Nobutaka Yoshioka
Albert L. Rhoton, Jr.
Juan C. Fernandez-Miranda

Atlas of the Facial Nerve and Related Structures

Second Edition

Springer

Atlas of the Facial Nerve and Related Structures

Nobutaka Yoshioka • Albert L. Rhoton, Jr.
Juan C. Fernandez-Miranda

Atlas of the Facial Nerve and Related Structures

Second Edition

Springer

Nobutaka Yoshioka
Director, Department of Neuroplastic
and Reconstructive Surgery
Social Medical Corporation Kotobukikai,
Tominaga Hospital
Osaka-shi, Osaka, Osaka, Japan

Albert L. Rhoton, Jr.
R.D. Keene Family Professor and Chairman
Emeritus, Department of Neurosurgery,
College of Medicine
University of Florida
Gainesville, FL, USA

Juan C. Fernandez-Miranda
Professor of Neurosurgery and, by courtesy,
of Otolaryngology-Head & Neck Surgery,
School of Medicine
Stanford University
Palo Alto, CA, USA

ISBN 978-981-96-3619-8 ISBN 978-981-96-3620-4 (eBook)
https://doi.org/10.1007/978-981-96-3620-4

Cover illustration: The right figure illustrates the left facial nerve from its origin inside the skull to its exit from the temporal bone. The left figure depicts the left side of the face, where all the branches of the facial nerve emerge from the parotid gland.

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Foreword

Since antiquity, the intricate anatomy of the human nervous system has fascinated anatomists and surgeons alike. Early pioneers who studied and named these structures, particularly the cranial nerves, include such luminaries as Marinus, Galen, Herophilus, Erasistratus, da Vinci, Estienne, Vesalius, and Willis (Persaud et al. 2014). It was not until the late eighteenth century, with von Soemmerring's classification, that the cranial nerves were enumerated as the 12 distinct pairs we appreciate today. His work refined earlier concepts, dividing the "facial-vestibulocochlear" complex into the now-recognized facial (VII) and vestibulocochlear (VIII) nerves. Subsequent contributions to understanding the facial nerve's anatomy have come from eminent figures such as Fallopius, Eustachius, Wrisberg, and Bell (Maoz and Canalis 2022). In modern times, advances in the surgical anatomy of the facial nerve, spurred by tools like the operative microscope, have been pioneered by individuals including Balance, Bunnell, House, and Fukushima.

In 2015, renowned surgeons Drs. Yoshioka and Rhoton published their groundbreaking *Atlas of the Facial Nerve and Related Structures,* which has since become a gold-standard reference. Building on this foundation, the second edition of the atlas represents a collaborative effort between Dr. Nobutaka Yoshioka, the late Dr. Albert L. Rhoton, and the well-known neurosurgeon Dr. Juan Carlos Fernandez-Miranda. This updated edition reflects the evolution of our understanding of the facial nerve's complex and circuitous route. The authors have succeeded in capturing this intricate nerve's "true" anatomy (along its entire course), a feat made possible through some of the most meticulous and visually striking cadaveric dissections currently available. Moreover, illustrating the anatomical relationships of the facial nerve in different regions and from various viewpoints makes this atlas very useful.

As an author and editor of numerous anatomical textbooks and atlases, I am honored to share my perspective on this exceptional resource. The second edition of *Atlas of the Facial Nerve and Related Structures* is an invaluable reference for trainees and practitioners across disciplines, including neurosurgery, facial plastic and reconstructive surgery, otolaryngology, neurotology, head and neck surgery, maxillofacial surgery, and craniofacial surgery. Its detailed insights into the morphology of the seventh cranial nerve will undoubtedly enhance patient outcomes. Moreover, anatomists and clinicians interested in detailed cranial nerve anatomy will find this atlas both enlightening and indispensable. Readers will be rewarded with a deeper understanding of the facial nerve's anatomy, paving the way for academic and clinical advancements.

R. Shane Tubbs
Professor of Neurosurgery, Surgery, Neurology,
and Structural and Cellular Biology
Tulane University School of Medicine
New Orleans, LA, USA

References

Maoz SLL, Canalis RF. From Galen to Eustachio: discovering the anatomy of the facial nerve. Otol Neurotol 2021;42:1434–41.

Persaud TVN, Loukas M, Tubbs RS. A history of human anatomy. 2nd ed. Charles C. Thomas; 2014.

Preface

The field of facial reanimation surgery represents one of the most profound intersections of art, science, and human compassion. This discipline, which seeks to restore movement, expression, and identity to those affected by facial paralysis, has seen remarkable advances in recent years. At its core, the success of facial reanimation surgery depends on an intimate understanding of the intricate web of neurovascular and musculoskeletal structures that govern facial movement. It is within this context that Nobutaka Yoshioka, MD, world renown expert on *Neuroplastic and Reconstructive Surgery*, has created this groundbreaking anatomical atlas.

Dr. Yoshioka's journey to produce this work is as extraordinary as the atlas itself. A devoted student of anatomy and surgery, Dr. Yoshioka's formative training included mentorship under the legendary Professor Albert L. Rhoton, Jr., MD, at the University of Florida over 20 years ago, and he is, in fact, the one and only neuroplastic surgeon to ever undergone such specialized training within the highly exclusive list of Prof. Rhoton fellows. As a result of his work with Prof. Rhoton, the first edition of this atlas was published in 2015. Impressively, over two decades after his training with Prof. Rhoton, Dr. Yoshioka's commitment to advancing his field led him to spend six months in my laboratory at Stanford University—the Stanford Neurosurgical Training and Innovation Center, refining and perfecting the material that forms the basis of the second edition of this atlas. His pursuit of precision, clarity, and surgical relevance is reflected in every anatomical dissection of this atlas.

However, this atlas is not merely a collection of anatomical dissections; it is a masterclass in *microsurgical anatomy* as it relates to facial reanimation surgery. With the rising prominence of techniques like nerve grafting, muscle transfers, and free flap reconstructions, a thorough understanding of facial anatomy has never been more crucial. Dr. Yoshioka's meticulous approach offers a resource that is at once practical and profound, bridging the essential gap between theoretical anatomy and applied surgical technique.

A defining feature of this atlas is its *clinical orientation*. Unlike traditional anatomical references, which often depict static dissections, this work emphasizes the *dynamic nature of anatomical relationships*—essential for surgeons performing facial reanimation. The illustrations not only highlight structures of interest but also provide clear context for their relevance to specific surgical procedures. Nerve paths, vascular supply, and muscle insertions are presented with stunning clarity, allowing surgeons to visualize surgical corridors and anticipate potential challenges.

Beyond its visual excellence, this atlas is a testament to Dr. Yoshioka's commitment to surgical education. The material reflects not only his experience as a practicing surgeon but also his dedication to teaching future generations. His methodical approach, influenced by the teachings of Prof. Rhoton, is designed to *inspire curiosity*, *precision*, and *confidence* in those who seek to master the complexities of facial reanimation.

This work is both a *practical reference* and an *enduring legacy*. As the field of facial reanimation continues to evolve, so too will the demand for surgeons with a profound command of the anatomy that underlies it. Dr. Yoshioka's atlas offers surgeons, students, and educators a unique opportunity to deepen their understanding of this critical field. From the pathways of cranial nerves to the intricacies of muscle transfer techniques, this atlas will undoubtedly serve as a touchstone for surgical planning, education, and innovation.

I extend my deepest gratitude and admiration to Nobutaka Yoshioka, MD, for his dedication to advancing the anatomical knowledge that fuels surgical excellence. His work builds on the enduring legacy of our mentor, Prof. Rhoton, while charting a bold, new course for the field of facial reanimation surgery. I am confident that this atlas will leave a lasting impact on the field of plastic and reconstructive surgery, offering guidance, inspiration, and insight to surgeons and medical professionals worldwide.

Palo Alto, CA, USA Juan C. Fernandez-Miranda

Preface

After publishing the first edition, I made a promise to Dr. Rhoton that I would return to his research institute for further study and subsequently produce a second edition. Although Dr. Rhoton has since passed away, the publication of this revised edition fulfills that promise and represents a project I have long envisioned.

Surgical progress always requires a thorough understanding of anatomy. In this second edition, we have expanded our exploration of the detailed anatomy of the facial mimetic muscles, their innervation, and the intratemporal segment of the facial nerve through meticulous dissections of several specimens. I would like to express my deepest gratitude to Professor Miranda for establishing a state-of-the-art 3D microneuroanatomy laboratory at Stanford University. His dedication, reminiscent of our mentor, Dr. Rhoton, has been invaluable, and he graciously allowed me to join his skull base team for research. Continuing our precise work on human anatomy is a tribute to the legacy of Albert L. Rhoton Jr. We take pride in our work and are committed to continuing this journey for the benefit of our patients.

The use of human cadavers in this atlas offers an irreplaceable and profound understanding of anatomy. The donors of these cadavers have, through their generous contributions, become our greatest teachers, guiding us through the essential details of anatomy during every dissection. Their selfless gift allows us to gain insights that go beyond standard descriptions, bringing a deeper and more tangible comprehension of the human body. During my six months in Professor Miranda's lab, I was profoundly moved by the new knowledge I gained regarding facial nerve anatomy. While standard textbooks often describe this anatomy in vague and anecdotal ways, this atlas provides a vivid visual approach that illuminates its unique structures. Our work would not have been possible without the generous and invaluable contributions of these donors, to whom we owe an immeasurable debt of gratitude.

Finally, I am deeply grateful to my children for their patience and understanding during the countless hours I spent immersed in this work. I hope that, in time, they will come to understand the importance of our dedication to advancing medical knowledge and patient care.

Osaka, Japan — Nobutaka Yoshioka

Preface to the First Edition by Albert L. Rhoton

One of the joys of my professional career has been to work with Nobutaka Yoshioka, MD, PhD, an outstanding plastic surgeon, on this atlas. My applause and congratulations go to him for this outstanding book. Michelangelo and da Vinci and many great artists pursued cadaveric dissection as a way of achieving perfection in their art; this beautiful anatomical volume highlights Dr. Yoshioka's own passion for perfection. Dr. Yoshioka worked in our microsurgery laboratory, where he created precise and accurate dissections of the facial nerve as a guide to improving the lives of our patients. We are fortunate to have had Dr. Yoshioka in our laboratory, where he worked night and day to achieve the excellence reflected in the photographs in this book. In sections, which begin with the skull and intracranial structures, followed by the upper, mid, and lower face and the posterolateral neck, this atlas captures the full course of the facial nerve. Each section is filled with stunning color images of his magnificent dissections, and every figure is supplemented with a concise, well-focused description that provides a wealth of information. Surgeons, particularly neurosurgeons and plastic surgeons, as well as ENT and head and neck specialists around the world will benefit from this work. Students and trainees will also benefit from studying this book cover to cover, while readers with advanced knowledge and experience will find it a useful reference. My work with Dr. Yoshioka and other young surgeons from across the globe has been one of the most rewarding aspects of my career and a source of many treasured friendships. This book is a reflection of this friendship and cooperation.

Albert L. Rhoton, Jr.

Preface to the First Edition by Nobutaka Yoshioka

It has been more than ten years since I finished my fellowship at the Microneuroanatomy Laboratory at the University of Florida. I first met Dr. Albert Rhoton at the seventh meeting of the Japanese Society for Skull Base Surgery, held in Hakata, Japan, in 1995. I will never forget how deeply impressed I was by the anatomical illustrations he showed at that meeting. As every neurosurgeon now knows, his images detail delicate brain anatomy in a unique way, and it was something that I had never seen before. Then, from September 2003 to August 2004, I had an opportunity to study head anatomy at his laboratory. At that time, I was a board-certified plastic surgeon and a board-certified neurosurgeon in Japan. Although I had been working exclusively as a plastic surgeon rather than as a neurosurgeon, Dr. Rhoton generously allowed me to study the anatomy of the extracranial region at his laboratory. This had been my major interest as a plastic surgeon, and I found in my research that the qualities of anatomical specimens varied greatly. For example, the quality of silicon injection of the extracranial region differed from the intracranial region, and this concerned me. Fortunately, at Dr. Rhoton's laboratory I was finally able to obtain some good specimens in which the silicon was almost perfectly injected into the extracranial region. Facial reanimation surgery has been my life's work for more than 10 years, and with this book, Dr. Rhoton and I had as our goal the creation of an atlas of anatomy of the facial nerve illustrated with precisely dissected specimens, similar to the beautifully illustrated Pernkopf Anatomy. I believe that an atlas of anatomy consisting of specimens is more understandable than one with illustrations, even if they are delicately drawn. Our appreciation of basic human anatomy is not always complete, and a thorough reevaluation of the literature supplemented by detailed cadaver dissections can lead to new insights that may alter our surgical technique. Finally, I want to express my appreciation for the patience of my children, Aya, Satoshi, Akira, and Jun, while I have been immersed in this project and clinical work. I think this book should be dedicated to the donors of the specimens shown because only their devotion made this work possible.

Osaka, Japan — Nobutaka Yoshioka

Contents

Note: Every figure shows the left side whenever the unilateral side is shown.

Part I

Facial Nerve: Intracranial, Intratemporal, and Main Trunk

1 Intracranial and Intratemporal Regions

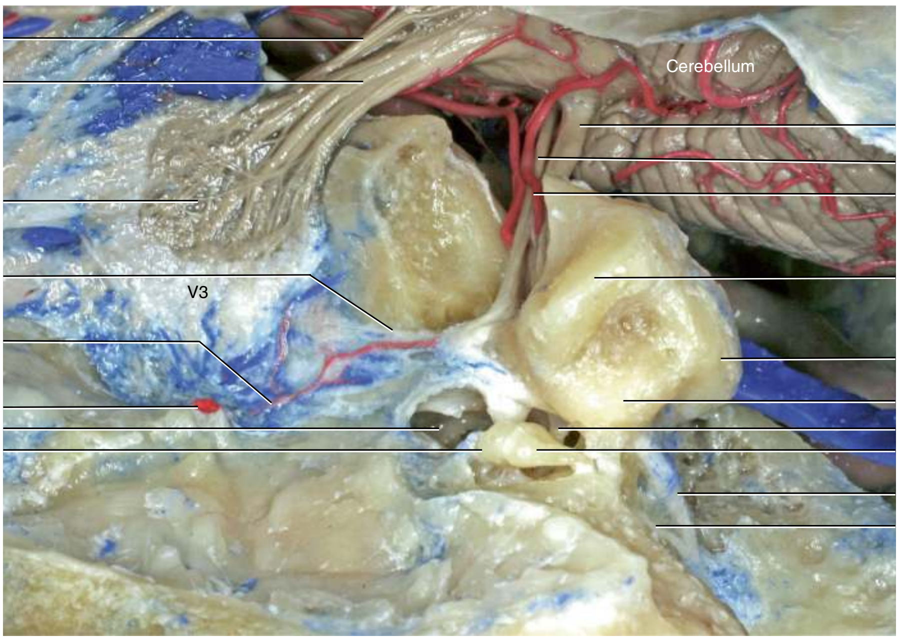


Fig. 1.1 Superior view of the middle cranial fossa. The tegmen tympani and the roof of the internal acoustic meatus have been opened

The facial nerve is the seventh cranial nerve and controls the muscles of facial expression, taste, general sensation, and glandular secretion. It has the second longest intraosseous course of the 12 cranial nerves, after the mandibular division of the trigeminal nerve. The facial nerve is the most complex in terms of adjacent anatomical structures.

The facial nerve is associated with three nuclei within the brain stem: the facial nucleus, the superior salivatory nucleus, and the solitary nucleus. The facial nucleus is located in the pons and receives the motor signal from the cerebral motor cortex via the corticobulbar tract. The input from the motor cortex is transmitted to the contralateral facial nucleus, except for the input that supplies the upper facial expression muscles, which is sent to the bilateral facial nuclei. The superior salivatory nucleus projects a parasympathetic motor supply to the lacrimal, submandibular, sublingual, nasal, and palatal glands. The solitary nucleus receives general sensation (auricular concha) and taste sensation (anterior two-thirds of the tongue and palate).

The facial nerve emerges from the brain stem at the ventrolateral pontomedullary junction and passes through the cerebellopontine angle cistern to the internal acoustic meatus. The course of the facial nerve can be divided into intracranial, intratemporal, and extratemporal segments. The intratemporal segment can be divided into four segments: meatal, labyrinthine, tympanic (horizontal), and mastoid (vertical).

The anterior inferior cerebellar artery supplies the facial nerve in the cisternal, meatal, and labyrinthine segments. The petrosal branch of the middle meningeal artery and the stylomastoid artery, which enters the temporal bone through the stylomastoid foramen, supply the facial nerve from the geniculate ganglion to the mastoid segment.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_1

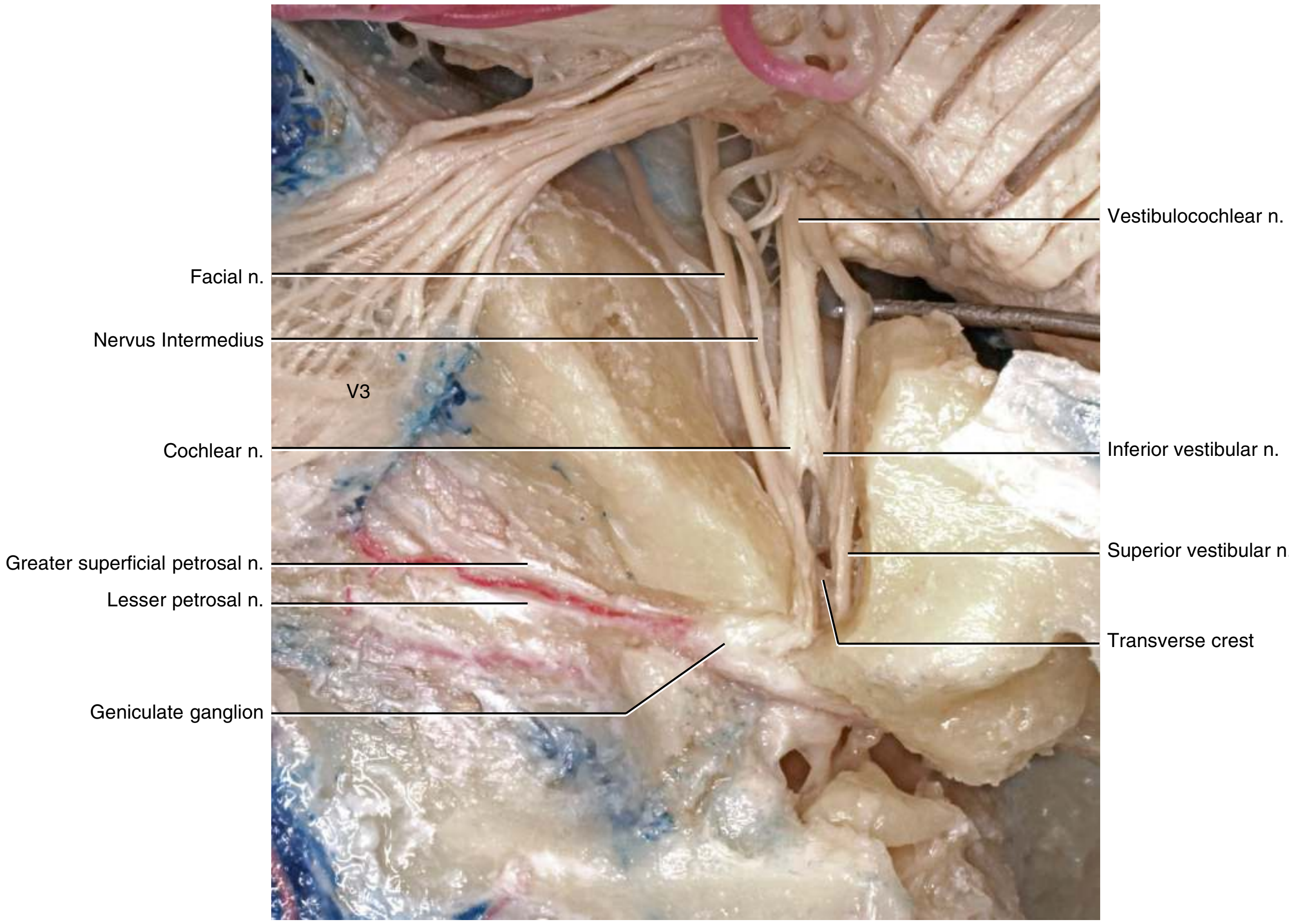


Fig. 1.2 Superior view of the facial and vestibulocochlear nerves. The roof of the internal acoustic meatus has been opened

The intracranial segment of the facial nerve, known as the cisternal segment, spans roughly 25 mm and connects the facial nerve from its origin to the entrance of the internal acoustic meatus. The facial nerve has two roots: the motor root, which supplies the muscles of the face, and the nervus intermedius, which contains sensory fibers involved in the perception of taste and parasympathetic (secretomotor) fibers to the lacrimal, submandibular, sublingual, nasal, and palatal glands. They run parallel and anterior to the vestibulocochlear nerve.

The facial nerve enters the temporal bone through the internal acoustic meatus. The motor root courses anterior to the nervus intermedius into the internal acoustic meatus. The facial nerve travels with the vestibulocochlear nerve for approximately 10 mm into the internal acoustic meatus as a meatal segment before entering a bony canal called the facial or Fallopian canal. The motor root and the nervus intermedius merge within the meatus.

The internal acoustic meatus is divided at its fundus into superior and inferior compartments by the transverse crest (falciform crest). A vertically directed bony crest (Bill's bar) subdivides the superior compartment into anterior and posterior quadrants. The former is occupied by the facial nerve and nervus intermedius, and the latter holds the superior vestibular nerve. The inferior compartment contains the cochlear nerve in the anterior quadrant and the inferior vestibular nerve in the posterior quadrant.

The facial canal begins in the anterosuperior aspect of the fundus of the internal acoustic meatus and ends at the stylomastoid foramen. It has three segments: the labyrinthine, tympanic, and mastoid segments. The cisternal, meatal, and labyrinthine segments of the facial nerve are ensheathed by the arachnoid mater and lack an epineurium. However, the tympanic and mastoid segments of the facial nerve are ensheathed by the perineurium and epineurium.

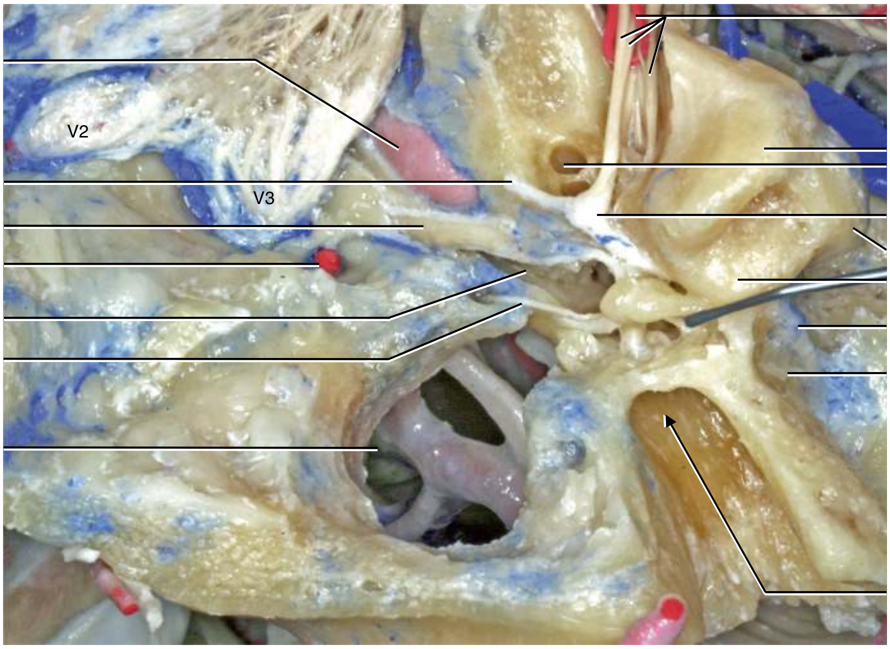


Fig. 1.3 Superior view of the middle cranial fossa. The mandibular fossa and the roof of the external acoustic meatus have been opened

The trigeminal nerve supplies sensation to the face, mucous membranes, and other head structures. It also contains the motor nerve for the muscles of mastication and proprioceptive fibers. It exits the brain as a large sensory root and a smaller motor root from the anterolateral surface of the mid-pons. It courses laterally to join the trigeminal (Gasserian or semilunar) ganglion in the trigeminal cave (Meckel's cave) above the apex of the petrous part of the temporal bone. The nerve then divides into three major branches: the ophthalmic, maxillary, and mandibular nerves. After the meningeal layer of the dura mater is peeled from the middle cranial fossa, the maxillary (V2) and mandibular (V3) nerves are exposed. The ophthalmic nerve passes through the lateral wall of the cavernous sinus, while the maxillary nerve courses just below the cavernous sinus along the floor of the middle cranial fossa to enter the foramen rotundum. The mandibular nerve passes directly through the foramen ovale.

The middle meningeal artery, a branch of the maxillary artery (mandibular segment), enters the middle cranial fossa through the foramen spinosum. This artery gives rise to branches that supply the trigeminal ganglion and the greater superficial petrosal nerve, including the petrosal branch, which provides blood supply to the facial nerve. An accessory meningeal artery, also a branch of the maxillary artery (mandibular segment), passes through the foramen ovale into the middle cranial fossa to supply the trigeminal ganglion and the dura mater lining the floor of the middle cranial fossa.

The tensor tympani muscle, one of the two intratympanic muscles, is a long, slender muscle arising from the cartilaginous part of the Eustachian tube. It passes within a bony canal and terminates in a tendon that bends laterally over the cochleariform process and attaches to the handle of the malleus. The cochleariform process is a small bony projection that serves as a pulley or fulcrum for the tendon of the tensor tympani muscle. This muscle draws the handle of the malleus medially, tensing the tympanic membrane and helping to dampen sound vibrations. The nerve to the tensor tympani muscle is derived from the mandibular division of the trigeminal nerve.

