 September 2009, and with due regard to the methodological guidelines of the Ministry of Health of Ukraine titled “Procedure for procuring biological objects from deceased individuals whose bodies are subject to forensic medical examination and pathological investigation, for scientific purposes” (2018).

The study was approved by the Biomedical Ethics Committee of Bukovinian State Medical University (Minutes No. 4, dated 18 December 2025); no violations of moral or legal standards were identified during the course of the research.

Results of the study. The first anatomical layer of the lateral facial region, composed of the skin and subcutaneous adipose tissue, contains the proximal part of the facial artery, with the facial vein situated posterior to it. The superficial fascia and the muscles of facial expression form the second conventional topographic-anatomical layer. The terminal segments of the facial vessels and the muscular branches of the facial nerve pass between the laminae of the superficial fascia and between the muscles of facial expression. Notably, we identified topographical variants of the facial artery within the examined human fetuses. Along its course toward the medial angle of the eye, the facial artery may pass either superficially to or deeper than the muscles of facial expression, exhibiting a “diving” (undulating) course and being located at varying distances from the angle of the mouth and the ala of the nose. In this second layer of the adjacent cervical regions, the platysma muscle, the external jugular vein, and branches of the cervical plexus are located. The platysma muscle is predominantly innervated by 2–4 trunks originating from the cervical branch of the facial nerve. The latter enters the substance of the muscle in a transverse direction relative to the muscle bundles, whereas within the substance of the platysma, the nerve trunks run parallel to the muscle fibers. In certain fetuses, we observed communication between the branches of the facial nerve and those of the cervical plexus within the substance of the platysma muscle.

The third conventional topographic-anatomical layer of the lateral facial region is formed by the fascia propria, specifically its superficial lamina, which invests the parotid gland and the masseter muscle and is designated as the parotid-masseteric fascia. The latter is loosely attached to the zygomatic arch and extends superiorly into the temporal fascia. At the anterior border of the masseter muscle, the parotid-masseteric fascia continues into the buccopharyngeal fascia, which forms the capsule of the buccal fat pad. Near the angle of the mandible, the parotid-masseteric fascia fuses with the fascia propria of the neck. The superficial lamina of the fascia propria, which splits to form the capsule of the parotid gland, is termed the parotid fascia. Notably, over the superior and deep portions of the parotid gland, the fascia is thin or entirely absent, which may facilitate the spread of a purulent process from the parotid gland into the external acoustic meatus or the parapharyngeal space. In the adjacent cervical regions, the superficial lamina of the fascia propria forms the sheath of the sternocleidomastoid muscle.

The fourth topographic-anatomical layer, which reveals the parotid gland, the parotid duct, and the sternocleidomastoid muscle after the removal of the superficial lamina of the fascia propria, constitutes the first conventional structural layer within the lateral facial region and adjacent cervical zones. This layer encompasses the organs of the specified regions after the removal of the skin, subcutaneous tissue, superficial fascia, and the superficial lamina of the fascia propria. During macromicroscopic dissection, efforts were made to preserve the superficial vessels and nerves on one side. The internal carotid artery projects onto the lower two-thirds of the parotid gland, the anterior border of the sternocleidomastoid muscle, and the retromandibular vein.

In certain human fetuses, the superficial part of the parotid gland exhibits a triangular configuration, the base of which is oriented toward the zygomatic arch and situated on the external surface of the masseter muscle; along the course of its duct, the gland may extend to the anterior border of the masseter muscle. In 7 cases, an accessory parotid gland was identified (Fig. 1A), situated along the course of the parotid duct.

The parotid duct typically emerges from the superior third of the gland and runs slightly inferior to the zygomatic arch across the external surface of the masseter muscle (Fig. 1B). Subsequently, the parotid duct courses around the anterior border of the masseter muscle, passes through or loops around the buccal fat pad (4 observations), pierces the buccinator muscle, and opens into the oral vestibule. We noted significant variability in the length of the extra-glandular segment of the parotid duct, which ranged from 2.5 to 4.0 cm, depending on the development of its anterior process or the presence of an accessory lobe of the gland. The primary blood supply to the parotid gland is provided by the transverse facial artery, a branch of the superficial temporal artery. In 2 observations, the latter originated directly from the external carotid artery, and in 1 case, from the maxillary artery. The number of branches of the transverse facial artery supplying the parotid gland ranges from 3 to 9. The transverse facial artery typically emerges from beneath the anterior border of the parotid gland and runs obliquely in a downward direction superior to the parotid duct; occasionally (2 cases), it crosses the duct near the anterior border of the masseter muscle. In one fetus with a CRL of 245.0 mm, the right transverse facial artery passed inferior to the duct of the right parotid gland. Notably, the right facial artery was absent in this specimen, being completely replaced by the right transverse facial artery.