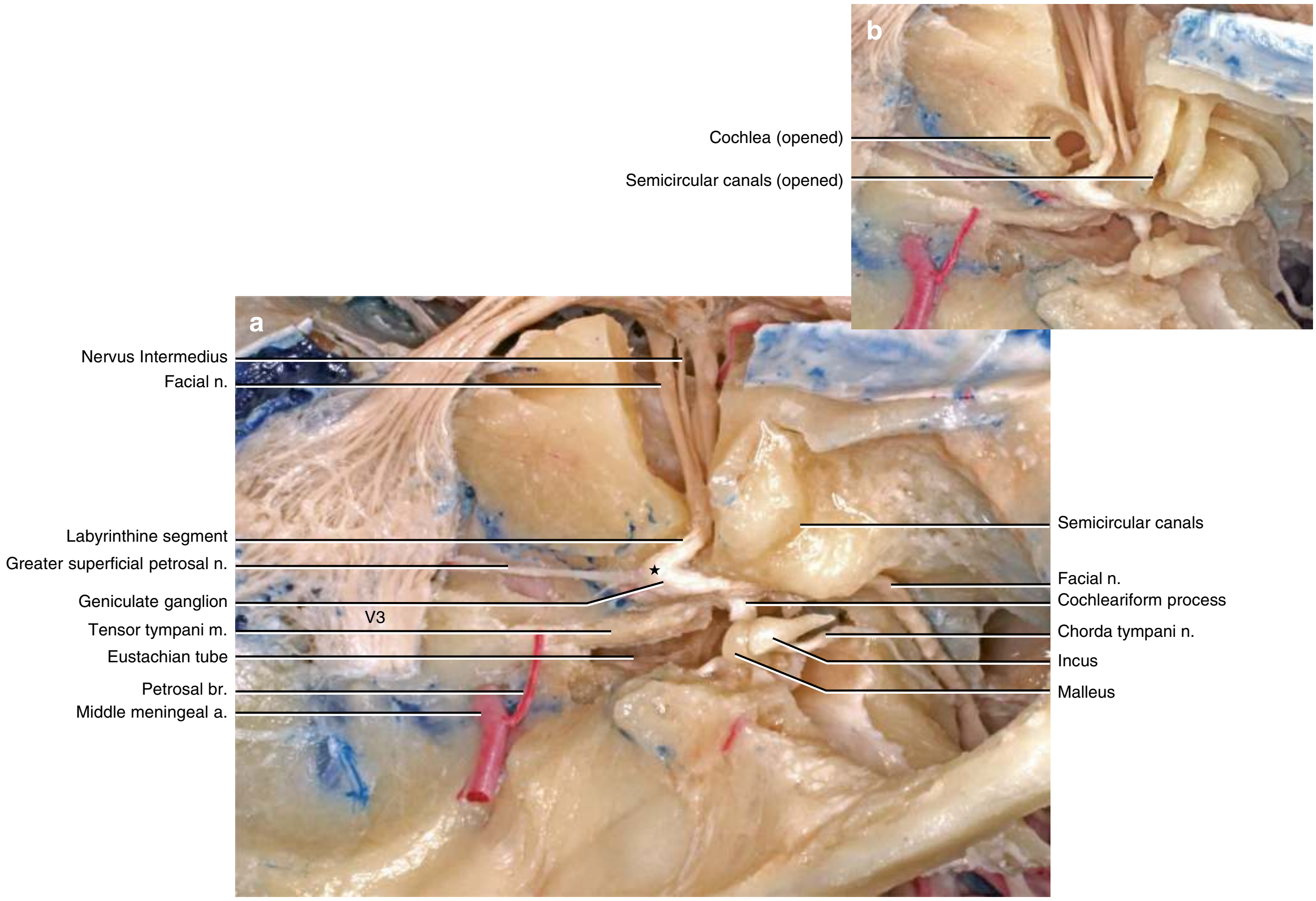


Fig. 1.4 (**a**, **b**) Superior view of the middle cranial fossa. (**a**) Note the acute angle of the first genu (asterisk). (**b**) The semicircular canals and cochlea have been opened

The labyrinthine segment is the shortest and narrowest intratemporal segment, extending from the internal acoustic meatus to the geniculate ganglion. It has a length of approximately 3–4 mm. The facial nerve courses laterally toward the cochlea, turning forward to reach the geniculate ganglion, where the first genu is situated at the end of the labyrinthine segment. After that, the direction abruptly changes posteriorly as the segment transitions into the tympanic segment. The angle of the curve varies. Incomplete bony covering of the dural surface of the geniculate ganglion is frequently seen.

The facial nerve gives rise to the greater superficial petrosal nerve (GSPN) from the geniculate ganglion, a branch of the nervus intermedius. The GSPN courses anteriorly through the bone to appear on the floor of the middle cranial fossa. It then passes beneath the trigeminal ganglion to reach the foramen lacerum. Within the foramen lacerum, it is joined by the deep petrosal nerve from the internal carotid sympathetic plexus to become the nerve of the pterygoid canal, also known as the Vidian nerve. Upon leaving the pterygoid canal, the nerve emerges into the pterygopalatine fossa, where it joins the pterygopalatine ganglion. The nerve carries parasympathetic fibers to the ganglion and eventually to the lacrimal, nasal, and palatine glands. Additionally, it contains taste fibers derived from the palate.

The lesser petrosal nerve is located in a groove lateral to the greater superficial petrosal nerve. It courses toward the foramen ovale and then enters the infratemporal fossa through the foramen ovale to join the otic ganglion. The lesser petrosal nerve carries parasympathetic fibers to the otic ganglion, sending postganglionic secretomotor fibers via the auriculotemporal nerve, which supplies the parotid gland. This nerve receives a connecting branch from the facial nerve.

The external petrosal nerve carries sympathetic fibers from the sympathetic plexus surrounding the middle meningeal artery to the geniculate ganglion. It courses medial to the lesser petrosal nerve within the middle cranial fossa.

Fig. 1.5 Lateral view of the mastoid after mastoidectomy. The posterior half of the external acoustic meatus and tympanic membrane have been removed

The tympanic segment of the facial nerve extends from the geniculate ganglion to the area near the cochleariform process. It then courses to the pyramidal eminence, immediately inferior to the lateral (horizontal) semicircular canal. The pyramidal eminence is a small, conical, bony projection that contains a tiny canal housing the tendon of the stapedius muscle. The length of this segment is approximately 10 mm. Bony dehiscence of this portion of the facial canal wall occurs more frequently than in the other segments. This segment executes its second turn (second genu) above the pyramidal eminence and below the lateral end of the lateral semicircular canal. The end of the segment between the semicircular canal and the pyramidal eminence represents the narrow portion of the facial canal.

Fig. 1.6 Lateral view of the tympanic cavity. The tympanic membrane and auditory ossicles have been removed

The labyrinth has been opened to visualize the posterior, superior, and lateral semicircular canals. The tympanic branch of the glossopharyngeal nerve (Jacobson's nerve) and the caroticotympanic nerve constitute the tympanic plexus on the surface of the promontory. The tympanic branch, which arises from the petrous ganglion of the glossopharyngeal nerve, reaches the tympanic cavity through the tympanic canaliculus, located on the ridge between the carotid canal and the jugular fossa. The tympanic plexus provides sensory branches to the mucosa of the tympanic cavity, mastoid air cells, and the Eustachian tube. The lesser petrosal nerve, regarded as a continuation of the parasympathetic fibers of the tympanic branch, passes through the hiatus for the lesser petrosal nerve in the petrous part of the temporal bone to reach the floor of the middle cranial fossa.

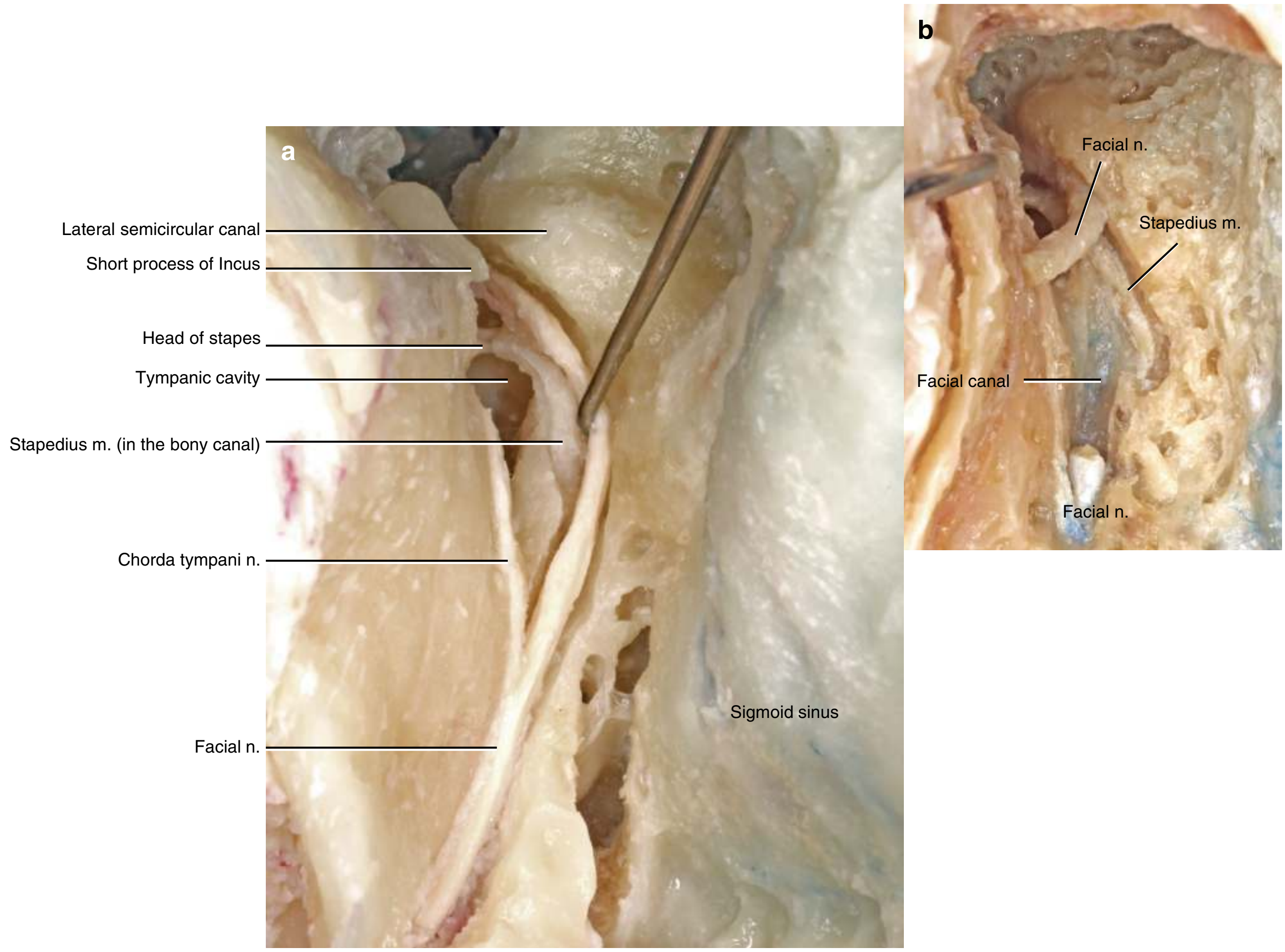


Fig. 1.7 (**a**, **b**) Lateral view of the mastoid. (**a**) The facial recess and bony canal for the stapedius muscle have been opened. (**b**) The mastoid segment of the facial nerve has been transected to expose the stapedius muscle

The mastoid segment of the facial nerve is the longest intratemporal segment, measuring approximately 12 mm in length. It begins at the second genu and descends vertically near the posterior wall of the external acoustic meatus before exiting the temporal bone at the stylomastoid foramen. The depth of the facial canal from the bone surface at the level of the posterior wall of the bony external acoustic meatus is approximately 15 mm. The mastoid segment gives rise to three branches: the nerve to the stapedius muscle, the chorda tympani nerve, and the sensory auricular branch of the facial nerve.

The nerve to the stapedius muscle arises from the facial nerve within the facial canal, close to the pyramid. The sickle-shaped muscle, one of the two intratympanic muscles, lies in the bony canal anterior and medial to the facial canal. In some instances, the bony canal for the muscle extends posteriorly to the facial canal. The stapedius muscle may contact the facial nerve directly, without any bony wall between them (Fig. 1.7b). Its tendon attaches to the posterior surface of the neck of the stapes. The muscle stabilizes the stapes and helps dampen excessive sound vibrations when the sound is too loud. Hyperacusis develops as a result of its paralysis.

The chorda tympani nerve is the second branch given off just before the stylomastoid foramen. It arises from the nervus intermedius and contains parasympathetic fibers going to the submandibular ganglion and taste fibers from the anterior two-thirds of the tongue. The nerve initially passes through its own canal before entering the tympanic cavity and then crosses medial to the upper part of the malleus handle. It then enters another canal before leaving the temporal bone through the petrotympanic (squamotympanic) fissure.

The sensory auricular branch of the facial nerve is another branch that arises from the mastoid segment of the facial nerve. There is limited literature regarding the detailed anatomy of the sensory auricular branch of the facial nerve. This branch joins the auricular branch of the vagus nerve (Arnold's nerve). This nerve crosses the facial canal in the mastoid bone above the stylomastoid foramen and sends a branch to the facial nerve. The fibers from the nervus intermedius of the facial nerve are transmitted to the auricular branch of the vagus nerve via this branch.

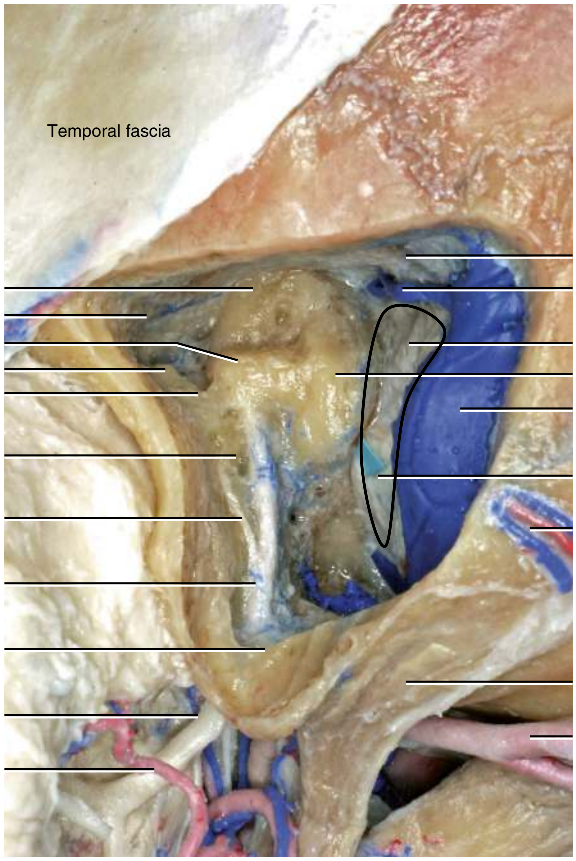


Fig. 1.8 Lateral view of the mastoid. The mastoid segment of the facial nerve and the chorda tympani nerve have been exposed

The digastric ridge corresponds to the digastric groove (mastoid notch) and marks the location of the facial canal just anterior to it. This ridge is located just medial to the mastoid tip. The mastoid process is a prominence projecting from the undersurface of the mastoid portion of the temporal bone. This process serves as a point of attachment for the sternocleidomastoid, splenius capitis, longissimus capitis, and the posterior belly of the digastric muscle.

Trautmann's triangle (indicated by a black triangle), which faces the cerebellopontine angle, is a space bounded by the bony labyrinth anteriorly, the sigmoid sinus posteriorly, and the superior petrosal sinus superiorly. The size of this triangle varies depending on the size of the sigmoid sinus.

The facial recess is a triangular region delineated by the fossa incudis superiorly, the facial nerve posteriorly, and the chorda tympani anteriorly. Drilling into the facial recess leads to the tympanic cavity.

Hypoglossal-facial direct neurorrhaphy using the mastoid segment of the facial nerve generally mobilizes the facial nerve just below the second genu. The procedure entails the sacrifice of the three branches arising from the mastoid segment of the facial nerve. The tympanic segment of the facial nerve can be employed for the neurorrhaphy without impairing the labyrinth.

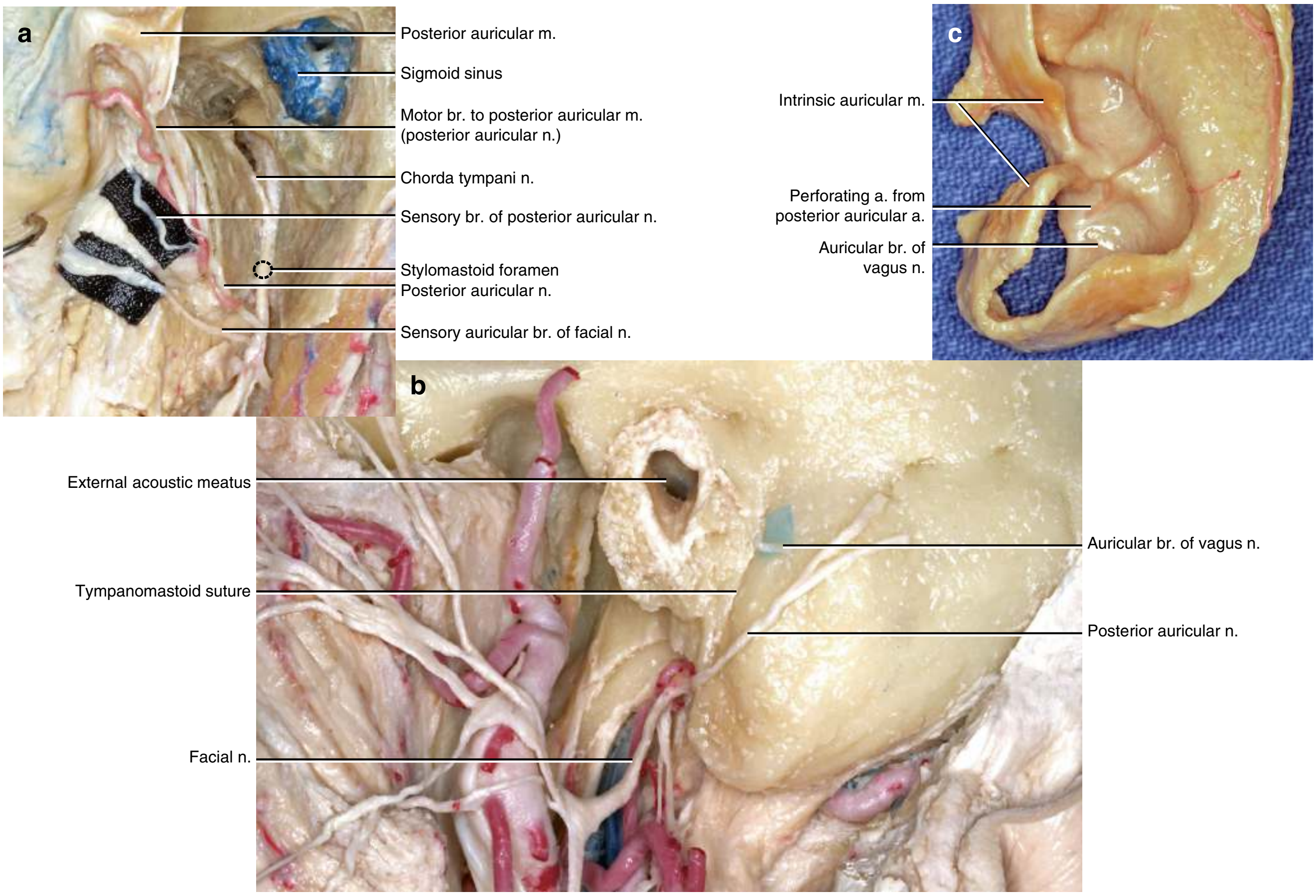


Fig. 1.9 (**a**–**c**) (**a**) Lateral view of the mastoid segment and the main trunk of the facial nerve after mastoidectomy. (**b**) Lateral view of the mastoid after the removal of auricular cartilage. (**c**) Lateral view of the auricular cartilage

The auricular branch of the vagus nerve (Arnold's nerve) arises from the superior ganglion of the vagus nerve below the jugular foramen and ascends through the mastoid canaliculus on the lateral wall of the jugular fossa. It crosses the facial canal approximately 4 mm above the stylomastoid foramen and sends a branch to the facial nerve. Fibers from the nervus intermedius of the facial nerve are transmitted to the auricular branch via this branch. The auricular branch of the vagus nerve then passes through the tympanomastoid fissure. It subsequently divides into two branches: one joins with the posterior auricular nerve, and the other reaches the external acoustic meatus through the junction between the auricular cartilage and the bony part of the external acoustic meatus or penetrates through the conchal cartilage (Fig. 1.9c). It innervates the skin of the concha, tympanic membrane, and a small area of the cranial surface near the mastoid. In some instances, the facial nerve gives rise to a direct sensory auricular branch (Fig. 1.9a). The posterior auricular nerve also gives rise to a sensory branch that supplies the posterior concha and the external acoustic meatus.

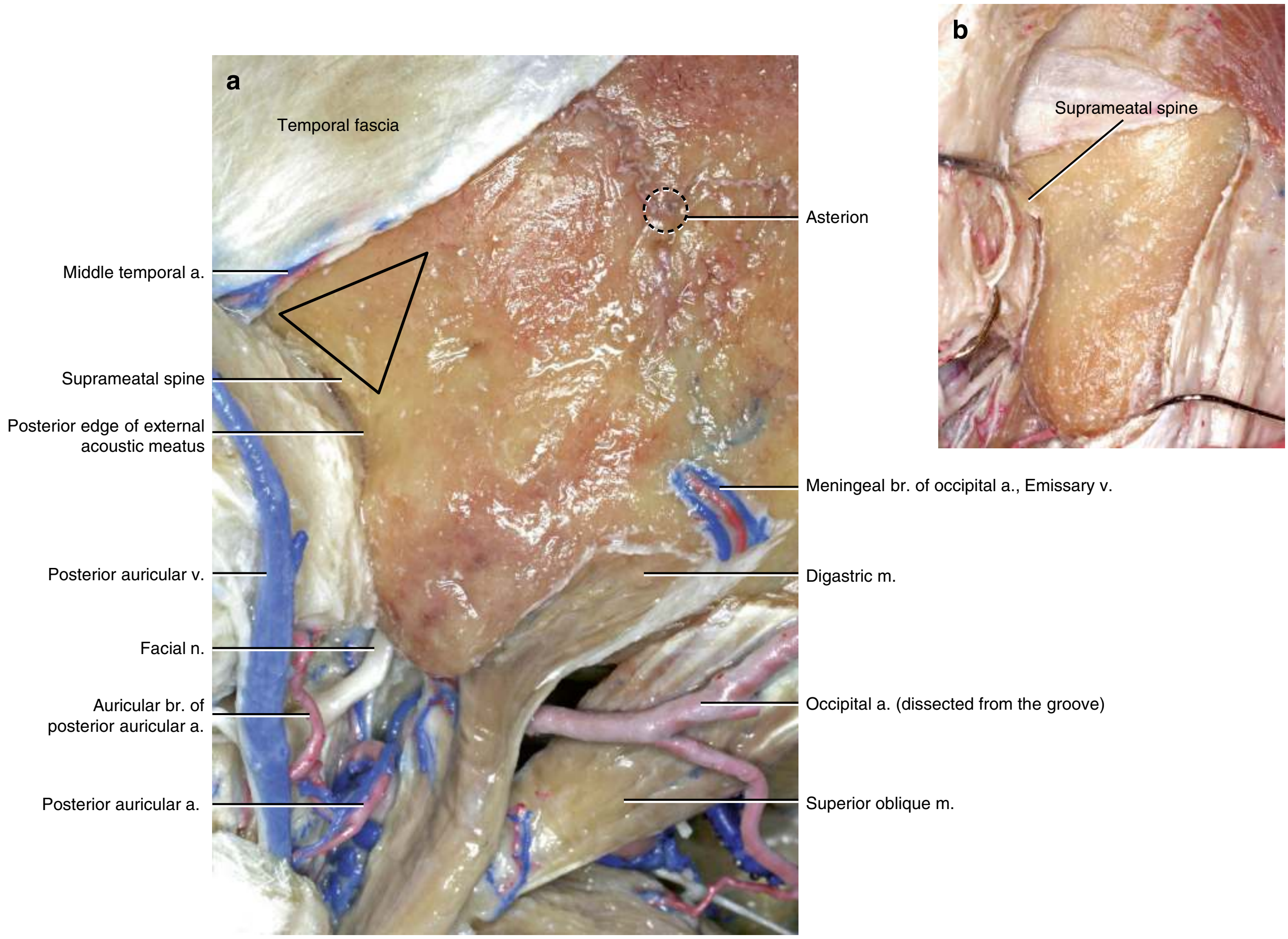


Fig. 1.10 (**a**, **b**) Lateral view of the mastoid. (**a**) The surface anatomy is shown. (**b**) Note the prominent suprameatal spine

The posterior belly of the digastric muscle arises from the digastric groove, which is located on the inferior surface of the skull, medial to the mastoid process of the temporal bone. The digastric branch of the facial nerve provides motor innervation to the posterior belly of the digastric muscle. The stylomastoid foramen is located at the anterior end of the digastric groove.

The suprameatal spine, also called the spine of Henle, is a small spine situated anterior to the supramastoid pit at the upper and posterior margin of the external acoustic meatus. It is a projection for the attachment of the auricular cartilage.

The suprameatal triangle (indicated by a black triangle), also known as MacEwen's triangle, is a landmark on the surface of the mastoid bone, situated just superior to the external acoustic meatus. It is bounded by the posterosuperior border of the external acoustic meatus anteroinferiorly, the supramastoid crest superiorly, and a vertical tangent extending up from the posterior border of the external acoustic meatus posteriorly. The mastoid antrum is located at a depth of 10–15 mm.

The asterion, defined as the junction between the lambdoid, parietomastoid, and occipitomastoid sutures, is a landmark for the transverse-sigmoid sinus junction.

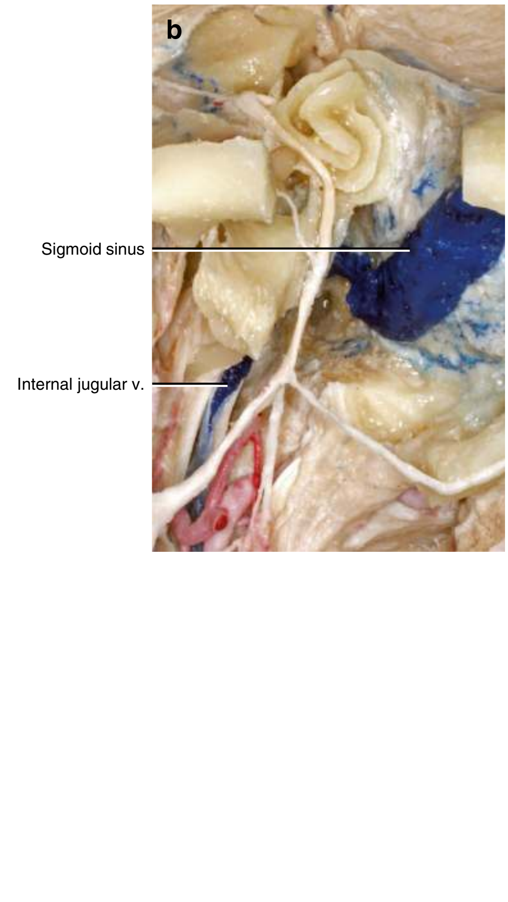


Fig. 1.11 (**a**, **b**) Lateral view of the mastoid. (**a**) The relationship between the facial nerve and the venous sinus is shown. (**b**) The intra- and extracranial venous pathways are shown

The sigmoid sinus descends within the mastoid bone, medial to the facial nerve, and communicates with the jugular bulb before continuing as the internal jugular vein. The distance between the facial nerve and the jugular bulb or sigmoid sinus varies, and the nerve may be near or in contact with the sinus and/or jugular bulb. The distance between the floor of the tympanic cavity and the jugular bulb also varies. A high jugular bulb, which may be vulnerable to damage during middle ear surgery, indicates that the roof of the jugular bulb extends more superiorly in the petrous part of the temporal bone.

2 Facial Nerve Trunk

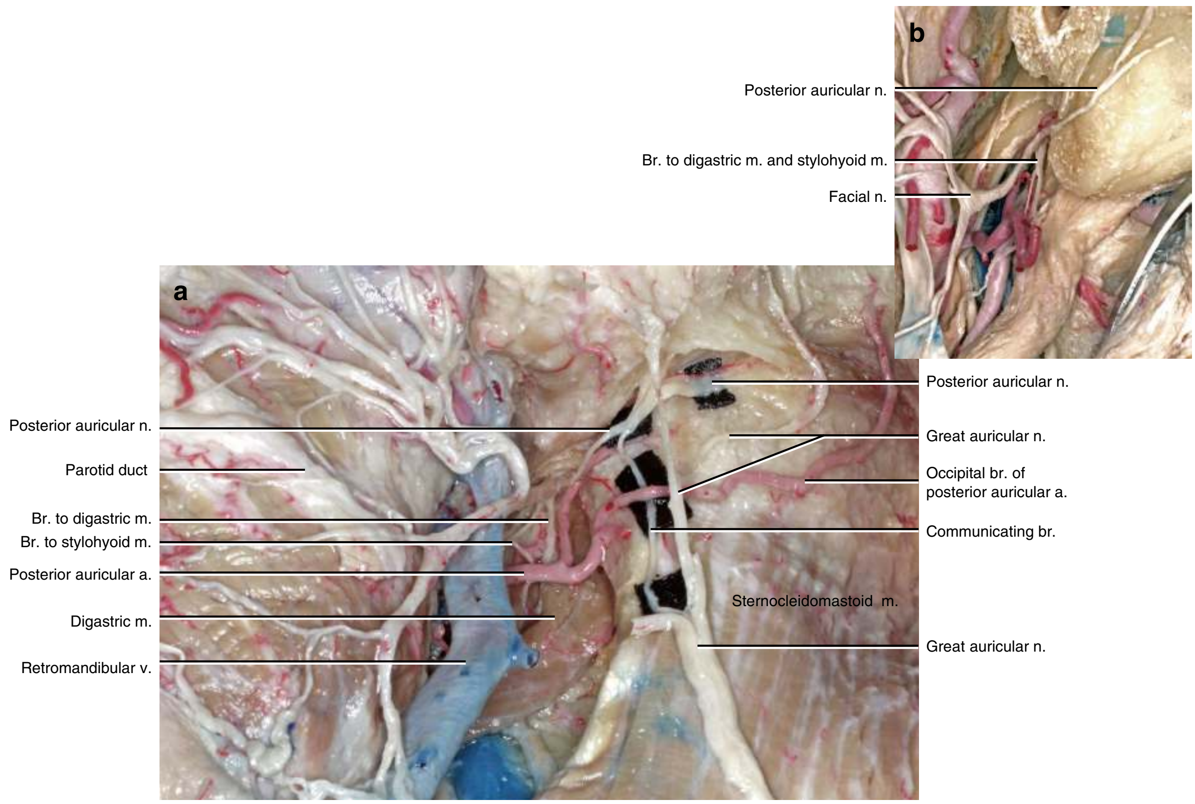


Fig. 2.1 (**a**, **b**) The main trunk of the facial nerve. The parotid gland has been removed. (**a**) An anastomosis between the great auricular and posterior auricular nerves is shown. (**b**) Note that a single branch bifurcates to innervate the digastric and stylohyoid muscles

The extratemporal segment of the facial nerve begins at the stylomastoid foramen. The nerve is surrounded by dense connective tissue at the exit of the stylomastoid foramen, where the parotid gland immediately surrounds the nerve. The facial nerve then passes downward and anterolaterally. The main trunk of the facial nerve gives off three main branches: the posterior auricular nerve, branches to the posterior belly of the digastric, and the stylohyoid muscles.

The posterior auricular nerve is the first extracranial branch of the facial nerve. It arises from the facial nerve close to the stylomastoid foramen and courses posteriorly and upward over the mastoid pericranium and sternocleidomastoid muscle. It supplies sensory fibers to the posterior concha and external acoustic meatus while also providing motor fibers to the posterior auricular and occipital muscles and the intrinsic auricular muscles on the cranial aspect of the auricle. It communicates with branches of the great auricular and lesser occipital nerves.

The second and third branches from the main trunk supply the posterior belly of the digastric and stylohyoid muscles. They arise close to the stylomastoid foramen, individually or as a single branch (Fig. 2.1b).

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_2

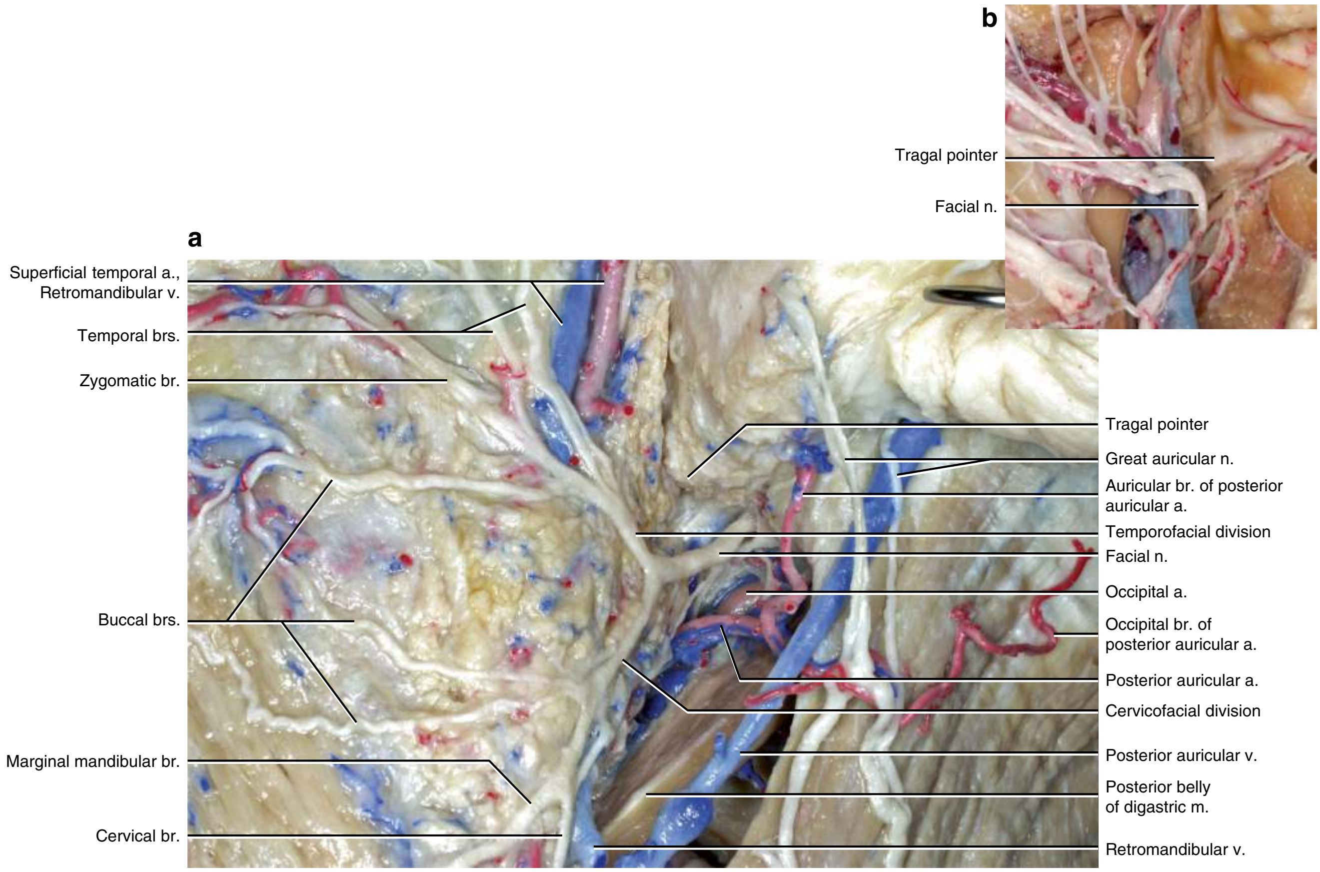


Fig. 2.2 (**a**, **b**) The main trunk of the facial nerve. (**a**) The superficial lobe of the parotid gland has been removed. (**b**) The tragal pointer indicates the main trunk

After giving rise to the branches for the digastric and stylohyoid muscles, the main trunk of the facial nerve divides at the pes anserinus into two divisions at an obtuse angle, forming the temporofacial (upper) and cervicofacial (lower) divisions.

The tragal pointer, or tragal cartilage, is located anterior to the opening of the external acoustic meatus and points directly to the facial nerve at its exit from the stylomastoid foramen. The facial nerve courses approximately 1 cm below and medial to the tip of the tragal pointer. However, the tragal pointer is a mobile, asymmetrical cartilage with a blunt, irregular tip, which can sometimes make it difficult to determine its position accurately.

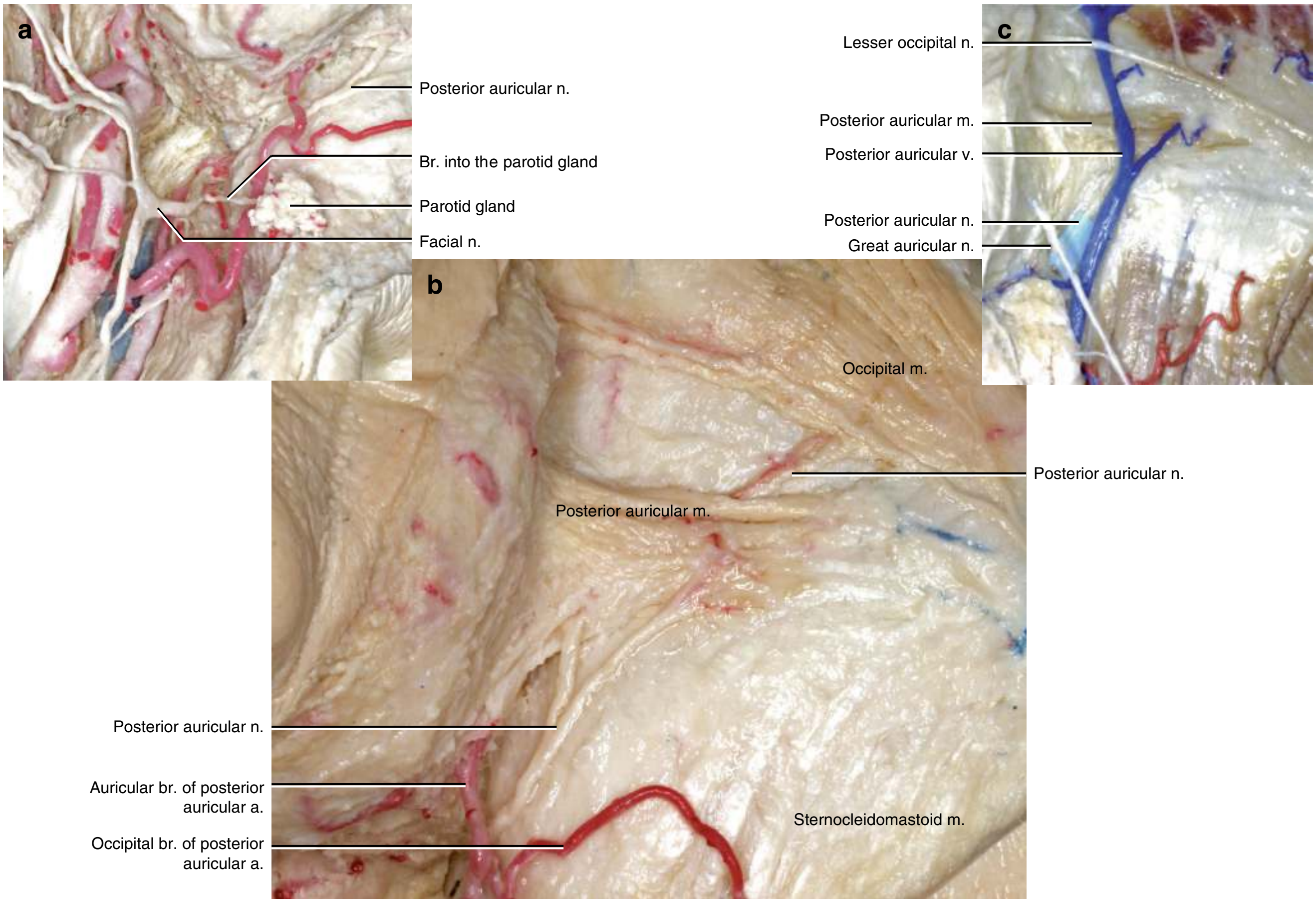


Fig. 2.3 (**a**–**c**) (**a**) The main trunk of the facial nerve has a small branch within the parotid gland. (**b**, **c**) Close-up views of the postauricular region

The main trunk of the facial nerve has some small branches (Fig. 2.3a) that run into the parotid gland, which may communicate with the terminal branches of the great auricular and auriculotemporal nerves.

The posterior auricular nerve provides sensory fibers to the posterior concha and external acoustic meatus, motor fibers to the posterior auricular and occipital muscles, and the intrinsic auricular muscles on the cranial aspect of the auricle.

The occipital branch of the posterior auricular artery courses posteriorly over the insertion of the sternocleidomastoid muscle to supply the skin behind the ear. The development of the posterior auricular vein varies. A well-developed posterior auricular vein may compensate if the superficial temporal vein is underdeveloped (Fig. 2.3c).

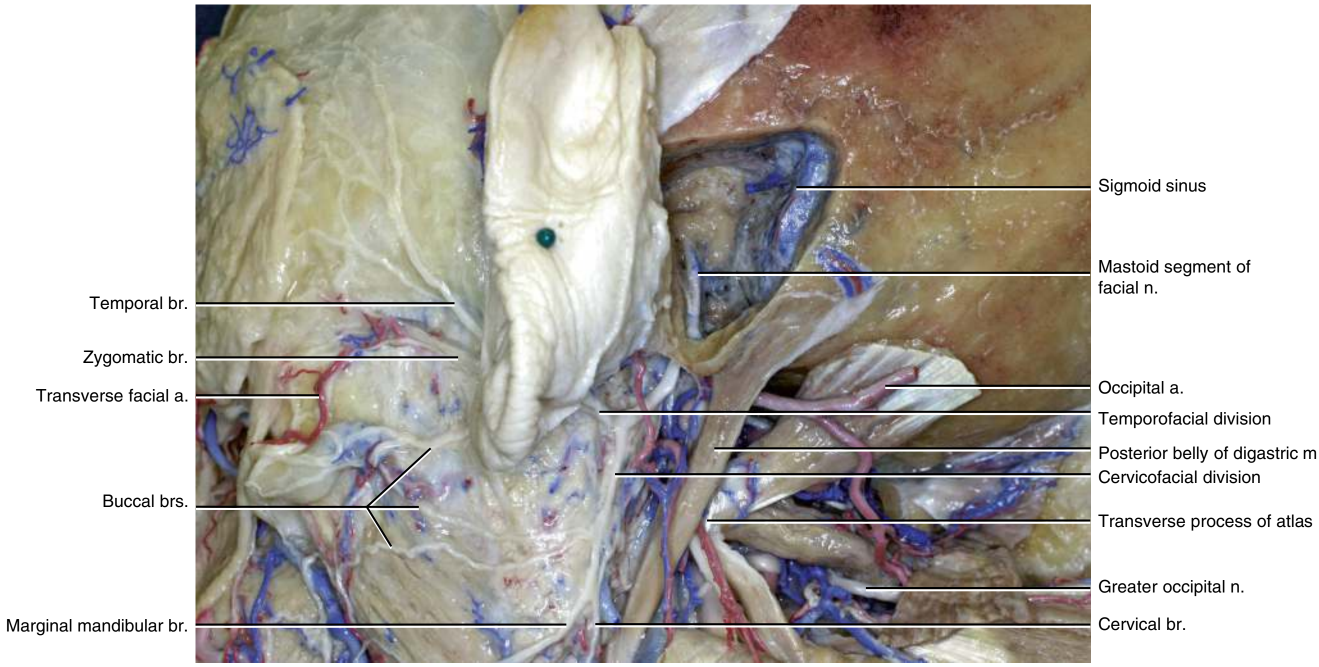


Fig. 2.4 Posterolateral view of the pes anserinus of the facial nerve. The superficial lobe of the parotid gland has been removed

The facial nerve has five terminal branches: temporal, zygomatic, buccal, marginal mandibular, and cervical. The temporofacial division gives rise to the temporal, zygomatic, and buccal branches, whereas the cervicofacial division gives rise to the buccal, marginal mandibular, and cervical branches. The buccal branches frequently arise from both the upper and lower divisions of the facial nerve and interconnect with the zygomatic and marginal mandibular branches.

The digastric muscle comprises two distinct muscle bellies, the anterior and posterior, which are connected by an intermediate tendon. The anterior belly of the digastric muscle attaches near the midline of the inferior margin of the mandible at the digastric fossa and extends toward the hyoid bone. The posterior belly is attached to the digastric groove of the mastoid process. When the digastric muscle contracts, it elevates the hyoid bone. If the hyoid bone is stabilized by the infrahyoid muscles, it depresses the mandible, thereby opening the mouth. The posterior belly of the digastric muscle is innervated from its anterior surface by a branch of the facial nerve.

The stylohyoid muscle inserts into the body of the hyoid bone. The intermediate tendon of the digastric muscle perforates the stylohyoid muscle near its insertion point. When the stylohyoid muscle contracts, it elevates the hyoid bone, an action that primarily occurs during swallowing.

Part II

Skull

3 External and Internal Views

Fig. 3.1 The external surface of the skull base. Close-up view of the stylomastoid foramen

The facial nerve exits the skull through the stylomastoid foramen and is supplied by the stylomastoid artery, which arises from the posterior auricular or occipital artery. The stylomastoid artery enters the skull through the stylomastoid foramen.

The foramen ovale allows the passage of the mandibular division of the trigeminal nerve, the lesser petrosal branch of the glossopharyngeal nerve, the accessory meningeal branch of the maxillary artery, and some emissary veins between the middle cranial fossa and the infratemporal fossa. The foramen spinosum, located posterior to the foramen ovale, serves as a conduit for the middle meningeal vessels and the meningeal branch of the mandibular division of the trigeminal nerve.

The jugular foramen is located between the temporal bone and the occipital bone. The structures that traverse the jugular foramen include the sigmoid sinus and jugular bulb; the inferior petrosal sinus; meningeal branches of the ascending pharyngeal and occipital arteries; the glossopharyngeal, vagus, and accessory nerves with their ganglia; the tympanic branch of the glossopharyngeal nerve (Jacobson's nerve); the auricular branch of the vagus nerve (Arnold's nerve); and the cochlear aqueduct. The intrajugular process is a small, curved process that partially or entirely divides the jugular foramen into lateral and medial parts.

Behind the foramen spinosum, the bone is raised to form the spine of the sphenoid bone, to which the sphenomandibular ligament is attached. The posterior margin of this spine is grooved and is associated with the cartilaginous component of the Eustachian tube.

The tympanic canaliculus, which allows the passage of the tympanic nerve derived from the glossopharyngeal nerve, is located on the ridge between the carotid canal and the jugular fossa. The mastoid canaliculus, which allows the passage of the auricular branch of the vagus nerve, is located in the lateral part of the jugular fossa.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_3

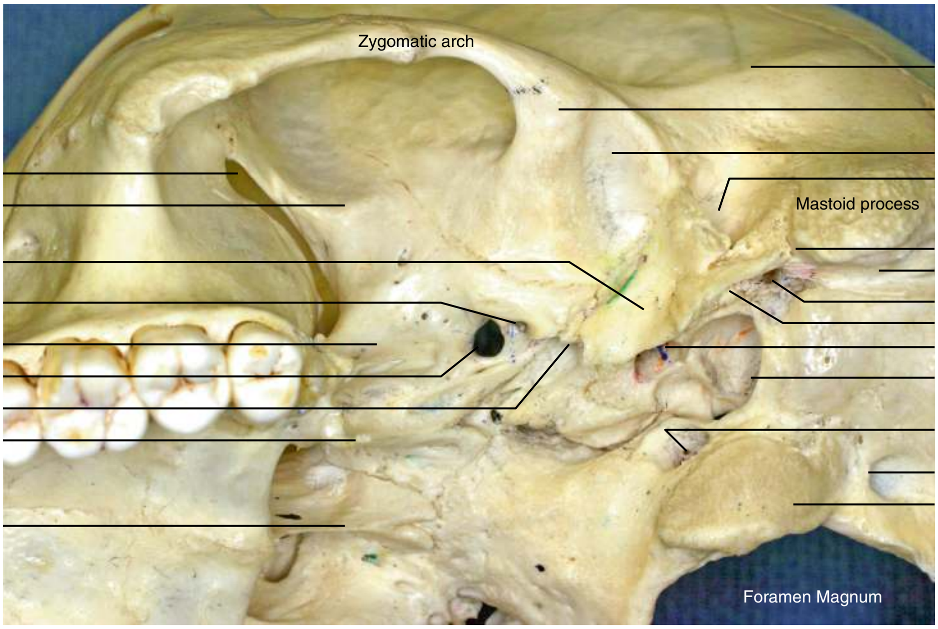


Fig. 3.2 Infratemporal fossa. The mandible has been removed

The osseous boundaries of the infratemporal fossa are as follows: the posterolateral maxillary surface is located anteriorly, the lateral pterygoid plate is situated anteromedially, the mandibular ramus is positioned laterally, and the tympanic part of the temporal bone and styloid process are located posteriorly. The fossa is domed anteriorly by the infratemporal surface of the greater sphenoid wing, the site of the foramina ovale and spinosum, and posteriorly by the squamous part of the temporal bone. The inferior, posteromedial, and superolateral aspects are open without bony walls. The infratemporal crest defines the boundary between the temporal and infratemporal fossae.

The digastric muscle is attached to the digastric groove (mastoid notch), the anterior end of which indicates the stylomastoid foramen. The tympanomastoid suture is a landmark for the facial nerve trunk. The facial nerve (stylomastoid foramen) is located 6–8 mm medial to the inferior "drop off" point of the tympanomastoid fissure.