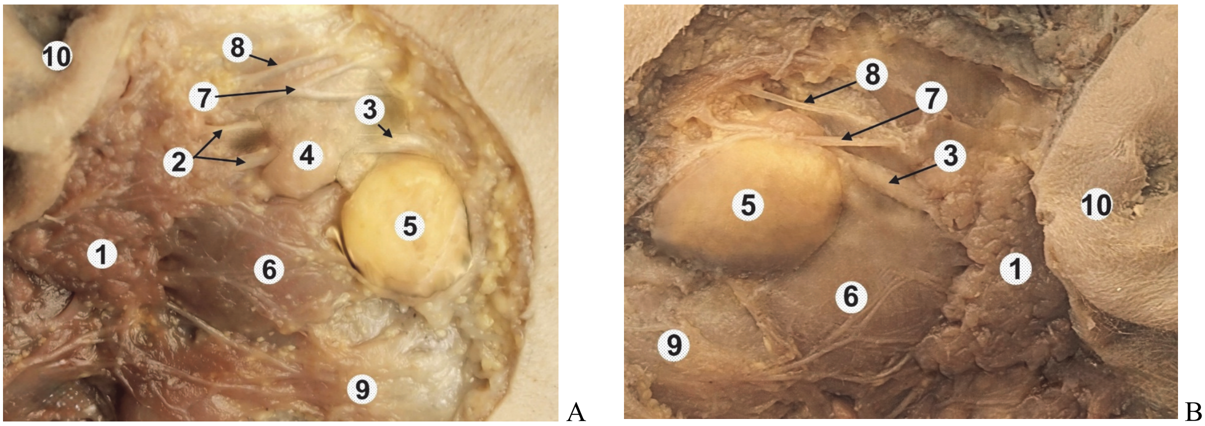

Fig. 1. Parotid glands of human fetuses with a CRL of 250.0 mm (7th month). Photographs of gross specimens. (A) – right-sided view; (B) – left-sided view. Magnification: ×4.5: 1 – parotid gland; 2 – interlobular ducts (two); 3 – parotid duct; 4 – accessory lobe of the right parotid gland; 5 – buccal fat pad; 6 – masseter muscle; 7 – transverse facial artery; 8 – branch of the facial nerve; 9 – angle of the mandible; 10 – auricle.

Following the removal of the superficial part of the parotid gland down to the level of the intraparotid plexus of the facial nerve, while preserving the superficial vessels and nerves, visualisation of the second conventional layer of the lateral facial region and adjacent cervical regions was achieved. In the majority of the early fetuses examined, the trunk of the facial nerve exhibits an ascending course, whereas starting from the end of the 6th month of intrauterine development, it gradually assumes a horizontal orientation. Notably, toward the end of the fetal period of ontogenesis (fetuses aged 8–10 months), the depth of the facial nerve course increases. In a fetus with a CRL of 130.0 mm, the trunk of the facial nerve was located almost entirely within the parenchyma of the parotid gland. In human fetuses, we observed two extreme anatomical variants of the intraparotid plexus configuration: plexiform (reticular) (35%) and trunk (magistral) (65%). Upon exiting the parotid gland, the branches of the facial nerve course radially, giving rise to the temporal, zygomatic, buccal, marginal mandibular, and cervical branches. Solitary communications are identified between these branches, resulting in the formation of small plexuses within the buccal and temporal regions. During the study, individual variations in the innervation of specific facial muscles were identified. In particular, the frontalis muscle, which remains underdeveloped in human fetuses, receives 2 to 5 extremely thin nerve trunks from the temporal branches of the facial nerve. These trunks penetrate the muscle substance from its lateral border, initially running in a transverse direction relative to the muscle bundles.