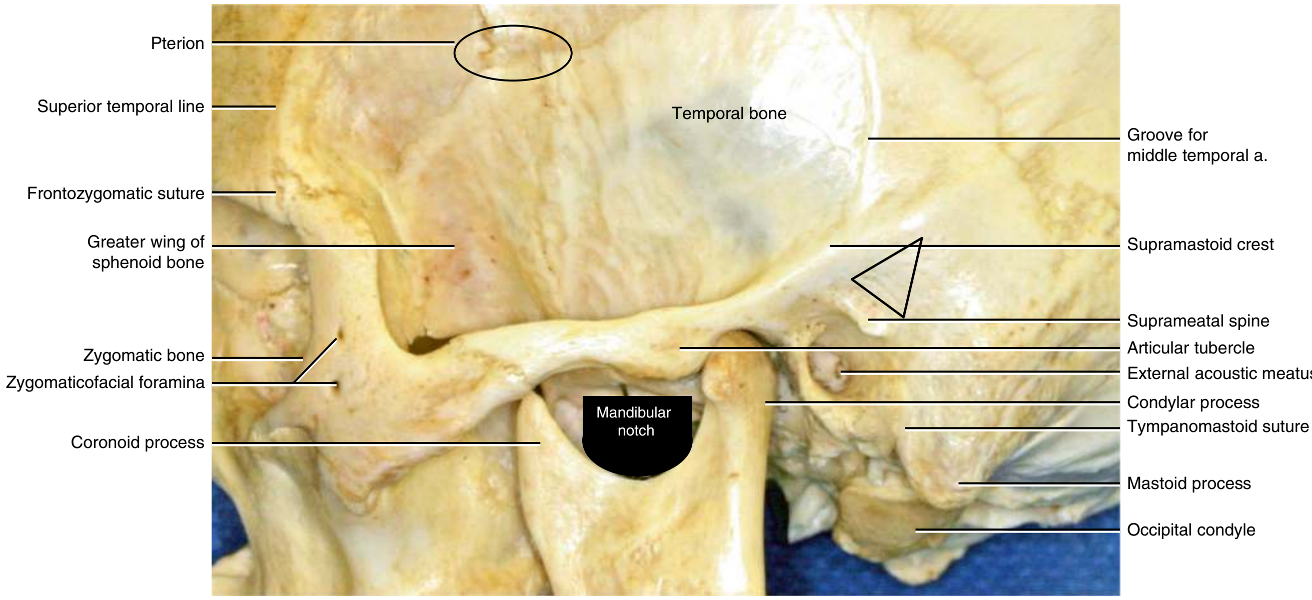


Fig. 3.3 Lateral view of the skull with the temporal bone highlighted

The suprameatal triangle (indicated by a black triangle) is a depressed area located below the anterior portion of the supramastoid crest and behind the posterosuperior margin of the external acoustic meatus. It marks the deep location of the mastoid antrum. The suprameatal spine, located in the anterior part of the suprameatal triangle, approximates the deep site of the tympanic segment of the facial nerve and the lateral semicircular canal.

The zygomaticofacial nerve is a sensory nerve of the cheek and one of the two branches of the zygomatic nerve originating from the maxillary nerve. It extends to the face through the zygomaticofacial foramen, which is sometimes doubled, as in this specimen.

The pterion (indicated by a black ellipse) is a landmark for frontotemporal craniotomy. The pterion is an H-shaped structure where the four calvarial bones—frontal, sphenoid, parietal, and temporal—meet.

The superior temporal line begins at the zygomatic process of the frontal bone and curves superoposteriorly and then inferiorly toward the supramastoid crest. It provides attachment for the temporal fascia.

The groove for the middle temporal artery, which supplies the posterior and upper parts of the temporalis muscle, is sometimes prominent on the temporal bone.

The base of the temporomandibular ligament is attached to the zygomatic process of the temporal bone and the articular tubercle.

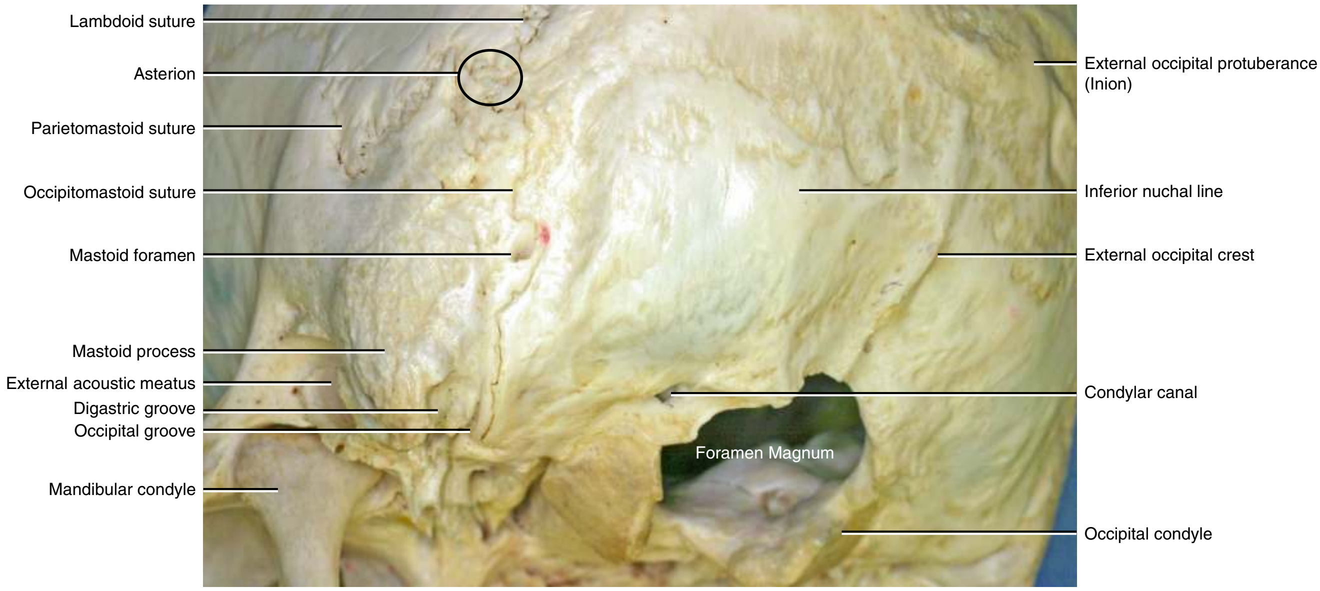


Fig. 3.4 Posterolateral view of the skull

The digastric and occipital grooves are positioned in parallel on the posterior aspect of the mastoid process. The digastric muscle attaches to the former, which is located laterally, and the occipital artery passes in the latter, which is located medially.

The meningeal branch of the occipital artery and emissary veins penetrate the skull through the mastoid foramen.

The asterion (indicated by a black circle), located at the convergence of the lambdoid, occipitomastoid, and parietomastoid sutures, lies over the junction of the lower part of the transverse and sigmoid sinuses. It is a crucial landmark for retrosigmoid approaches.

The external occipital protuberance (inion) is a projection on the outer surface of the occipital bone squama, approximately at its midpoint. It provides attachment for the medial fibers of the trapezius muscle. Below this prominence is a crest that extends inferiorly to the posterior edge of the foramen magnum. This crest, the external occipital crest, provides attachment for the nuchal ligament.

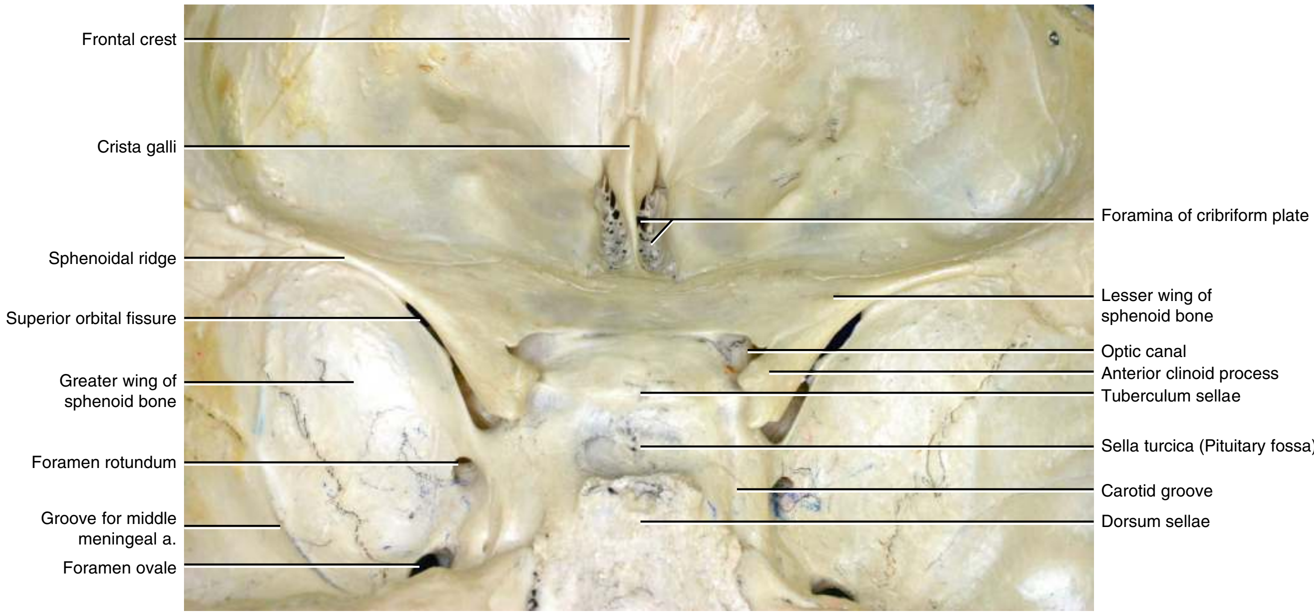


Fig. 3.5 Anterior and middle skull base (internal surface)

The trigeminal nerve, comprising three divisions (ophthalmic, maxillary, and mandibular), is responsible for the sensory innervation of the face.

The superior orbital fissure is located between the greater and lesser wings of the sphenoid at the junction of the orbital roof and the lateral wall. The superior orbital fissure allows the passage of the oculomotor, trochlear, and abducens nerves, sympathetic filaments from the internal carotid plexus, the ophthalmic division of the trigeminal nerve, and the ophthalmic veins. It may also transmit the orbital branch of the middle meningeal artery and the recurrent branch of the lacrimal artery.

The foramen rotundum is situated within the greater wing of the sphenoid bone. This foramen allows for communication between the middle cranial fossa and the pterygopalatine fossa. The maxillary division of the trigeminal nerve traverses the foramen.

The foramen ovale is located within the greater wing of the sphenoid bone. This foramen serves to facilitate communication between the middle cranial fossa and the infratemporal fossa. The mandibular division of the trigeminal nerve, the lesser petrosal branch of the glossopharyngeal nerve, the accessory meningeal branch of the maxillary artery, and some emissary veins from the cavernous sinus to the pterygoid venous plexus also pass through the foramen.

The ophthalmic nerve provides sensory innervation to the forehead, upper eyelid, and dorsum of the nose. The maxillary nerve supplies the lower eyelid, cheek, upper lip, ala of the nose, part of the temple, maxillary teeth, and nasal cavity. The mandibular nerve has motor and sensory fibers. The sensory fibers supply the skin over the mandible, lower cheek, part of the temple and ear, lower teeth, gingival mucosa, and lower lip.

The crista galli is a thick crest of bone that projects above the cribriform plate. The crest is thickest near its base and tapers superiorly. It projects between the cerebral hemispheres, with the falx cerebri attaching to its posterior margin.

The frontal crest is an anterior crest of bone in the midline of the internal surface of the frontal bone. This sharp ridge of bone is a continuation of the converging edges of the sulcus for the superior sagittal sinus. The anterior part of the falx cerebri is attached to the ridge.

4 Orbit and Facial Bones

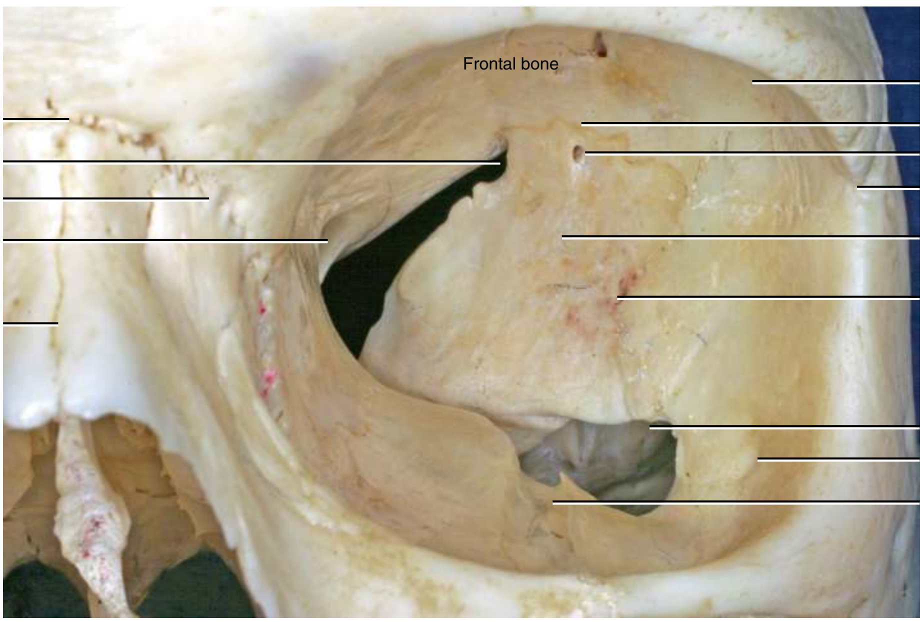


Fig. 4.1 Anterior view of the orbit

The inferior orbital fissure is located at the junction of the lateral orbital wall and the orbital floor. The infraorbital and zygomatic branches of the maxillary division of the trigeminal nerve, along with their accompanying vessels, pass through the fissure.

The infraorbital nerve is the terminal branch of the maxillary nerve. It courses along the orbital floor in the infraorbital groove, then enters a canal, and emerges onto the face at the infraorbital foramen.

The zygomatic nerve arises from the maxillary nerve in the pterygopalatine fossa. It passes through the inferior orbital fissure to course along the lateral wall of the orbit, where it divides into the zygomaticofacial and zygomaticotemporal nerves. The nerves enter the zygomatico-orbital foramina on the orbital surface of the zygomatic bone. When one foramen is present, the zygomatic vessels and nerve enter and then branch within the bone to exit different foramina as the zygomaticofacial and zygomaticotemporal vessels and nerves. The zygomaticotemporal nerve provides sensation to the temporal skin, and the zygomaticofacial nerve provides sensation to the skin over the prominence of the cheek. The meningo-orbital foramen (lacrimal foramen) is located in the greater wing of the sphenoid anterior to the tip of the superior orbital fissure. It is the source of anastomosis between the lacrimal artery and the orbital branch of the middle meningeal artery. This foramen is present in approximately 50% of the Caucasian population.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_4

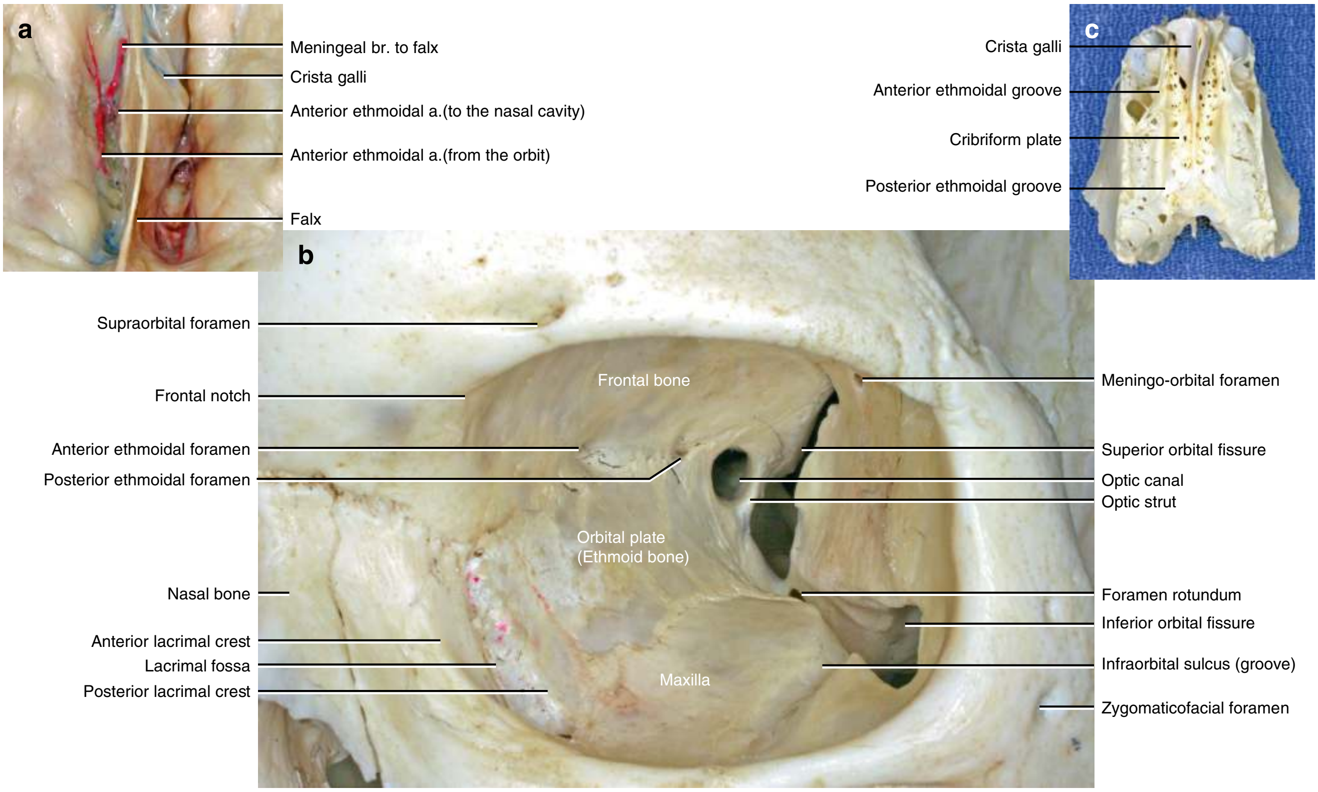


Fig. 4.2 (**a–c**) (**a**) Superior view of the cribriform plate. (**b**) Anteromedial view of the orbit. (**c**) Superior view of the ethmoid bone

The supraorbital notch transmits the supraorbital nerve and artery. In approximately 20–30% of cases, as shown in Fig. 4.2b, the notch will form a supraorbital foramen. The frontal notch is situated medially to the supraorbital notch and transmits the supratrochlear nerve and artery.

The optic canal lies within the lesser wing of the sphenoid and transmits the optic nerve and ophthalmic artery.

The anterior and posterior ethmoidal foramina for the same nerves and vessels are situated at the medial wall. The anterior ethmoidal nerve exits the orbit through the anterior ethmoidal foramen and enters the anterior cranial fossa. It then passes into the roof of the nose through a small slit located on each side of the crista galli. The posterior ethmoidal nerve exits the orbit through the posterior ethmoidal foramen and supplies the sphenoidal sinus and the posterior ethmoidal air cells. The view of the ethmoid bone from above shows the anterior and posterior ethmoidal grooves for the same nerves and vessels. These grooves are converted into foramina by articulation with the frontal bone (Fig. 4.2c). The lowest point of the cribriform plate (anterior skull base) is situated below the anterior and posterior ethmoidal foramen on the medial orbital wall (Fig. 4.2a). This serves as an essential landmark for estimating the position of the anterior skull base from within the orbit.

The fossa for the lacrimal sac is formed by the lacrimal notch on the maxilla and a matching groove on the lacrimal bone. When the adjacent grooves are combined, they form a fossa and canal that houses the lacrimal sac and transmits the beginning of the lacrimal duct toward the nasal cavity.

The cribriform plate is the horizontal plate of the ethmoid bone that is perforated with numerous foramina to allow the passage of the olfactory nerve filaments from the nasal cavity.

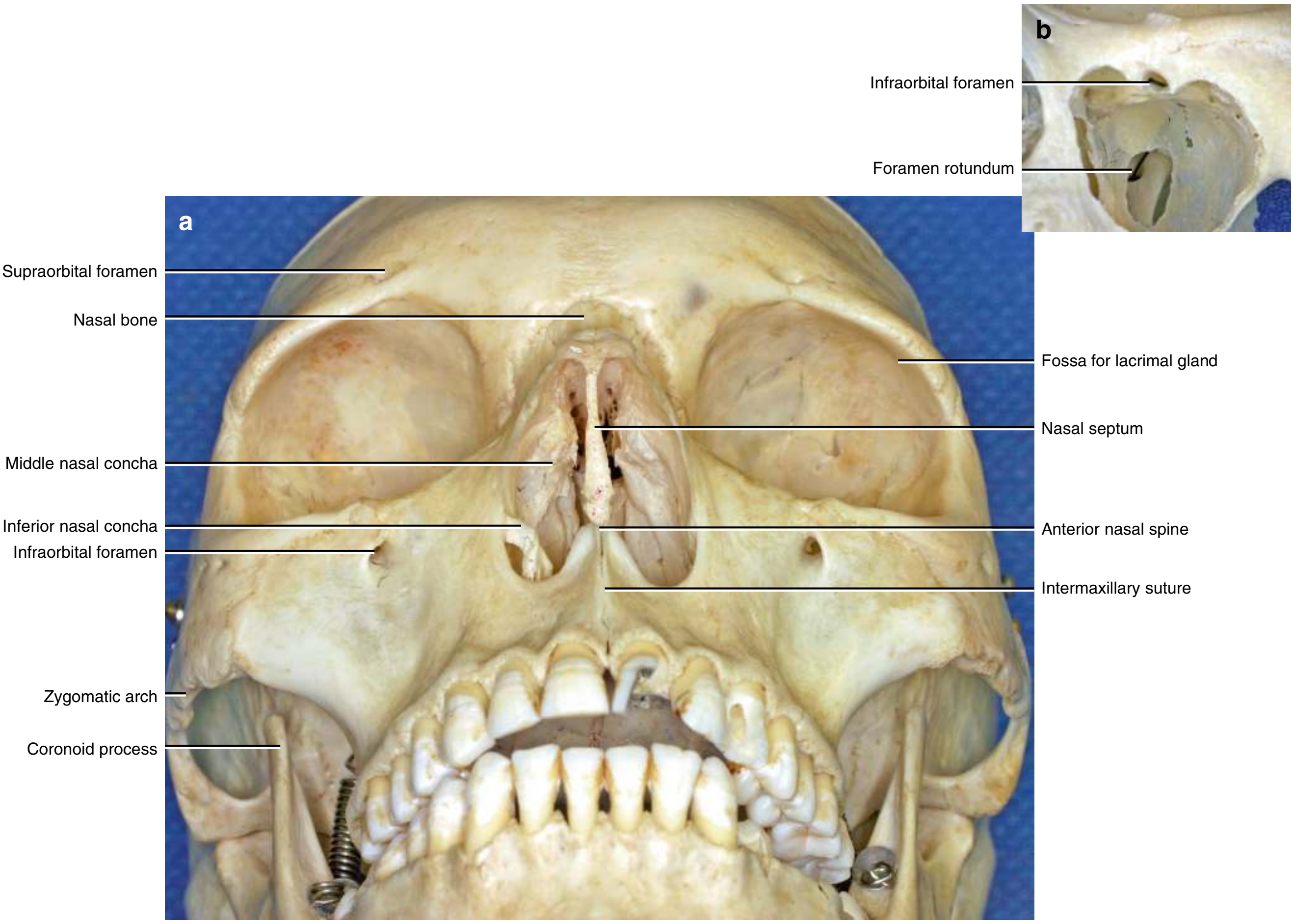


Fig. 4.3 (**a**, **b**) (**a**) Anteroinferior view of the skull. (**b**) Anterior view of the maxilla after the removal of anterior and posterior sinus walls to show the foramen rotundum

The infraorbital foramen is located below the infraorbital rim. The infraorbital branch of the maxillary nerve and infraorbital vessels pass through this foramen.

The anterior and posterior walls of the left maxillary sinus have been opened to expose the pterygopalatine fossa and foramen rotundum. A black string has been passed from the foramen rotundum to the infraorbital foramen (Fig. 4.3b). The pterygopalatine fossa is a conical, paired depression situated deep to the infratemporal fossa and posterior to the maxilla on each side of the skull. It is located between the pterygoid process and the maxillary tuberosity, in close proximity to the apex of the orbit. The fossa is the indented area medial to the pterygomaxillary fissure, which leads into the sphenopalatine foramen. The pterygopalatine fossa is connected to the nasal and oral cavities, infratemporal fossa, orbit, pharynx, and middle cranial fossa through eight foramina.

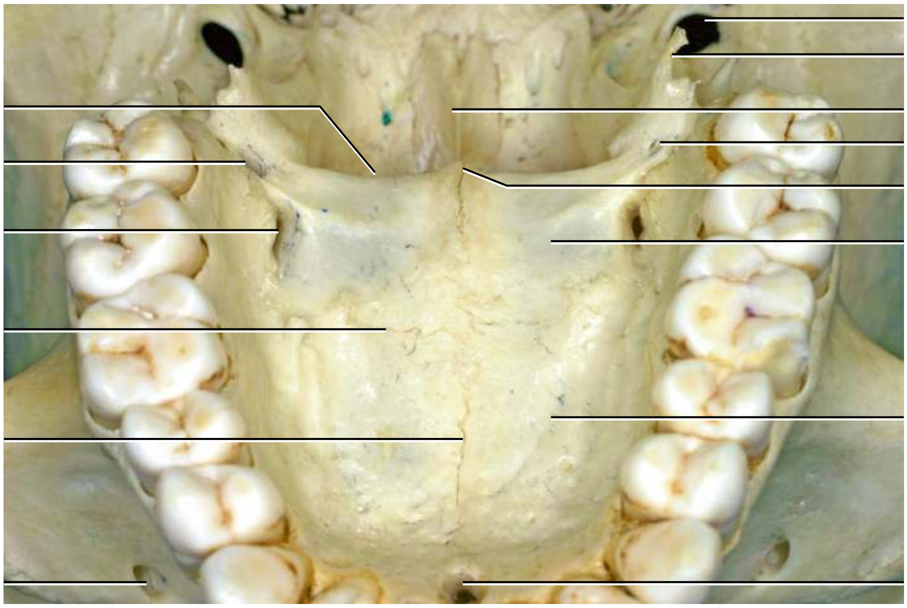


Fig. 4.4 Inferior view of the palatine bone

The nasopalatine nerve, a branch of the pterygopalatine ganglion, enters the nasal cavity through the sphenopalatine foramen and passes obliquely downward and forward on the nasal septum. It terminates as the incisive nerve, which passes through the incisive canal with an accompanying artery onto the hard palate to supply oral mucosa around the incisive papilla. It communicates with the corresponding nerve of the opposite side and the greater palatine nerve.

The greater palatine nerve is a branch of the pterygopalatine ganglion that carries general sensory and parasympathetic fibers. It passes through the greater palatine canal and onto the hard palate at the greater palatine foramen. It then passes forward in a groove in the hard palate, nearly as far as the incisor teeth. The greater palatine nerve supplies the gums, the mucous membrane, and the glands of the hard palate and communicates in front with the terminal filaments of the nasopalatine nerve.

The lesser palatine nerve branches off from the greater palatine nerve in the greater palatine canal and emerges through the lesser palatine foramina in the palatine bone. It passes backward to supply the soft palate and also has nasal branches that innervate the nasal cavity.

The pterygoid hamulus is a laterally deflected hook of bone located at the inferior end of the medial pterygoid plate. It serves a pulley-like function for the tendon of the tensor veli palatini muscle and serves as the attachment site for the pterygomandibular raphe.

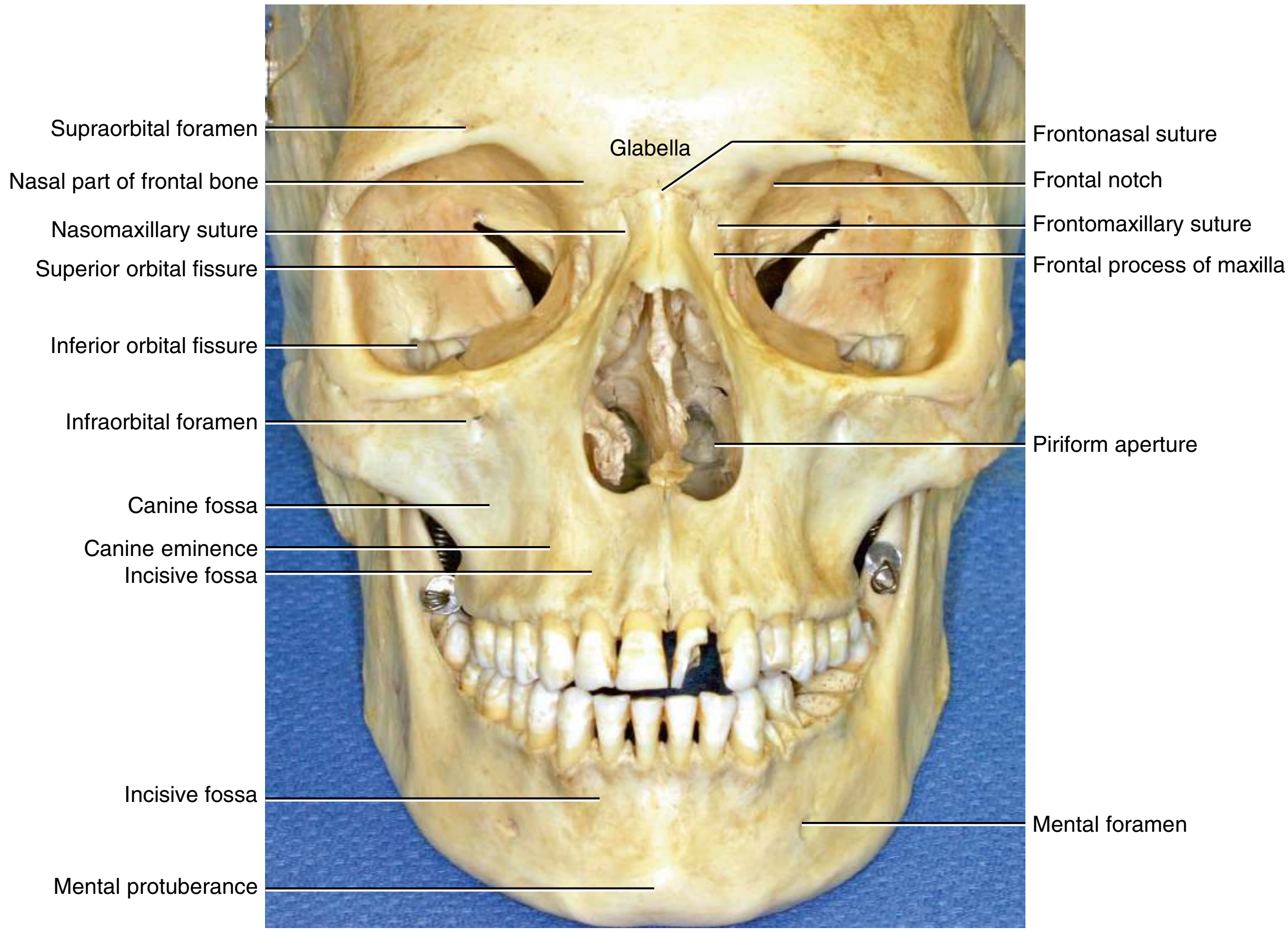


Fig. 4.5 Anterior view of the skull

The orbicularis oculi muscle arises from the nasal part of the frontal bone, the frontal process of the maxilla, and the medial palpebral ligament.

The corrugator supercilii muscle arises from the medial end of the supraorbital ridge on the frontal bone.

The procerus muscle arises from the nasal bone and the lateral nasal cartilage.

The transverse part of the nasalis muscle arises from the canine eminence, while the alar part arises from the area adjacent to the origin of the transverse part, on the canine eminence.

The depressor septi muscle arises from the incisive fossa, which is medial to the origin of the incisivus labii superioris muscle.

The incisivus labii superioris muscle arises from the incisive fossa, just lateral to the origin of the depressor septi muscle.

The levator labii superioris muscle arises from the maxilla at the inferior orbital rim, above the infraorbital foramen.

The levator labii superioris alaeque nasi muscle arises from the frontal process of the maxilla.

The zygomaticus major muscle arises from the lateral surface of the zygomatic bone medial to the zygomaticotemporal suture.

The zygomaticus minor muscle also arises from the zygomatic bone medial to the origin of the zygomaticus major muscle. However, in some instances, a portion of the muscle may arise from the orbicularis oculi muscle.

The canine eminence is located over the root of the canine tooth. The eminence divides the anterior surface of the maxilla into two concave areas: the shallow incisive fossa in front and the deeper canine fossa behind. The levator anguli oris muscle arises from the canine fossa of the maxilla, just below the infraorbital foramen.

The supraorbital, infraorbital, and mental foramina lie approximately in a vertical line.

The piriform aperture, also known as the anterior nasal aperture, is a heart-shaped or pear-shaped bony nasal opening in the skull.

Fig. 4.6 Anterior view of the mandible

The depressor labii inferioris muscle arises from the mandible below the mental foramen.

The depressor anguli oris muscle arises from an area around the lower border of the mandible, below the origin of the depressor labii inferioris muscle.

The platysma muscle arises from the superficial fascia of the upper part of the thorax. The muscle then ascends to the neck, where it inserts into the lower border of the body of the mandible, in proximity to the origin of the depressor anguli oris muscle. The superior portion of the platysma muscle extends to the lower lip and modiolus.

The mentalis muscle arises from the incisive fossa of the mandible.

The buccinator muscle arises from the alveolar processes of the maxilla and mandible in the region of the molar teeth and the pterygomandibular raphe.

The incisivus labii inferioris muscle arises from the incisive fossa of the mandible, laterally to the origin of the mentalis muscle.

A distinct prominence, the mental protuberance, is located at the inferior margin in the midline of the mandible. On each side of the protuberance are the mental tubercles. Above the mental protuberance is a shallow depression called the incisive fossa. The mental nerve arises from the inferior alveolar nerve and exits through the mental foramen onto the face, accompanied by vessels.

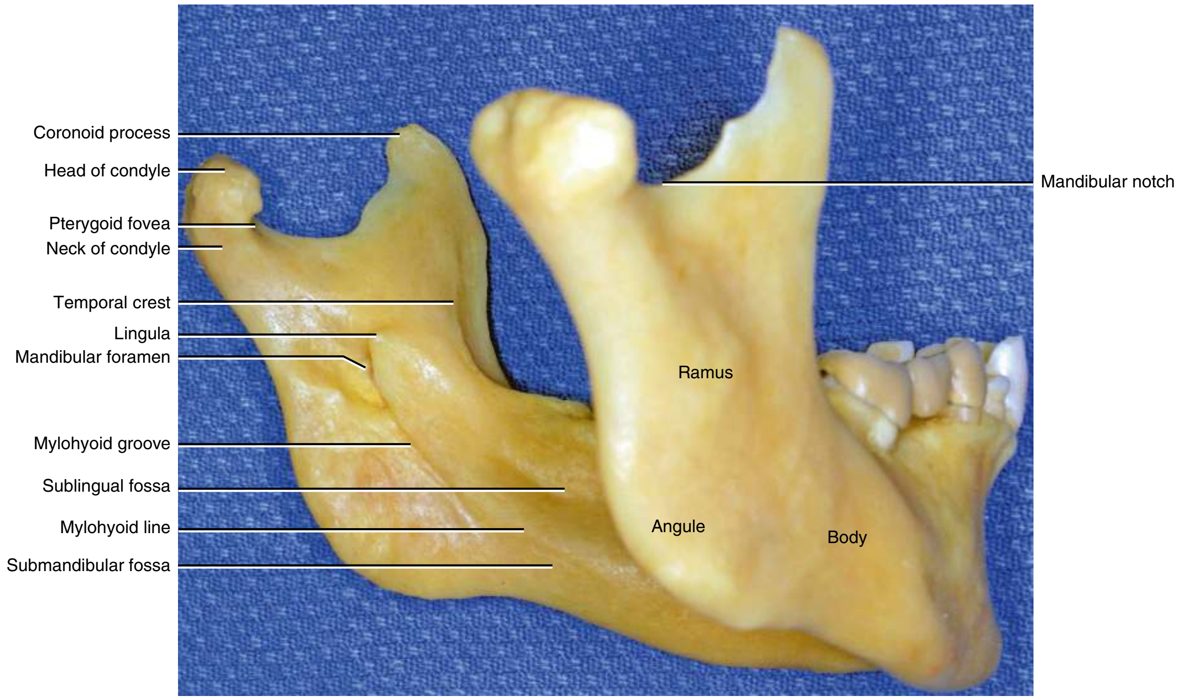


Fig. 4.7 Posterolateral view of the mandible

The temporalis muscle inserts into the coronoid process at its apex, the anterior and posterior borders, and the medial surface. The insertion extends down the anterior border of the ramus, near the third molar tooth. A significant proportion of the fibers have a tendinous insertion. The temporal crest is a ridge along the anteromedial aspect of the coronoid process and upper ramus of the mandible into which the temporalis muscle inserts.

A small depression, the pterygoid fovea, serves as the attachment site for the lower head of the lateral pterygoid muscle. It is located in the anterior portion of the neck of the condyle. The upper head of the lateral pterygoid muscle inserts into the temporomandibular joint capsule and the medial aspect of the articular disc.

The masseter muscle inserts into the lateral surface of the angle, ramus, and coronoid process of the mandible.

The medial pterygoid muscle inserts into the roughened surface of the angle of the mandible on its medial aspect.

The mandibular foramen, through which the inferior alveolar nerve and vessels pass into the mandibular canal, is located in the center of the medial surface of the ramus. A bony process, the lingula, extends from the anterosuperior surface of the foramen and provides attachment to the sphenomandibular ligament.

The mylohyoid groove, through which the mylohyoid branch of the inferior alveolar nerve passes, extends down from the posteroinferior surface of the mandibular foramen.

The mylohyoid line serves as an attachment site for the mylohyoid muscle. The sublingual fossa, situated above the mylohyoid line, contains the sublingual gland. The submandibular fossa, located below the mylohyoid line, is a depression that holds the submandibular gland.

Part III

Upper Facial and Midfacial Regions

5 Overview of Upper Facial and Midfacial Regions

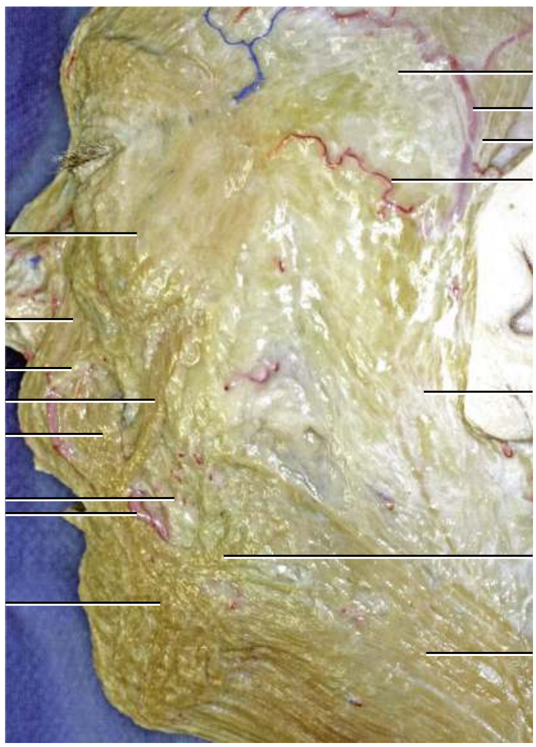


Fig. 5.1 Lateral view of the face. The skin has been removed to expose the superficial musculo-aponeurotic system (SMAS)

The superficial musculoaponeurotic system (SMAS) is a layer of the face beneath the subcutaneous fat. The SMAS is represented in the scalp by the galea aponeurotica, which then splits to ensheathe the frontalis, occipitalis, procerus, and some of the periauricular muscles.

In the temporal region, the SMAS, the temporoparietal fascia, and the superficial temporal fascia are considered synonymous. The former two are preferable because the superficial layer of the temporal fascia is situated beneath this layer, which may lead to confusion with the superficial temporal fascia.

The parotid fascia, a remnant of the primitive platysma, represents the SMAS in the cheek. The SMAS is thick over the parotid gland. However, it becomes considerably thin in the medial region, making it challenging to dissect medially. The SMAS is continuous with the platysma below and extends to the zygoma above.

The facial nerve and its branches are situated beneath the SMAS. The size and shape of the mimetic muscles vary considerably between individuals. Many mimetic muscles arise from the facial bones and insert into the skin. They are responsible for moving the facial skin to reflect emotions.

The facial artery courses superficially over the SMAS layer at the buccal (over the buccinator muscle) and nasolabial (over the orbicularis oris muscle) regions.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_5

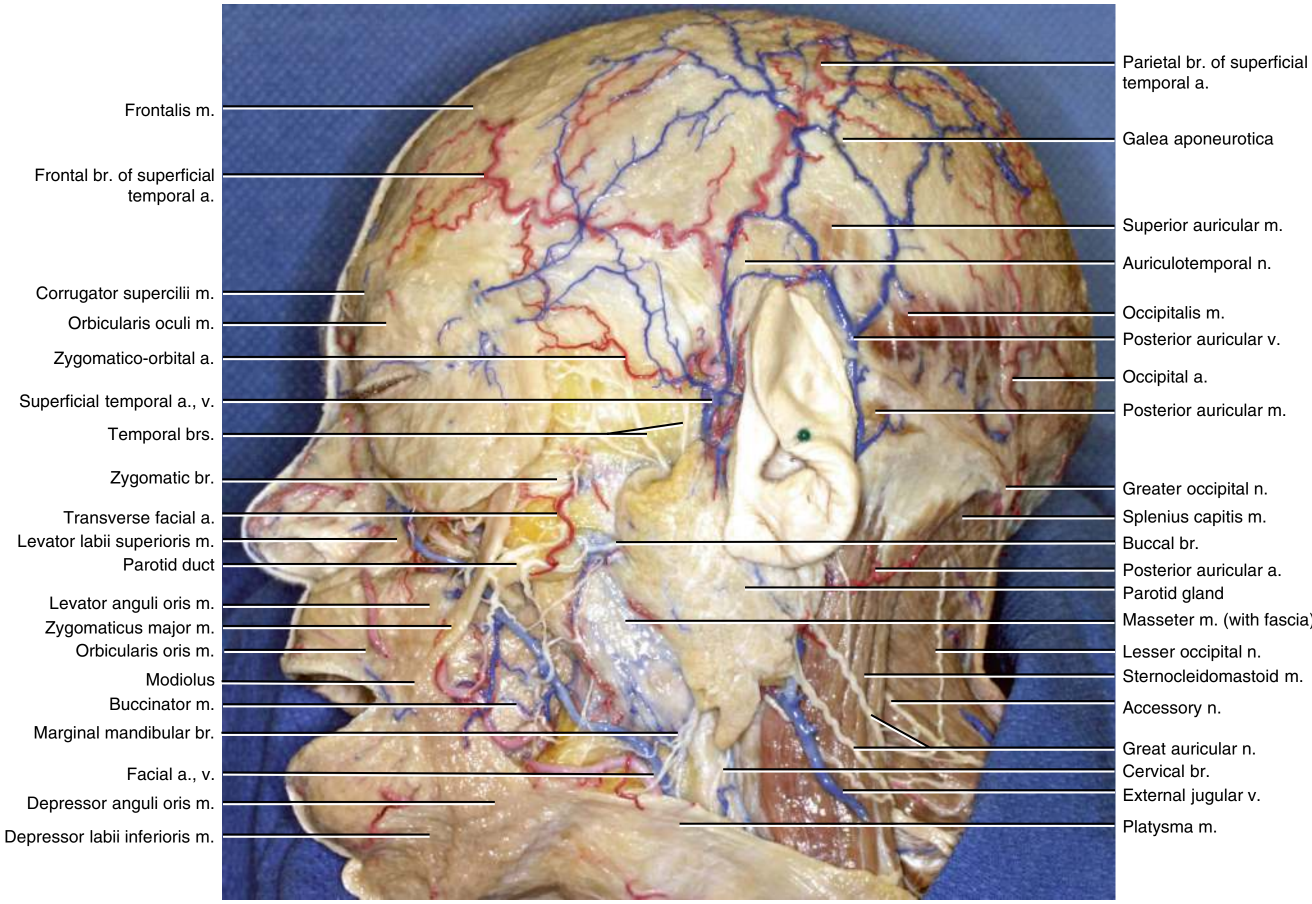


Fig. 5.2 Lateral view of the face. The extraparotid facial nerve branches have been exposed

The facial nerve branches innervate most mimetic muscles from their deep surface. Some deep-seated muscles, including the buccinator, orbicularis oris, levator anguli oris, nasalis, and mentalis muscles, are innervated from their superficial or lateral surfaces.

The superior auricular muscle arises from the temporoparietal fascia and inserts into the upper part of the cranial surface of the auricle. The auricular side of the temporal branches innervates this muscle and the intrinsic muscles on the lateral aspect of the auricle. The superior auricular muscle displaces the auricle superiorly. The posterior auricular muscle arises from the tendinous part of the sternocleidomastoid muscle and inserts into the cranial surface of the concha. It is innervated by the posterior auricular nerve, displacing the auricle backward.

The facial artery and vein course independently from the mandibular angle obliquely toward the medial canthus. The superficial temporal artery is one of the terminal branches of the external carotid artery. It ascends toward the scalp, crossing the zygomatic process of the temporal bone. It divides into anterior (frontal) and posterior (parietal) branches. A transverse facial artery arises from the superficial temporal artery within the parotid gland and crosses over the masseter muscle superior to the parotid duct.

The facial vein begins as the angular vein at the medial corner of the eye. The confluence of the supraorbital and supratrochlear veins forms the angular vein. The facial vein then descends posteriorly behind the facial artery to the inferior border of the mandible.

The superficial temporal vein is formed above the zygomatic arch by the union of anterior and posterior tributaries. It then enters the substance of the parotid gland. The superficial temporal vein then unites with the middle temporal and maxillary veins to form the retromandibular vein within the gland. If the superficial temporal vein is poorly developed (occasionally, it may be absent), the posterior auricular vein may compensate for this deficiency.

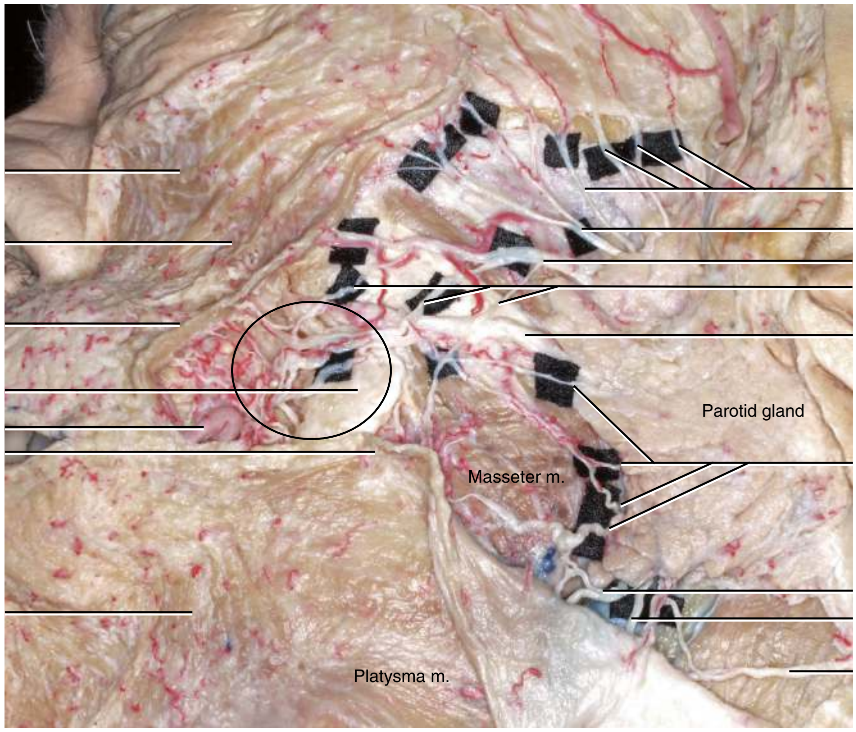


Fig. 5.3 Lateral view of the face. The masseteric fascia and a part of the buccal fat pad have been removed to expose the facial nerve branches. The black circle indicates the zygomaticobuccal plexus

The terminology employed to define the facial nerve branches at the peripheral margin of the parotid gland is somewhat arbitrary. Since the buccal branch innervates both the zygomaticus major and buccinator muscles, defining the name of the branch based on the muscles it innervates may lead to confusion. Therefore, the names of the branches are defined based on their locations in this atlas.

The temporal branch consists of three to four branches that emerge at the superior border of the parotid gland and cross over the zygomatic arch. It supplies the frontalis, upper orbicularis oculi, and corrugator muscles. It is often divided into anterior, middle, and posterior divisions. It supplies the frontalis and the upper part of the orbicularis oculi muscle in the "temple"; therefore, the "temporal" branch is more suitable than the "frontal" branch.

The zygomatic branch consists of two or three branches that emerge at the anterosuperior border of the parotid gland and pass forward below the zygomatic arch. These branches are often classified into the upper and main zygomatic branches. The former is defined as those that supply the lower lateral part of the orbicularis oculi and the upper part of the zygomaticus major muscles without crossing the zygomatic arch. The upper zygomatic branch anastomoses with the temporal branches. The main zygomatic branch courses above the parotid duct and supplies the zygomaticus major, zygomaticus minor, levator labii superioris, and lower orbicularis oculi muscles.

The buccal branch consists of approximately three branches that emerge at the anterior border of the parotid gland. The superior branch emerges from the parotid gland near or below the parotid duct, frequently receiving branches from the main zygomatic branch and forming a plexus around the buccal fat pad over the buccinator muscle. This plexus will be referred to as the "zygomaticobuccal plexus" (indicated by a black circle) in this atlas. In addition, one or two additional buccal branches, which arise from the upper or lower division of the facial nerve, converge with the zygomaticobuccal plexus.

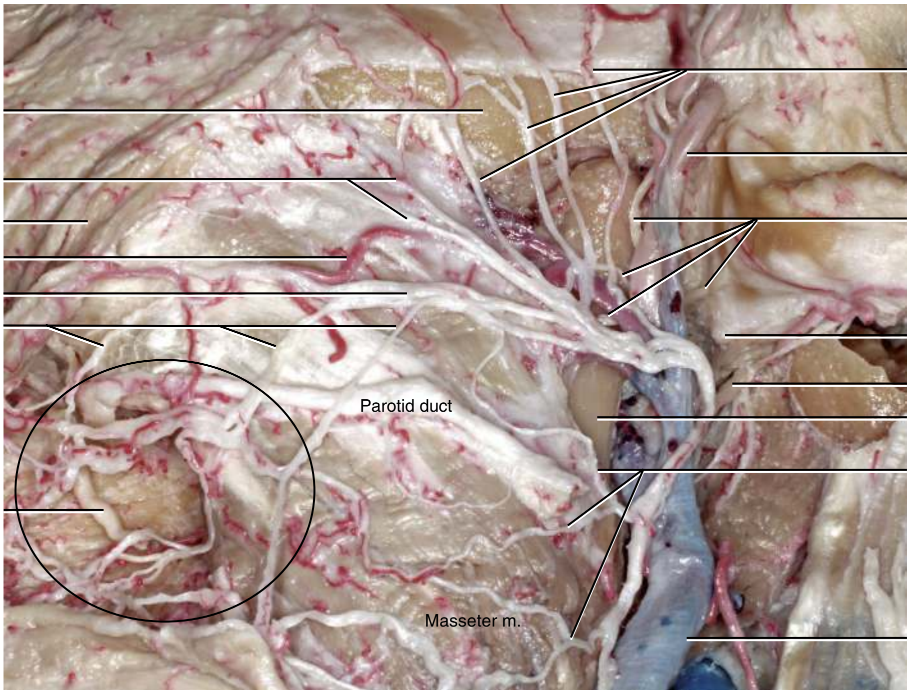


Fig. 5.4 Lateral view of the masseteric region. The substance of the parotid gland has been removed. The black circle indicates the zygomatico-buccal plexus

The facial nerve has interconnections with the trigeminal and other sensory nerves, as both run closely over the face. These communications may convey proprioceptive impulses from the facial muscles to the trigeminal nuclei of the brain stem. The auriculotemporal nerve courses anterolaterally from the posteromedial aspect of the neck of the mandibular condyle to wrap around the neck of the condyle. The nerve divides into two branches behind the condyle; one branch joins the facial nerve branches superficial to the condyle, and the other ascends to the temple with the superficial temporal vessels after giving off branches to the auricle. This nerve innervates the capsule of the temporomandibular joint. The retromandibular vein, which descends beneath the facial nerve, is a landmark for the facial nerve branches.