Within the substance of the frontalis muscle, the cranial branching of the nerves runs parallel or obliquely relative to the muscle bundles. In several late-stage fetuses, we identified the formation of a fine-mesh plexus within the substance of the frontalis muscle. In three cases, branches of the trigeminal nerve also participated in the formation of this plexus. The innervation of the orbicularis oculi muscle is provided by 4–7 trunks originating from the zygomatic and temporal branches; within the muscle substance, these nerve trunks initially run transversely to the circularly arranged muscle bundles and subsequently form a fine-mesh plexus. Notably, the zygomaticus muscle is typically innervated by 3–5 zygomatic branches; a distinctive feature of the innervation of this muscle is the presence of perforating branches that pierce the muscle and proceed to the muscles surrounding the oral fissure. The sources of innervation for the orbicularis oris muscle include the buccal branches and the marginal mandibular branch. Investigation into the innervation of the orbicularis oris muscle revealed intramuscular nerve communications crossing to the contralateral side. The distinctive features of the innervation of the muscle group surrounding the oral fissure include the presence of perforating branches, most of which pass through the substance of other muscles before penetrating their target muscle.

The common, internal, and external carotid arteries project onto the organs of the second conventional layer. Specifically, the internal carotid artery courses over the facial nerve, the retromandibular vein, and the sternocleidomastoid muscle; inferior to the latter, the carotid sinus and the external carotid artery course. The organs and structures of the third conventional layer are revealed following the removal of the deep portion of the parotid gland, with partial preservation of the vessels and nerves passing through its substance, and after resection of the sternocleidomastoid muscle. Located within this layer are the external carotid artery and its branches – the transverse facial, superficial temporal, facial, and superior thyroid arteries – as well as the internal jugular vein, the accessory nerve, and the auriculotemporal nerve. In this layer, the internal carotid artery projects onto the ramus and angle of the mandible, along with the overlying masseter muscle, the posterior belly of the digastric muscle, and the retromandibular vein.

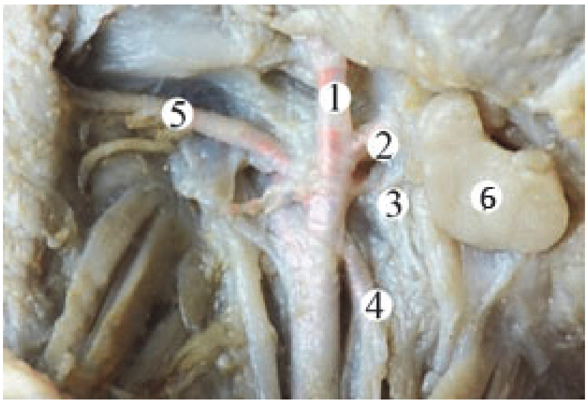

Fig. 2. Anterior cervical region (right side) of a 120.0 mm CRL fetus (the platysma and sternocleidomastoid muscles have been removed). Photograph of a gross specimen. Magnification: ×2.7: 1 – external carotid artery; 2 – facial artery; 3 – lingual artery; 4 – superior thyroid artery; 5 – occipital artery; 6 – submandibular gland.

Following resection of the ramus of the mandible and a portion of its body, along with the removal of the buccal fat pad, the organs and structures of the fourth layer were exposed – namely, the organs of the deep facial region and the adjacent cervical zone: the pterygoid muscles, the terminal branches of the external carotid artery (Figs 2, 3), the pterygoid venous plexus, and the branches of the mandibular nerve. The internal carotid artery projects onto the neck and angle of the mandible, the maxillary artery, the pterygoid venous plexus, the posterior belly of the digastric muscle, and the internal jugular vein.

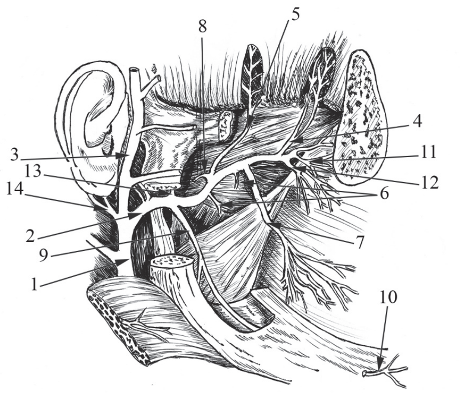

Fig. 3. Terminal branches of the external carotid artery (schematic diagram, modified from T.V. Zolotareva, 1968): 1 – external carotid artery; 2 – maxillary artery; 3 – superficial temporal artery; 4 – anterior deep temporal artery; 5 – posterior deep temporal artery; 6 – pterygoid branches; 7 – buccal artery; 8 – masseteric artery; 9 – inferior alveolar artery; 10 – mental artery; 11 – infraorbital artery; 12 – posterior superior alveolar artery; 13 – middle meningeal artery; 14 – occipital artery.