6 Forehead and Orbital Regions

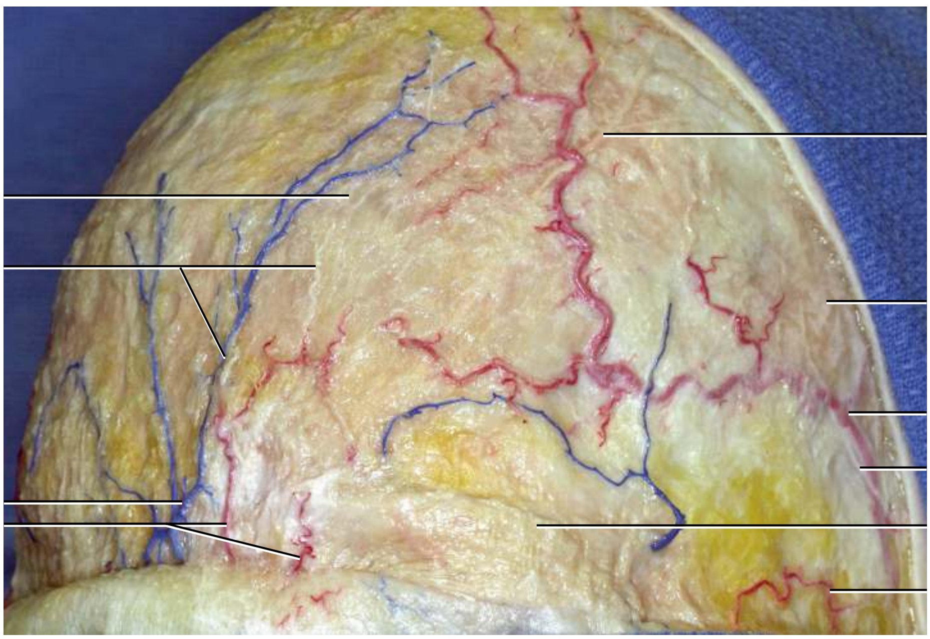


Fig. 6.1 The frontotemporal region. The skin has been removed to expose the frontalis muscle and galeal layer

The anterior and posterior muscles of the occipitofrontalis are connected by the galea aponeurotica. The galea aponeurotica is continuous laterally with the temporoparietal fascia overlying the temporal fascia. Each frontal belly of the frontalis muscle arises from the anterior margin of the galea aponeurotica around the level of the coronal suture line and extends forward to merge with the muscles adjacent to the supraorbital rim. The primary function of the occipitofrontalis muscle is to elevate the eyebrows.

The supraorbital and supratrochlear nerves provide sensation to the forehead. The supratrochlear nerve provides sensation to the medial side of the forehead. The supraorbital nerve has medial (superficial) and lateral (deep) branches. The former provides sensation to the forehead region, and the latter provides sensation to the frontoparietal area. The lateral branch generally penetrates the frontalis muscle and galeal layer above the hairline.

The superficial temporal artery and vein course over the galea aponeurotica. The superficial branches of the supraorbital and supratrochlear arteries communicate with the superficial temporal artery on the galeal layer.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_6

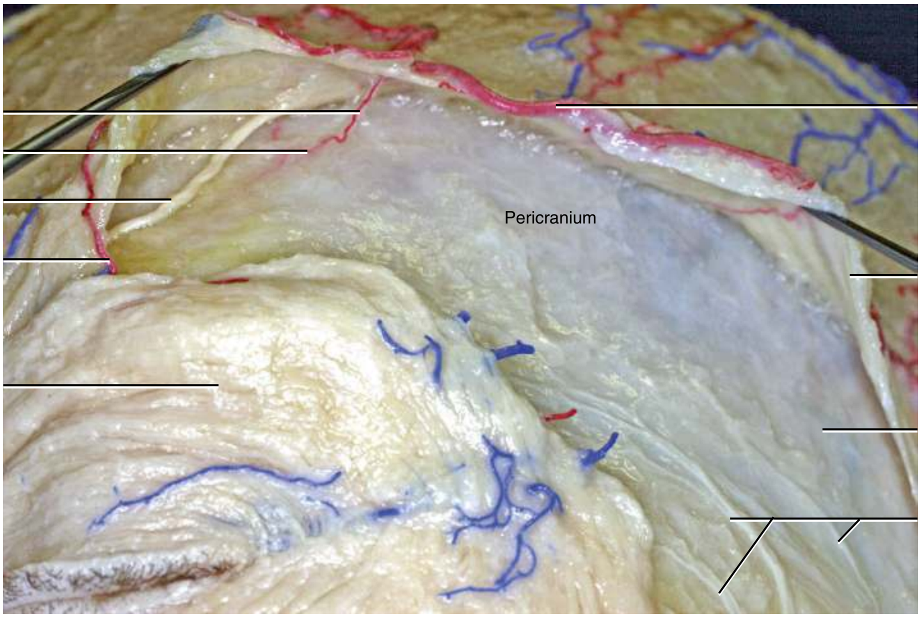


Fig. 6.2 The superolateral orbital region. The frontalis muscle has been divided from the orbicularis oculi muscle and elevated

The temporal branches of the facial nerve course in the subgaleal fat pad along the undersurface of the temporoparietal fascia. Figure 6.2 shows that the temporoparietal fascia and its extension frontalis muscle are elevated to expose the temporal branches of the facial nerve on the temporal fascia, which is continuous with the pericranium in the frontal region.

The lateral division of the supraorbital nerve courses upward across the lateral forehead between the frontalis muscle and the pericranium as the sensory nerve to the frontoparietal scalp. There is loose areolar tissue between the galea aponeurotica and the pericranium, which allows scalp mobility.

The arterial communication between the superficial temporal artery and the deep branch of the supraorbital artery is shown.

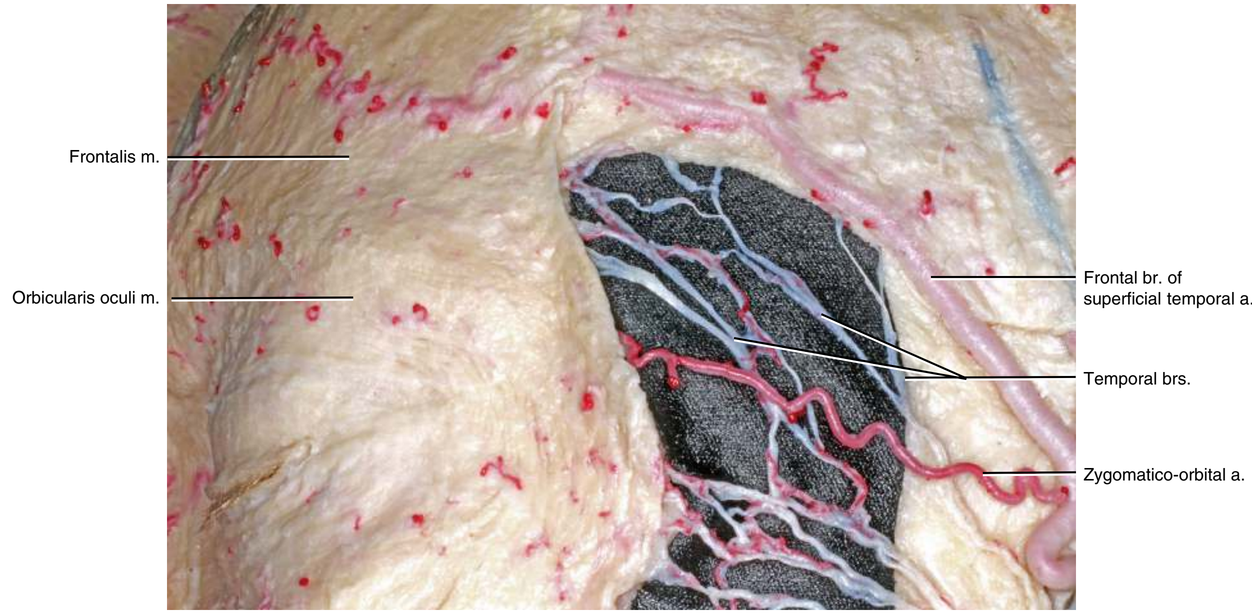


Fig. 6.3 The lateral orbital region. The temporoparietal fascia has been removed to expose the facial nerve branches

The frontalis muscle is a quadrilateral-shaped muscle extending from the anterior edge of the galea aponeurotica to the eyebrow. The middle and posterior divisions of the temporal branches enter the muscle at the supraorbital area above the orbicularis oculi muscle. The frontalis muscle is the primary elevator of the eyebrow, acting against the eyebrow depressor muscles: the procerus, corrugator supercilii, orbicularis oculi, and depressor supercilii muscles. Contraction of this muscle produces transverse wrinkles on the forehead.

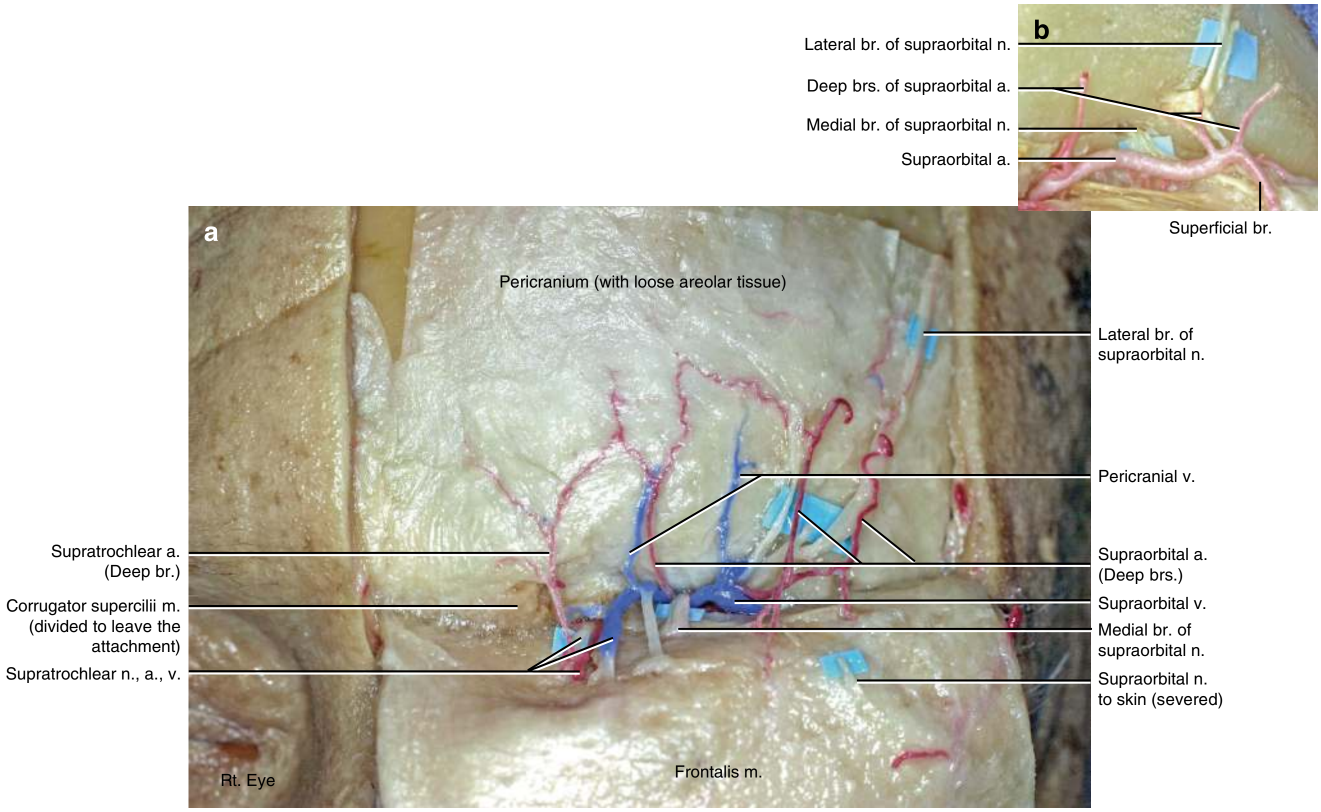


Fig. 6.4 (**a**, **b**) The supraorbital region. (**a**) The forehead skin and frontalis muscle have been reflected inferiorly. The attachment of the corrugator supercilii muscle is shown on the medial side of the frontal bone. (**b**) Medial view of the supraorbital region

The supraorbital nerve has two divisions: a medial division that courses shortly over the pericranium and then pierces the frontalis muscle, providing sensory supply to the skin of the forehead, and a lateral division that passes upward across the lateral forehead between the galea aponeurotica and the pericranium, providing sensory supply to the frontoparietal scalp. The lateral division almost always courses approximately 1 cm medial to the superior temporal line, which is the attachment of the temporal fascia. The lateral division can be identified beneath the galea aponeurotica at the hairline level. In contrast, the supratrochlear nerve has only a superficial branch.

The main trunks of the supraorbital and supratrochlear arteries pass below the orbital roof and divide near or above the supraorbital rim into superficial and deep branches (Fig. 6.4b). The superficial branches course in the galea-frontalis layer of the scalp, and the deep branches ascend on and supply the pericranium. The deep branch of the supratrochlear artery penetrates the corrugator supercilii muscle before reaching the pericranium. The forehead pericranium is primarily supplied by the deep branches of the supraorbital artery.

The deep veins from the pericranial layer and the superficial veins from the galea-frontalis layer empty into a transverse channel in the supraorbital area that passes between the galea-frontalis layer and the pericranium. This transverse venous trunk joins the supratrochlear veins medially and the superficial temporal veins laterally.

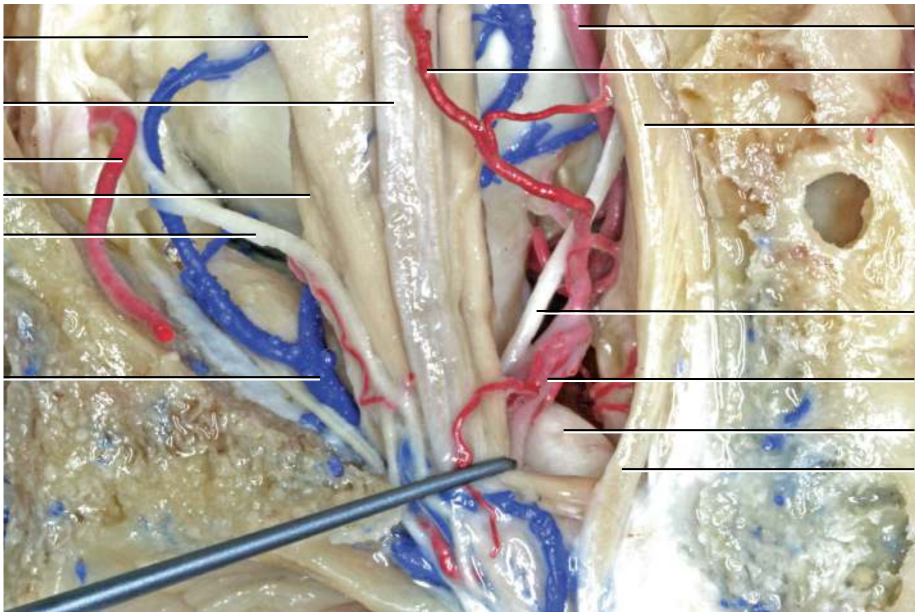


Fig. 6.5 Superior view of the orbit. The orbital fat has been removed. Extraocular muscles above the optic nerve have been retracted laterally to expose the ophthalmic artery

The ophthalmic nerve courses along the lateral dural wall of the cavernous sinus and gives rise to three main branches just before the superior orbital fissure. The three branches are the lacrimal, frontal, and nasociliary nerves.

The lacrimal nerve enters the orbit through the superior orbital fissure. It passes forward along the lateral wall of the orbit on the superior border of the lateral rectus muscle. It supplies the lacrimal gland, traverses the gland, and supplies the conjunctiva and skin of the lateral part of the upper eyelid.

The frontal nerve enters the orbit through the superior orbital fissure and passes forward on the levator palpebrae superioris muscle. It divides into the supraorbital and supratrochlear nerves.

The nasociliary nerve passes into the orbit through the superior orbital fissure and courses forward and medially across the optic nerve. The nasociliary nerve gives rise to the sensory root of the ciliary ganglion, the long ciliary nerves, and the posterior ethmoidal nerve. The posterior ethmoidal nerve leaves the orbit through the posterior ethmoidal foramen to enter the nose. It supplies the sphenoidal sinus and posterior ethmoidal air cells. Near the anterior ethmoidal foramen, the nasociliary nerve divides into its terminal branches: the anterior ethmoidal and infratrochlear nerves.

The ophthalmic artery arises from the internal carotid artery and traverses the optic canal below the optic nerve. It passes from the lateral to the medial side beneath the superior rectus muscle. It then runs with the nasociliary nerve and passes between the superior oblique and medial rectus muscles. The ophthalmic artery terminates near the medial canthus by dividing into the dorsal nasal and supratrochlear arteries.

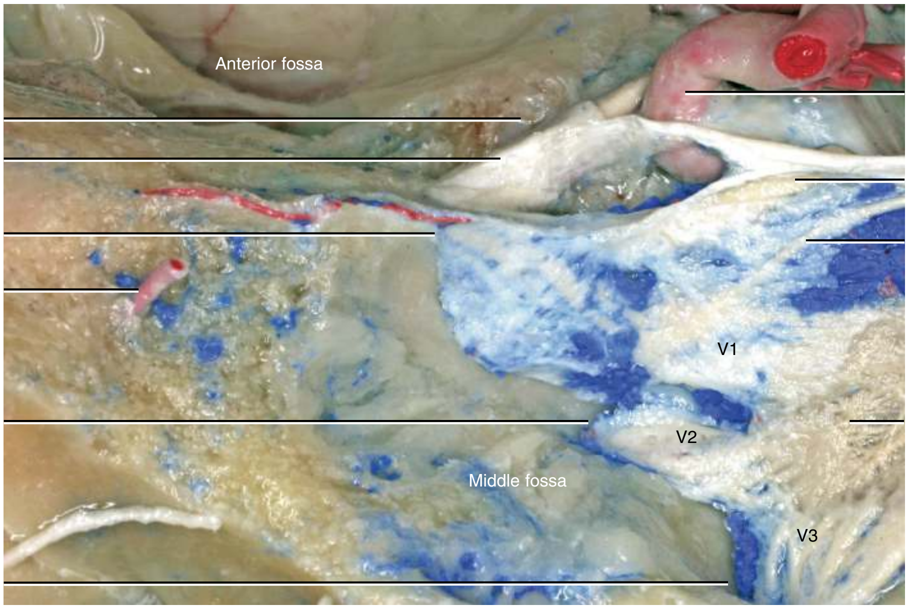


Fig. 6.6 Posterolateral view of the superior orbital fissure. The optic canal has been opened

The trigeminal nerve has three divisions: ophthalmic (V1), maxillary (V2), and mandibular (V3). The ophthalmic nerve passes into the orbit through the superior orbital fissure. The maxillary nerve passes into the pterygopalatine fossa through the foramen rotundum. The mandibular nerve passes into the infratemporal fossa through the foramen ovale. All divisions have meningeal branches. The meningeal branches from the trigeminal nerves mainly innervate the dura mater.

The motor division of the mandibular nerve supplies the muscle of mastication: masseter, temporalis, pterygoids, mylohyoid, and digastric muscles. These muscles produce elevation, depression, protrusion, retraction, and the side-to-side movements of the mandible. The motor division also supplies the tensor tympani and tensor veli palatini muscles.

The meningo-orbital foramen is located in the lateral wall of the orbit, linking it to the cranial cavity. It provides a passage for the artery connecting the orbital branch of the anterior division of the middle meningeal artery and the lacrimal branch of the ophthalmic artery.

Fig. 6.7 Superior view of the orbit. The orbital fat has been removed

The supraorbital nerve emerges from the orbit through the supraorbital notch and foramen; only some branches pass through when there is a foramen. It supplies most of the forehead and upper lid except for its lateral region.

The supratrochlear nerve emerges from the orbit above the trochlea, gives off a descending branch to the infratrochlear nerve, and ascends onto the medial part of the forehead through the frontal notch.

The nasociliary nerve divides into the anterior ethmoidal and infratrochlear nerves near the anterior ethmoidal foramen.

The infratrochlear nerve passes forward along the medial wall of the orbit below the pulley of the superior oblique muscle. It courses above the medial palpebral ligament to reach the side of the nose and supplies the skin of the medial aspect of the upper eyelid.

The anterior ethmoidal nerve exits the orbit through the anterior ethmoidal foramen. It enters the anterior cranial fossa, where the cribriform plate of the ethmoid bone meets the orbital part of the frontal bone. It then passes into the roof of the nose through a small foramen at the side of the crista galli. The anterior ethmoidal nerve terminates on the face as the external nasal nerve, supplying the skin of the nasal tip.

The ophthalmic artery gives rise to four branches that supply the face: the lacrimal artery, the supraorbital artery, the supratrochlear artery, and the dorsal nasal artery. The lacrimal artery passes along the upper lateral part of the orbit and supplies the lateral part of the upper eyelid. Within the orbit, the lacrimal artery gives off the zygomaticofacial and zygomaticotemporal arteries.

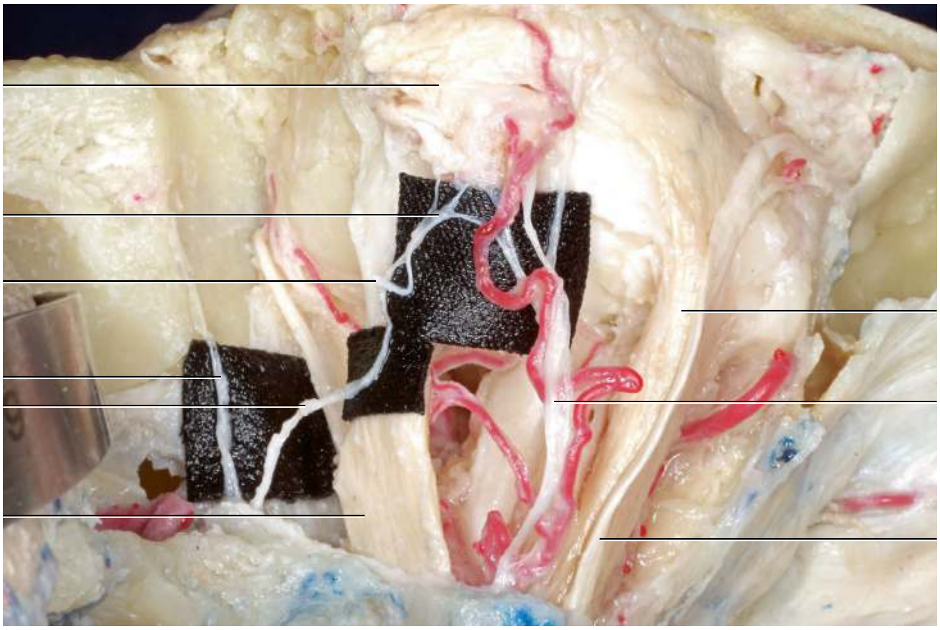


Fig. 6.8 Superolateral view of the orbit. The roof and lateral wall of the orbit have been removed

The zygomatic nerve arising from the maxillary nerve divides into the zygomaticotemporal and zygomaticofacial nerves. The former gives off a communicating branch to the lacrimal nerve in the orbit. Subsequently, the zygomaticotemporal nerve passes through the zygomaticotemporal foramen from the orbit into the temporal fossa. It pierces the temporalis muscle and fascia and reaches the subcutaneous layer to supply sensation to the temple. It communicates with the temporal branch of the facial nerve in the layer of the temporoparietal fascia. Previously, it was thought that the zygomaticotemporal nerve conveyed parasympathetic fibers from the pterygopalatine ganglion to the lacrimal gland. However, it is now believed that there are direct orbital branches that supply the lacrimal gland.

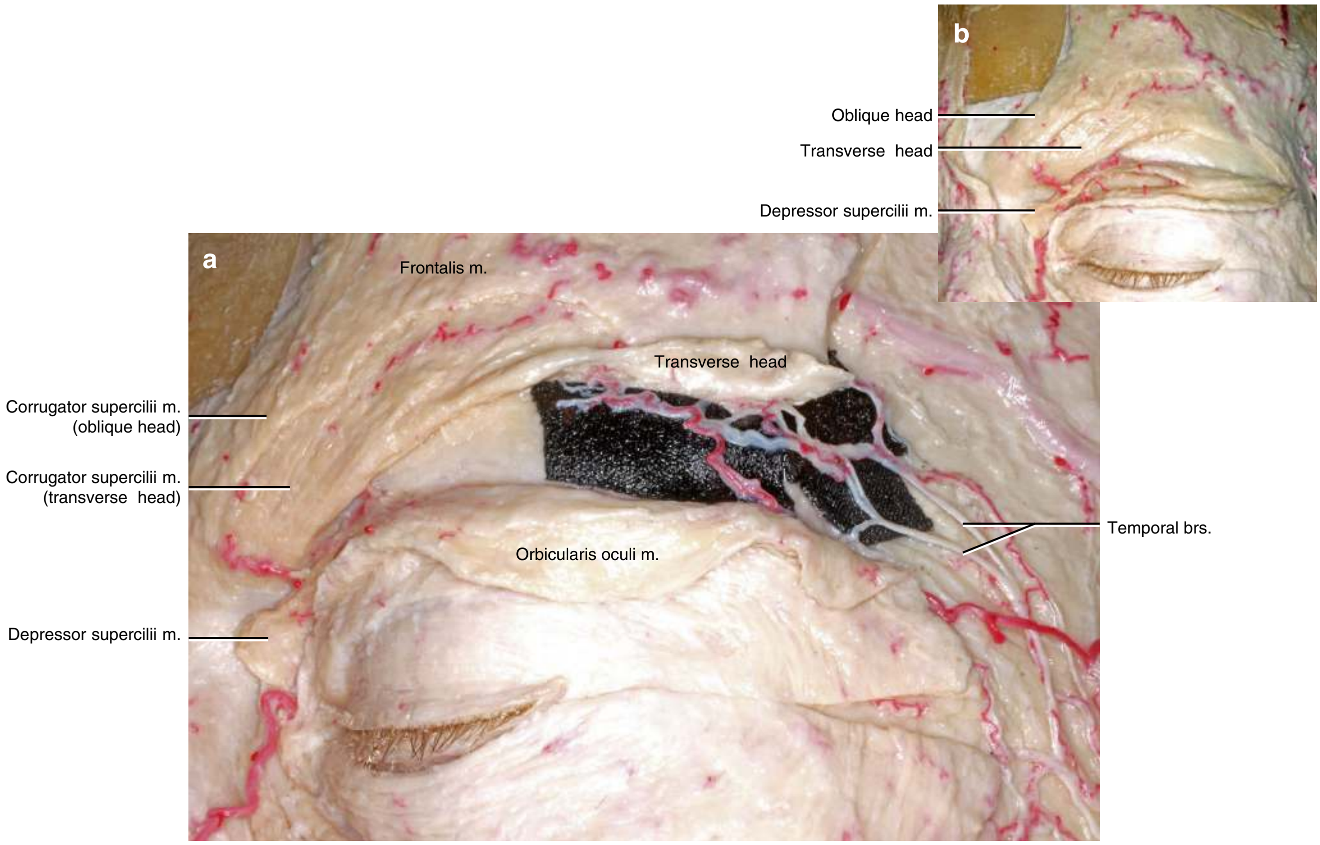


Fig. 6.9 (**a**, **b**) The upper orbital region. (**a**) Anterolateral view. The upper part of the orbicularis oculi muscle has been reflected inferiorly. A part of the frontalis muscle has been removed to expose the corrugator supercilii muscle, and the transverse head of the corrugator supercilii muscle has been reflected superiorly. (**b**) Anterior view shows the corrugator supercilii muscle

The corrugator supercilii muscle arises from the medial end of the supraorbital ridge on the frontal bone, situated deep to the orbicularis oculi and depressor supercilii muscles. It extends upward and laterally to insert into the skin of the middle of the eyebrow through the orbicularis oculi muscle. This muscle has two muscle bellies: medially, the minor oblique muscle and, laterally, the larger transverse muscle (Fig. 6.9b). Both muscles extend almost parallel laterally and upward. This muscle produces vertical wrinkles above the bridge of the nose when frowning by drawing the eyebrow downward and inward. The middle division of the temporal branch innervates the muscle from its deep surface (indicated by asterisks in Fig. 6.9a). In addition, the zygomatic branch and the branches of the zygomaticobuccal plexus may innervate the muscle.

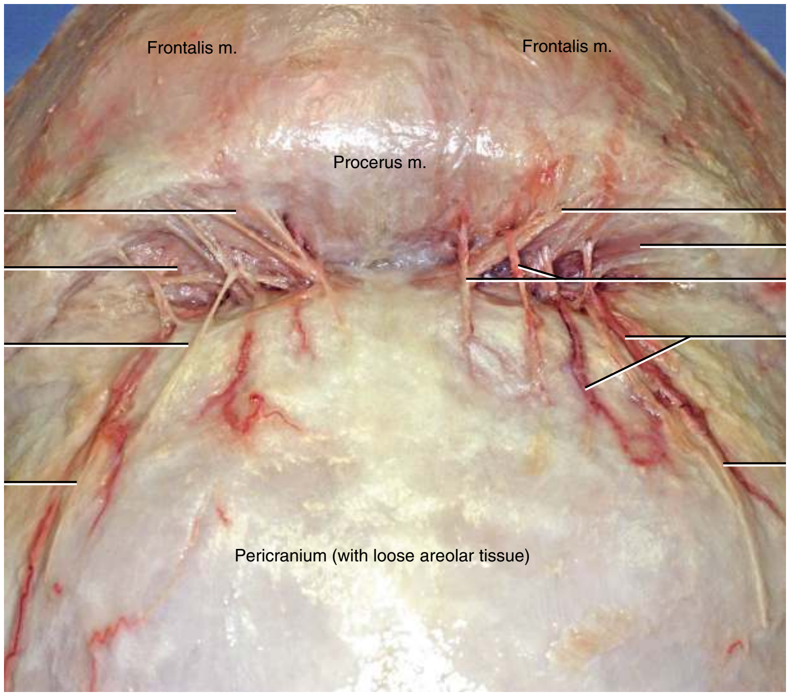


Fig. 6.10 Superior view of the supraorbital region. The skin and frontalis muscle have been reflected anteriorly

The frontalis muscle intermingles with the corrugator supercilii and orbicularis oculi muscles. The medial fibers of the frontalis muscle are continuous with the procerus muscle.

The lateral branch of the supraorbital nerve, which supplies the frontoparietal scalp, ascends obliquely along the superior temporal line on the pericranium with its concomitant artery. The lateral division almost always courses approximately 1 cm medial to the superior temporal line.

The deep branches of the supratrochlear and supraorbital arteries, which supply the pericranium, penetrate the corrugator supercilii muscle along with the medial branch of the supraorbital nerve.

The scalp consists of five layers: skin, connective tissue, galea aponeurotica, loose areolar tissue, and pericranium. The first three layers are bound together as a single unit. This single unit can move along the loose areolar tissue over the pericranium, which adheres to the calvaria. The pericranium is the external periosteum covering the skull's outer surface.

The pericranial flap consists of the pericranium and loose areolar tissue. The main blood supply to the flap is from the deep branches of the supratrochlear and supraorbital vessels.

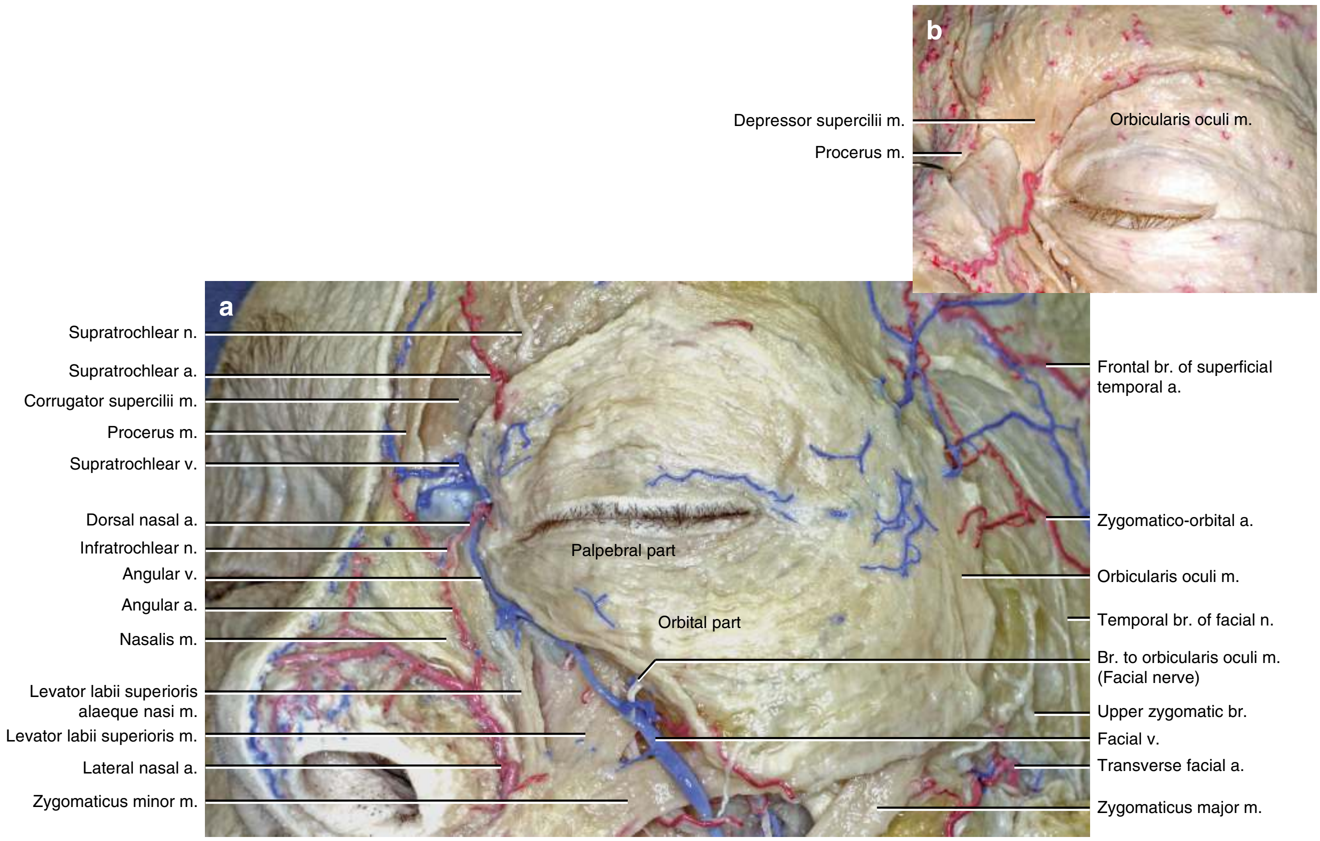


Fig. 6.11 (**a**, **b**) The orbital region. (**a**) The mimetic muscles around the orbit are shown. (**b**) A part of the superficial orbicularis oculi muscle has been removed to expose the depressor supercilii muscle

The orbicularis oculi muscle comprises three parts: the orbital, palpebral, and lacrimal. The muscle is a sphincter of the eyelids. The orbital part is the largest and arises from the nasal part of the frontal bone, the frontal process of the maxilla, and the medial palpebral ligament. The fibers pass around the orbit in concentric loops. The orbital part is involved in forced eye closure. The palpebral part is the central part and is confined to the eyelids. It arises from the medial palpebral ligament and extends across the eyelids to insert into the lateral palpebral ligament. The palpebral part gently closes the eyelids during involuntary or reflex blinking. The lacrimal part arises from the lacrimal bone and passes behind the lacrimal sac, where some fibers insert into the lacrimal fascia. The lacrimal part dilates the lacrimal sac to aid the tear's flow into the sac.

The depressor supercilii muscle arises from the frontal process of the maxilla above the medial canthal ligament, extends upward over the corrugator supercilii muscle, and inserts into the skin of the medial eyebrow. This muscle can be considered a deep part of the orbicularis oculi muscle. It draws the medial eyebrow downward. The temporal or zygomatic branch innervates this muscle (Fig. 6.11b).

The infratrochlear nerve is a branch of the nasociliary nerve. It supplies the skin over the bridge of the nose and at the medial corner of the upper eyelid. It exits the orbit below the trochlea.

The dorsal nasal artery is one of the terminal branches of the ophthalmic artery. It accompanies the infratrochlear nerve and emerges between the trochlea of the superior oblique muscle and the medial palpebral ligament to supply the upper part of the nose. It anastomoses with the angular artery of the facial artery.

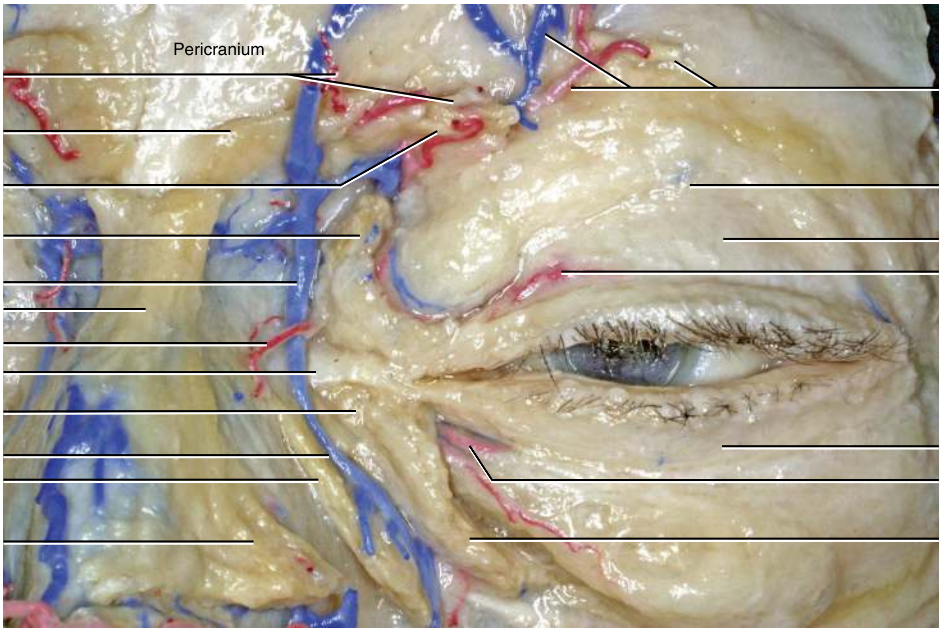


Fig. 6.12 The orbital region. The mimetic muscles have been partially removed to leave their attachments

The procerus muscle arises from the nasal bone and the upper lateral nasal cartilage and inserts into the skin between the eyebrows. The inferior part of the muscle intermingles with the transverse part of the nasalis muscle. It draws the medial angle of the eyebrow downward and produces transverse wrinkles over the bridge of the nose.

The palpebral branch of the lacrimal nerve, a sensory nerve, is small and emerges from the upper lateral margin of the orbit. It supplies the lateral part of the upper eyelid.

The supraorbital, supratrochlear, dorsal nasal, and superior and inferior medial palpebral arteries are branches of the ophthalmic artery. The superior and inferior lateral palpebral arteries are branches of the lacrimal artery. The eyelids receive their blood supply from the medial and lateral palpebral arteries. The supraorbital, supratrochlear, and angular veins form the superior ophthalmic vein in the orbit.

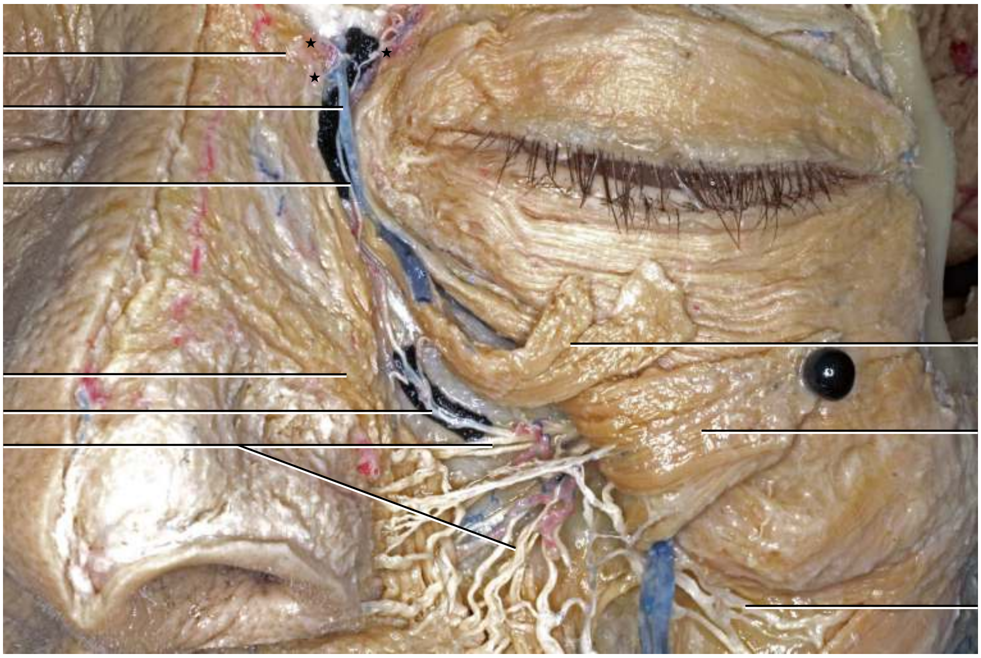


Fig. 6.13 The orbital region. The levator labii superioris and levator labii superioris alaeque nasi muscles have been detached and reflected superiorly to expose the angular nerve

Some of the terminal branches of the coalescence of the zygomatic branches and the branches of the zygomaticobuccal plexus innervate the procerus muscle and may innervate the corrugator supercilii muscle. In previous studies, this terminal branch has been referred to as the "angular nerve"; therefore, this term is used here based on its location and course. The anatomy of the angular nerve has not been thoroughly evaluated. In this specimen, the nerve appears to arise from a branch of the infraorbital nerve and ascends under the levator labii superioris alaeque nasi muscle toward the medial canthus. It courses medial to the angular vein. Two terminal branches of the angular nerve innervate the procerus (indicated by two asterisks on the left), and another communicates with the infratrochlear nerve (indicated by an asterisk on the right). The zygomatic branches and the branches of the zygomaticobuccal plexus have interconnection branches with the infraorbital nerve in the premaxillary region; therefore, this innervation pattern is likely possible.

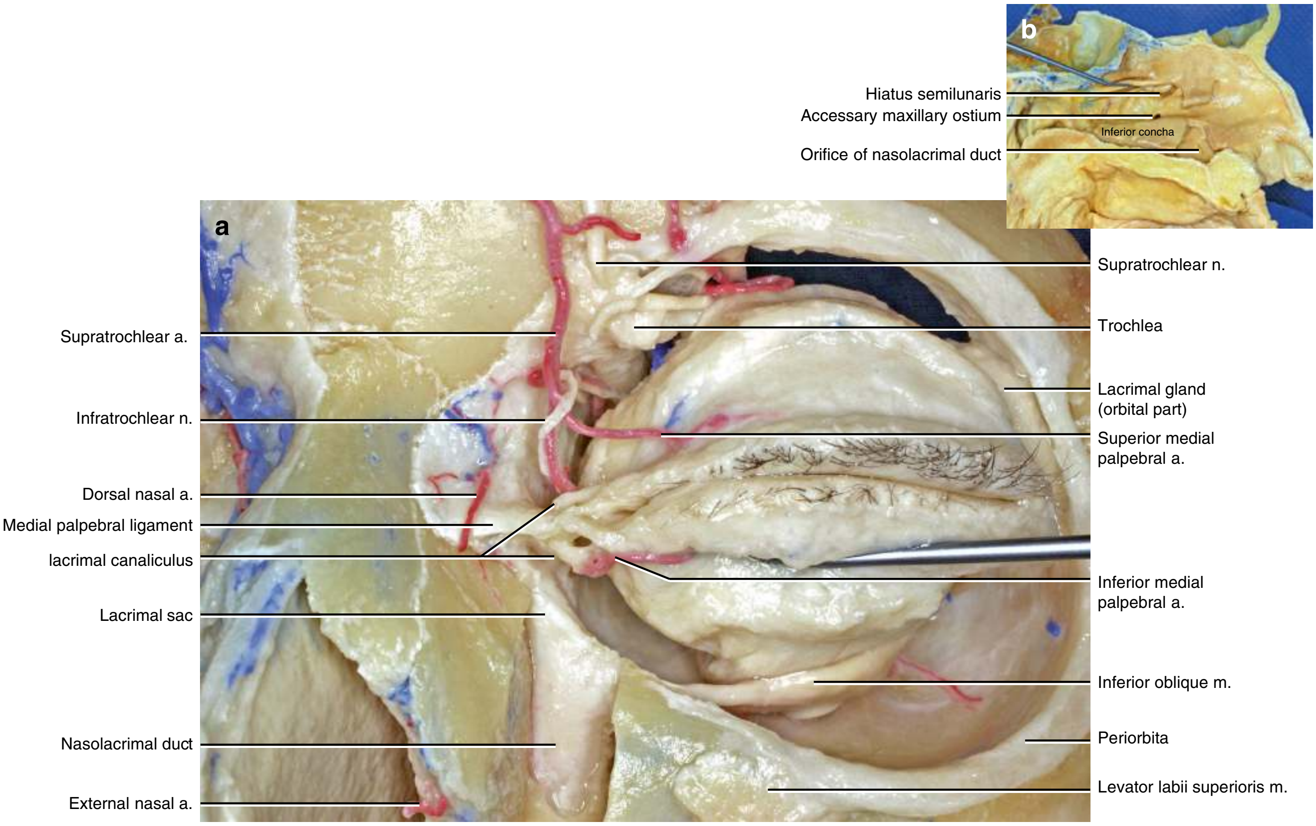


Fig. 6.14 (**a**, **b**) (**a**) The orbital region. The lacrimal apparatus has been exposed. (**b**) Medial view of the lateral nasal wall shows the orifice of the nasolacrimal duct

The lacrimal apparatus comprises the lacrimal gland, canaliculi, sac, and nasolacrimal duct. The lacrimal gland is divided into the orbital and palpebral parts. The orbital portion is more substantial and lies in a fossa of the frontal bone. The innervation of the lacrimal gland is associated with the pterygopalatine ganglion. Postganglionic parasympathetic fibers pass through the maxillary nerve and run with the zygomatic nerve into the orbit. The fibers conveyed by the zygomaticotemporal nerve join the lacrimal nerve to reach the lacrimal gland. Alternatively, direct branches of the postganglionic parasympathetic fibers reach the lacrimal gland, and recent studies suggest this is the more likely pathway. Sensory fibers associated with the gland are derived from the lacrimal nerve.

The lacrimal sac lies adjacent to the lacrimal groove in the anterior part of the medial wall of the orbit. The sac is bounded anteriorly by the anterior lacrimal crest of the maxilla and posteriorly by the posterior lacrimal crest of the lacrimal bone.

The nasolacrimal duct passes downward from the lacrimal sac to the anterior portion of the inferior nasal meatus on the lateral wall of the nose. The duct lies in a bony canal and produces a ridge in the medial wall of the maxillary sinus. The shape and position of the opening of the nasolacrimal duct into the inferior meatus may vary (Fig. 6.14b).

7 Temporal Region

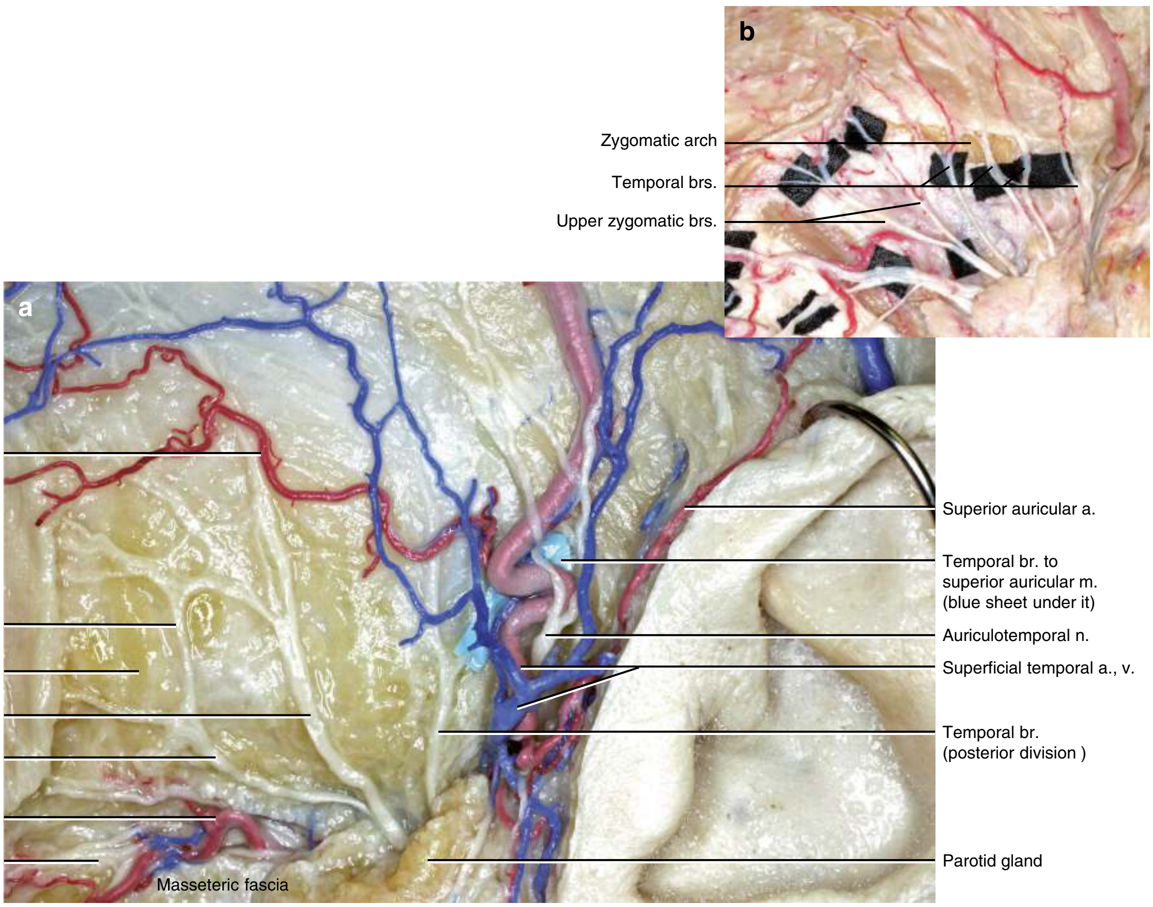


Fig. 7.1 (**a**, **b**) Close-up view of the superior margin of the parotid gland. (**a**) The facial nerve branches have been exposed. The masseteric fascia has been cut and opened. (**b**) The zygomatic arch has been exposed

The temporal branches and their interconnecting branches are shown. The temporal branches of the facial nerve leave the parotid gland immediately inferior to the zygomatic arch. The nerve provides motor innervation to the frontalis, upper part of the orbicularis oculi, corrugator muscles, and possibly the procerus muscle. There are three to four temporal branches, and a branch of the posterior division (indicated by a blue sheet under it in Fig. 7.1a) innervates the superior auricular muscle. The posterior and middle divisions innervate the frontalis muscle, while the middle and anterior divisions innervate the corrugator supercilii and the lateral part of the orbicularis oculi muscles.