Following the removal of a portion of the mandibular body and the condylar process, the organs and structures of the fifth conventional layer are exposed. These include the styloid process along with its originating muscles, and the terminal segment of the external carotid artery, which courses between the stylohyoid muscle and the styloglossus and stylopharyngeus muscles. The cervical part of the internal carotid artery, the external carotid artery, the bifurcation of the common carotid artery, and the internal jugular vein are also located within this layer. The internal carotid artery projects onto the terminal segment of the external carotid artery and the posterior belly of the digastric muscle.

After the removal of the styloid process, its originating muscles and ligaments, the posterior belly of the digastric muscle, and the previously retained deep portion of the sternocleidomastoid muscle, the components of the sixth conventional layer are exposed. These comprise the main neurovascular bundle of the neck in the region of the common carotid artery bifurcation and the neurovascular bundle of the deep facial region (within the posterior compartment of the lateral parapharyngeal space).

In the majority of the fetuses examined, the right vagus nerve in the cervical region courses along the posterolateral surface of the right common carotid artery, with the internal jugular vein situated ventrolaterally to the nerve. Upon reaching the level of the right subclavian artery, the right vagus nerve passes between it and the internal jugular vein. At the level of the inferior border of the thyroid gland, the superior cardiac branch originates from the right vagus nerve, coursing downward and transferring onto the anterior surface of the right common carotid artery. Typically, 2.0–5.0 mm superior to the level of the right subclavian artery, the superior cardiac branch divides into 2–4 branches: 1–2 medial branches cross the anterior surface of the proximal segment of the right common carotid artery and transfer to its posterior surface; and 1–2 lateral branches course in a caudal direction, giving off branches to the brachiocephalic trunk and the posterior surface of the right subclavian artery.

Subsequently, the lateral branches course along the external border of the brachiocephalic trunk and gradually transfer onto its posterior surface. At the level where the right vagus nerve intersects the right subclavian artery, the right recurrent laryngeal nerve branches off from it. The right recurrent laryngeal nerve then deviates medially, loops inferiorly around the right subclavian artery, and ascends toward the trachea and larynx. The inferior cardiac branch originates from the right recurrent laryngeal nerve, coursing in a caudomedial direction and being situated on the right anterolateral surface of the trachea. The left vagus nerve typically passes along the anterior surface of the aortic arch. However, in one instance (a 190.0 mm CRL fetus), both the right and left vagus nerves crossed the anterior surface of their respective subclavian arteries upon entering the thoracic cavity. Within the cervical region, the superior cardiac branch branches off from the left vagus nerve, proceeding to the anterior surface of the left common carotid artery. In the lower segment of the left common carotid artery, the superior cardiac branch gives off two branches: a medial branch – to the wall of the aortic arch, and a lateral branch, which courses along the anterior surface of the left common carotid artery. At the site where it adjoins the left surface of the aortic arch, the left vagus nerve gives off the left recurrent laryngeal nerve. The latter loops inferiorly around the aortic arch, ascends along the lateral surface of the trachea, and then accommodates within the tracheoesophageal groove, which is defined between the trachea and the esophagus protruding from beneath it and shifted slightly to the left.

The thyroid gland is situated anterior to the larynx and the cervical part of the trachea, predominantly exhibiting a butterfly-like configuration, whereby in early-stage fetuses, the lobes of the gland transition into one another without distinct boundaries. The posterolateral surface of the right and left lobes of the thyroid gland adjoins the anterior semicircle of the respective common carotid artery. Lateral to the common carotid artery runs the internal jugular vein, and posteriorly, within the groove between them, the vagus nerve. Skeletally, the right and left lobes of the thyroid gland are located at the level of the I–III (rarely I–IV) tracheal cartilages. Anteriorly, the trachea is invested by the pretracheal lamina of the cervical fascia, between the layers of which the paired sternohyoid and sternothyroid muscles are accommodated. In a 230.0 mm CRL fetus, a pyramidal lobe originated from the right lobe of the thyroid gland. The isthmus of the thyroid gland is typically situated inferior to the arch of the cricoid cartilage, whereas the right lobe and the pyramidal lobe overlie the cartilage arch. The inferior border of the cricoid cartilage is oriented horizontally and adjoins the first tracheal cartilage.

Discussion. Although the prenatal period of development is relatively brief, the structural transformations of the organism during this timeframe are far more substantial than those occurring throughout the entire human postnatal period. With the accumulation of data on the etiopathogenesis of disorders affecting various organs and structures, the significance of the intrauterine formation and establishment of topographic-anatomical relationships among organs, bones, fasciae, muscles, vessels, and nerves of different body regions becomes increasingly vital – a factor toward which the unremitting attention of healthcare must be directed. Therefore, at the current stage of development in perinatal medicine, performing surgical manipulations and operations in the deep facial region and adjacent cervical areas necessitates a detailed elucidation of data on the age-related and individual anatomical variability of organs, muscles, fasciomuscular and neurovascular formations in human fetuses and neonates. In our macroscopic study conducted on human fetal specimens aged 4–10 months, we emphasized the description of the topographic-anatomical layers of the lateral facial region and adjacent cervical areas, paying particular attention to the topography of the fasciae that bound the cellular spaces of the aforementioned regions, invest muscles, and surround organs, vessels, and nerves. Beyond their supportive function, these fasciae have important clinical significance in the propagation of purulent-inflammatory processes.

From the aforementioned data, it is evident that the branching of the facial nerve and the transverse facial artery – both characterized by topographical variations – closely contact the parotid gland and its duct, and, in distinct cases, an accessory parotid gland, as also indicated by several authors [13, 14, 19]. Therefore, during inflammatory processes, infiltrates, or neoplasms, the swollen tissues compress the nerve branchings, leading to transient or persistent long-term paralyses, which is also consistent with the findings of certain investigators [4, 12, 15]. As a consequence of such intimate topographic-anatomical relationships of the parotid gland with adjacent nerves and vessels, during surgeries (incisions, partial removal) on this gland, it remains challenging to avoid injury to the branches of the facial nerve, or even its trunk, especially if incisions are performed in the superior compartment of the parotid gland, as pointed out by some authors [1, 17]. To comprehend the complex syntopic relationships of the organs and structures of the lateral facial region with the viscera, muscles, and fascial-cellular structures of the adjacent cervical areas, it is essential to have a clear understanding of their layer-by-layer arrangement, which we described cohesively, given that the fasciae and their laminae transition from one region to another, forming a unified whole. We established the variability of the topographic-anatomical relationships among the constituent structures of the aforementioned regions in human fetuses, which aligns with the opinion of specific authors [3, 5, 9, 20].

Thus, the new scientifically substantiated data obtained by us significantly complement current concepts regarding the projection of fetal anatomy in specific head and neck regions. The purposeful study of the spatiotemporal relationships among organs, bones, muscles, fascial-cellular, and neurovascular formations of the lateral facial region and adjacent cervical areas in human fetuses aged 4–10 months allowed not only for expanding knowledge regarding the general patterns of the fetal development of these structures but also for identifying the spectrum of their individual anatomical variability.

Conclusion

The development and establishment of topographic-anatomical relationships among the constituent structures of the lateral facial region and adjacent cervical areas during the human fetal period are under the combined influence of spatiotemporal factors. These are associated with the dynamics and close syntopic correlation of the organs, neurovascular, fascial-cellular, and osseous structures of the given regions.

The results refute the concept of invariability in the topographic-anatomical relationships among organs and neurovascular structures of the head and neck in human fetuses, underscoring the necessity of a personalized approach in fetal and neonatal surgery.

In human fetuses, significant individual- and age-related anatomical variability in the organs, vessels, and nerves of the lateral facial region and adjacent cervical areas was observed, manifesting as variations in their shape, size, and topography.

Data regarding the identified variants of the structure and syntopy of the organs and structures of the lateral facial region and adjacent cervical areas in human fetuses of various ages will contribute to reducing the risk of operative complications and will increase the precision of diagnostic manipulations within these regions.

Prospects for further research. The topographic-anatomical relationships of the organs, arterial and venous vessels, and nerves of the lateral facial region and adjacent cervical areas require detailed study, accounting for their anatomical variability across different periods of human postnatal ontogenesis, to improve surgical practice and the planning of reconstructive interventions.

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Conflict of interest. The authors have no conflicts of interest to declare.

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Article received: 16.05.2025