The auriculotemporal nerve ascends with the superficial temporal vessels and supplies the temporal skin and the upper part of the auricle.

The zygomatico-orbital artery is a consistent branch from the superficial temporal artery to the orbicularis oculi muscle.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_7

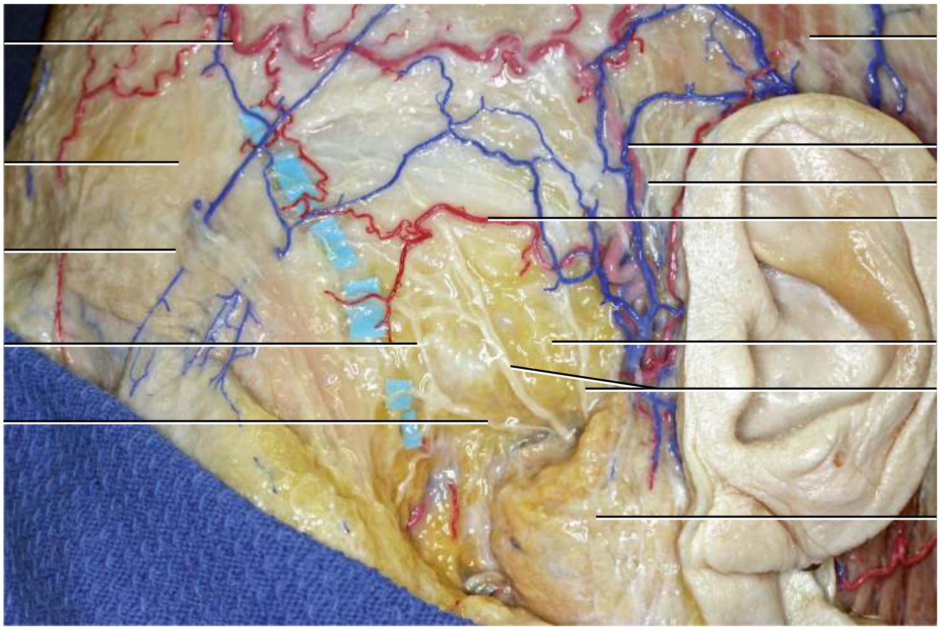


Fig. 7.2 The temporal region. The temporal branches and their innervation to the frontalis and orbicularis oculi muscles are shown

The superior auricular artery is a branch of the superficial temporal artery that courses onto the upper part of the helix.

The transverse facial artery is exposed by opening the masseteric fascia. The main zygomatic branch also passes forward with the artery under this fascia.

The superficial temporal vein courses superficially over the superficial temporal artery in front of the auricle and in the temporal region.

The temporal branches entering the frontalis and the lateral part of the orbicularis oculi muscles are shown (indicated by blue sheets under the branches) after removing a part of the temporoparietal fascia. The temporal branches of the facial nerve course within the subgaleal fat pad and generally pass below the frontal branch of the superficial temporal artery. The commonly used approximation for the temporal branch is Pitanguy's line, drawn from 0.5 cm below the tragus extending to a point 1.5 cm above the lateral eyebrow. It can serve to locate the estimated course of the temporal branches. The upper zygomatic branch can be distinguished from the temporal branch by its course as it never crosses the zygomatic arch. Both branches connect with anastomotic branches.

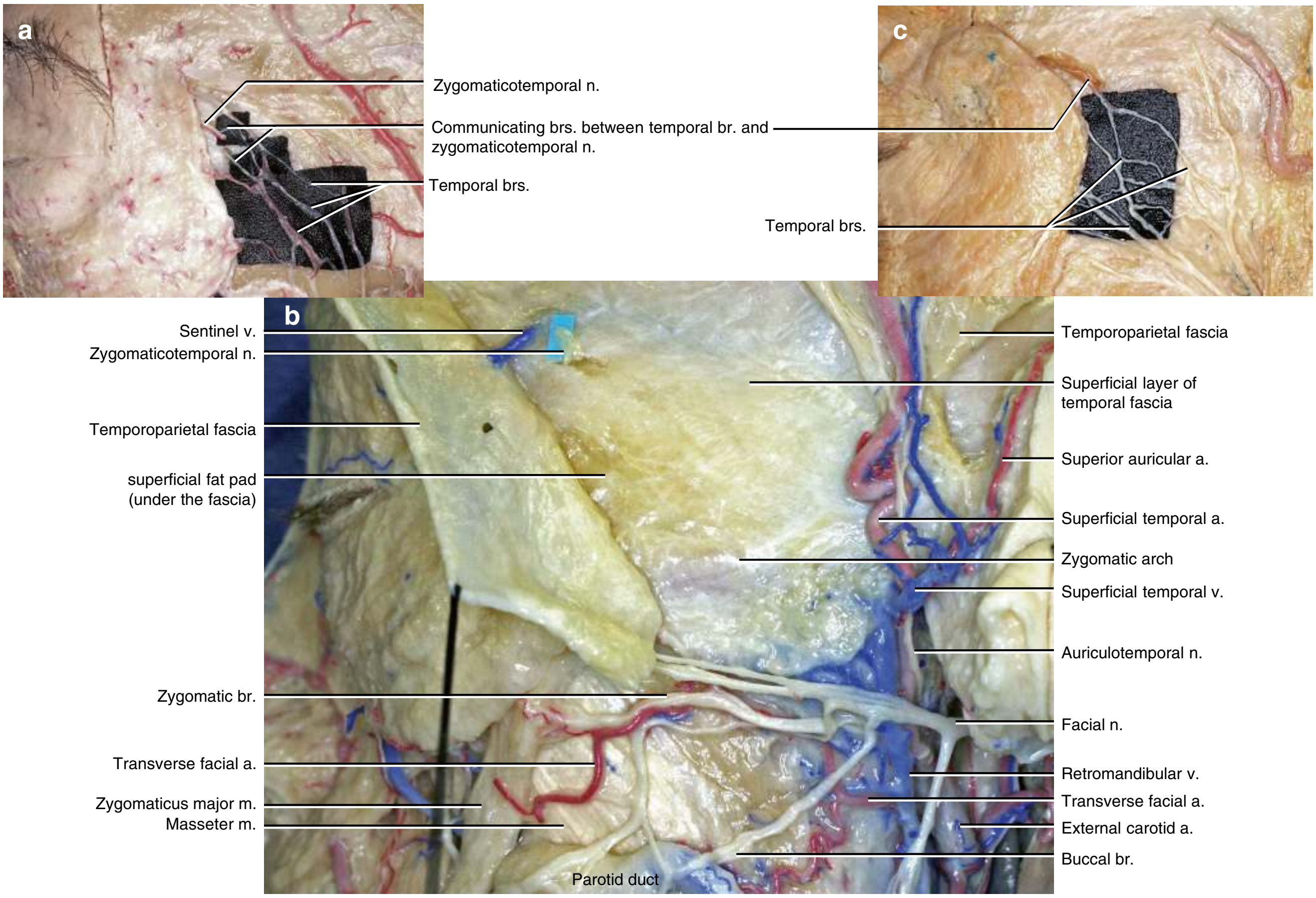


Fig. 7.3 (**a**–**c**) The temporal region. (**a**, **c**) The communicating branches between the facial nerve and the zygomaticotemporal nerve are shown. (**b**) The temporoparietal fascia with subgaleal fat pad has been reflected anteriorly

The "sentinel vein" is a landmark indicating the proximity of the temporal branch of the facial nerve. The temporal branch of the facial nerve, which courses along the undersurface of the temporoparietal fascia, is typically found cephalad to the sentinel vein. This vein is located about 5 mm lateral to the frontozygomatic suture line and is a tributary of the maxillary vein that drains the temporal region.

The zygomaticotemporal nerve provides sensation to the temporal skin. This nerve emerges from the orbit into the temporal fossa approximately 15 mm inferior to the frontozygomatic suture and 10 mm lateral to the lateral margin of the orbit. It then passes through the temporalis muscle and pierces the temporal fascia about 2 cm above the zygomatic arch. This nerve is located around 1 cm lateral to the sentinel vein on the superficial layer of the temporal fascia. The zygomaticotemporal nerve has communicating branches with the temporal branch of the facial nerve in the temporal region. The zygomaticotemporal nerve gives off these communicating branches before or after penetrating the fascia (Fig. 7.3a, c).

The superficial fat pad is the interfascial fat pad between the superficial and deep layers of the temporal fascia.

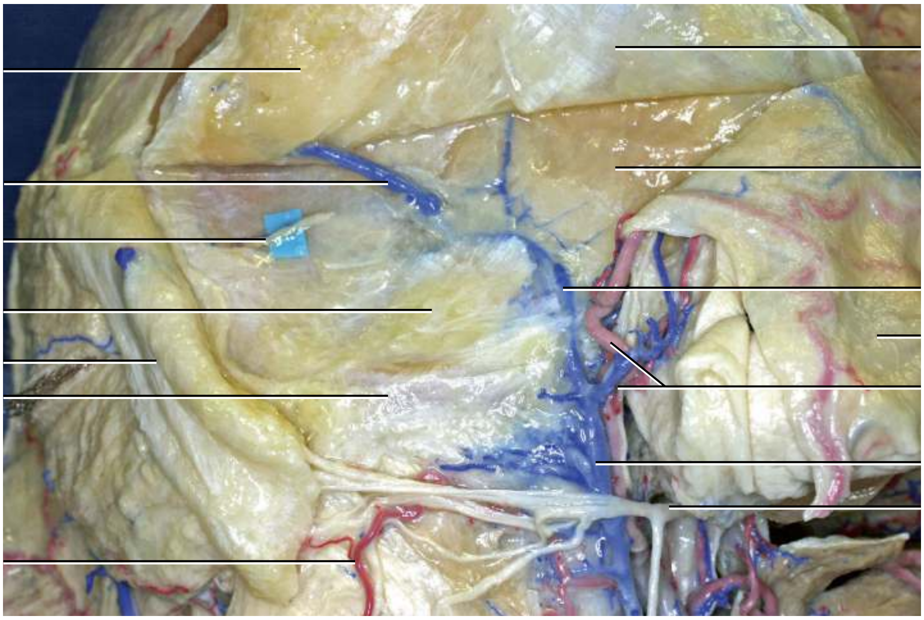


Fig. 7.4 The temporal region. The superficial layer of the temporal fascia with the interfascial fat pad has been reflected superiorly

The facial nerve branches generally cross over the retromandibular vein, and a small amount of parotid tissue may exist between the nerve and vein.

The sentinel vein passes backward, inferiorly, and deeply through the temporal fascia to the middle temporal vein. The middle temporal vein passes deeply over the temporalis muscle and joins the superficial temporal vein below the zygomatic arch to form the retromandibular vein. The maxillary vein joins the retromandibular vein in the parotid gland. The retromandibular vein usually divides into anterior and posterior branches around the inferior border of the parotid gland.

The deep fat pad is a fat pad between the temporalis muscle and the deep layer of the temporal fascia, visible through the deep layer of the temporal fascia. The temporal fascia splits into superficial and deep layers below the level of the superior orbital rim.

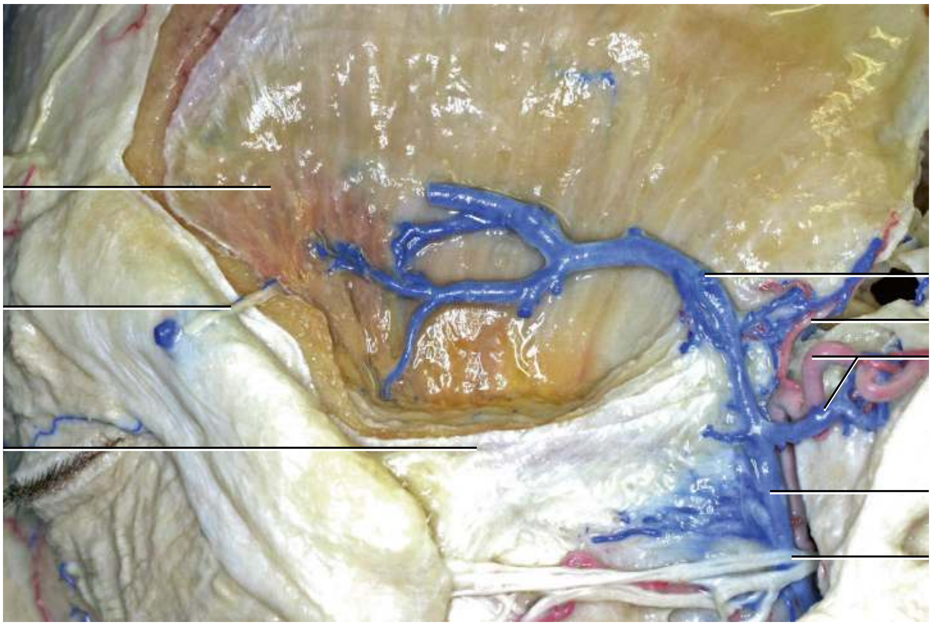


Fig. 7.5 The temporal region. The deep layer of the temporal fascia and the deep fat pad have been removed

The middle temporal artery arises from the superficial temporal artery at the level of the zygomatic arch or below it. This artery supplies the temporal fascia, the upper part of the temporalis muscle, and the posterior part of the muscle. This artery may leave a groove on the temporal bone. The middle temporal vein forms at the same level as the middle temporal artery, draining the temporalis muscle and temporal fascia, and joins the superficial temporal vein at this level.

The temporal fascia attaches above the superior temporal line on the skull. The superficial layer of the temporal fascia attaches to the lateral border of the zygomatic arch. In contrast, the deep layer of the temporal fascia attaches to the medial border of the zygomatic arch and merges with connective tissue beneath the masseter muscle.

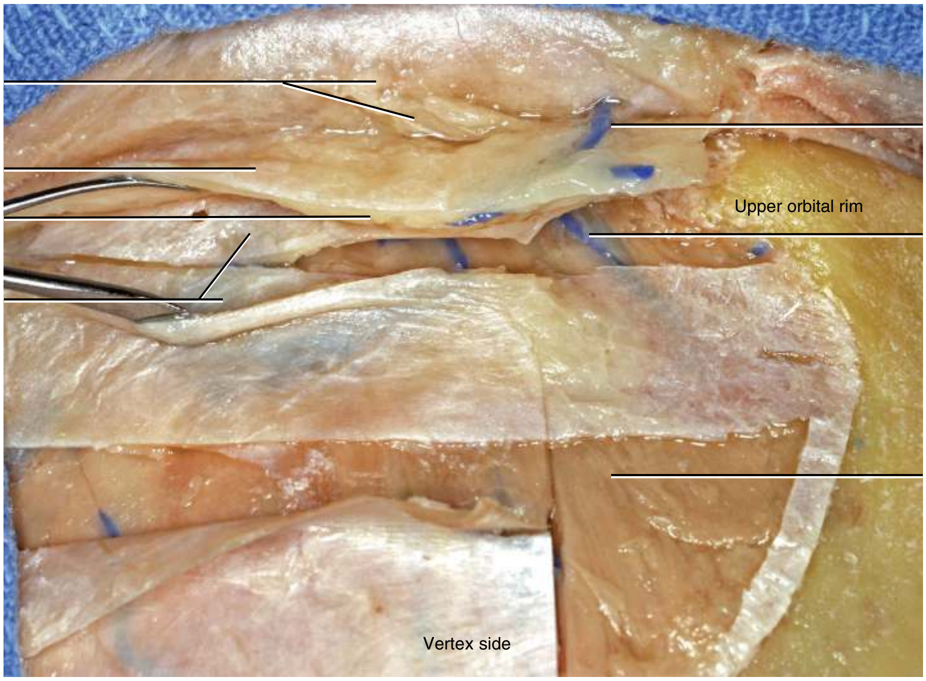


Fig. 7.6 Superior view of the temporal region. The superficial and deep layers of the temporal fascia have been separated

The temporal branch of the facial nerve courses in the subgaleal fat pad along the undersurface of the temporoparietal fascia. There are several techniques to preserve the temporal branch of the facial nerve in frontotemporal craniotomy. Dissection between the deep layer of the temporal fascia and the temporalis muscle is the most reliable technique for facial nerve preservation. However, postoperative temporal hollowing after this approach is related to decreased temporal fat pad volume. Therefore, a suprafascial dissection (dissection over the superficial layer of the temporal fascia) can achieve better cosmetic results if applicable.

The temporal fascia is the fascia of the temporalis muscle. The thick layer arises from the superior temporal line, fusing with the pericranium. The temporalis muscle arises from the deep surface of the temporal fascia and the whole of the temporal fossa. The temporal fascia splits into superficial and deep layers at the upper orbital rim level. The former attaches to the lateral border of the zygomatic arch and the latter to the medial border. The fat pad between the superficial and deep layers of the fascia is the superficial fat pad. The temporal region has three fat pads, listed from superficial to deep: subgaleal, superficial (interfascial), and deep.

8 Superficial Structures in the Midfacial Region

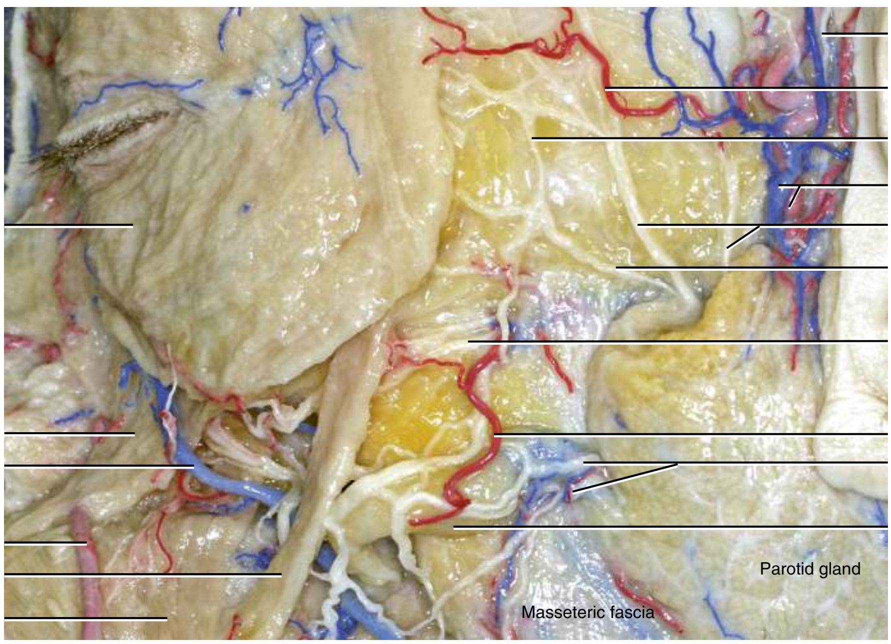


Fig. 8.1 Lateral view of the anterosuperior margin of the parotid gland

The facial nerve branches do not always run on the same layer after exiting the parotid gland. The main zygomatic branch usually passes beneath the masseteric fascia anterior to the parotid gland. It is also an essential surgical point that the parotid gland should only be divided directly above the facial nerve branches to preserve them during the dissection of the parotid gland. The most superior buccal branch of the facial nerve appears adjacent to the parotid duct, running most likely inferior to and within 1 cm of the duct.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_8

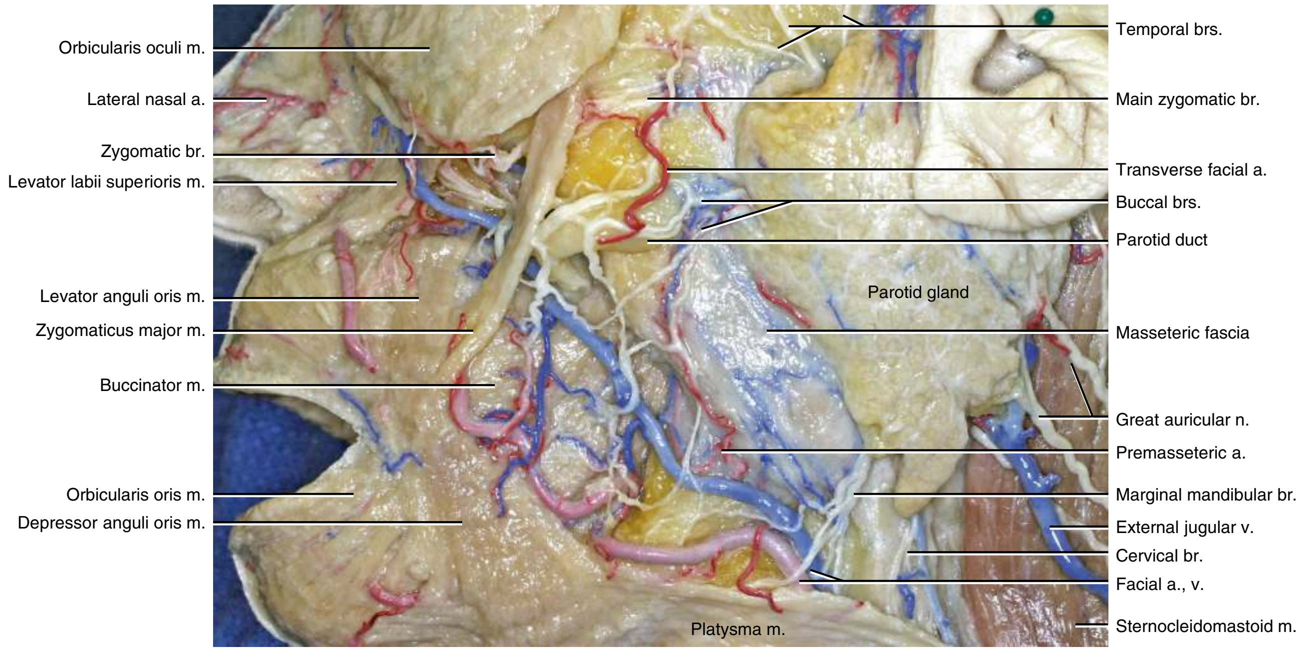


Fig. 8.2 Lateral view of the face. The extraparotid facial nerve branches have been exposed

The anterior margin of the parotid gland is a suitable site to identify the zygomatic and buccal branches for facial reanimation surgery. The skin incision can be made approximately 1 cm below the anterior end of the zygomatic arch or the mid-distance between the root of the helix and the corner of the mouth (Zuker's point). A small skin incision enables the exposure of the zygomatic and buccal branches. These branches can also be exposed at the anterior margin of the parotid gland via the preauricular skin incision. Careful selection of the donor facial nerve branch is mandatory for facial reanimation surgery. Some components of the buccal and zygomatic branches innervate the buccinator and orbicularis oris muscles but do not innervate the lip levator muscles, which are the target muscles for smile reconstruction.

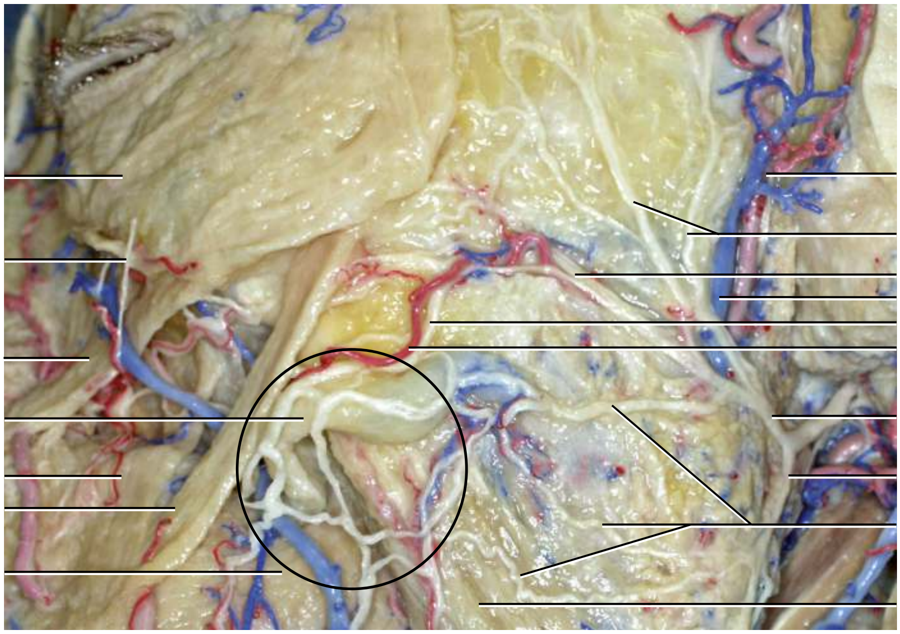


Fig. 8.3 Lateral view of the face. The superficial lobe of the parotid gland and masseteric fascia have been removed to show the facial nerve branches

The temporofacial and cervicofacial divisions generally cross forward over the retromandibular vein in the parotid gland. The facial nerve and its branches pass within the parotid gland, thereby dividing the parotid gland into deep and superficial lobes. There is no anatomical plane between the lobes.

The main zygomatic branch frequently gives rise to branches that connect to the buccal branch, forming a zygomaticobuccal plexus (black circle) with the buccal branches below the parotid duct. The branches of the zygomaticobuccal plexus innervate the buccinator and the lower part of the zygomaticus major muscles and then pass medially under the zygomaticus major muscle.

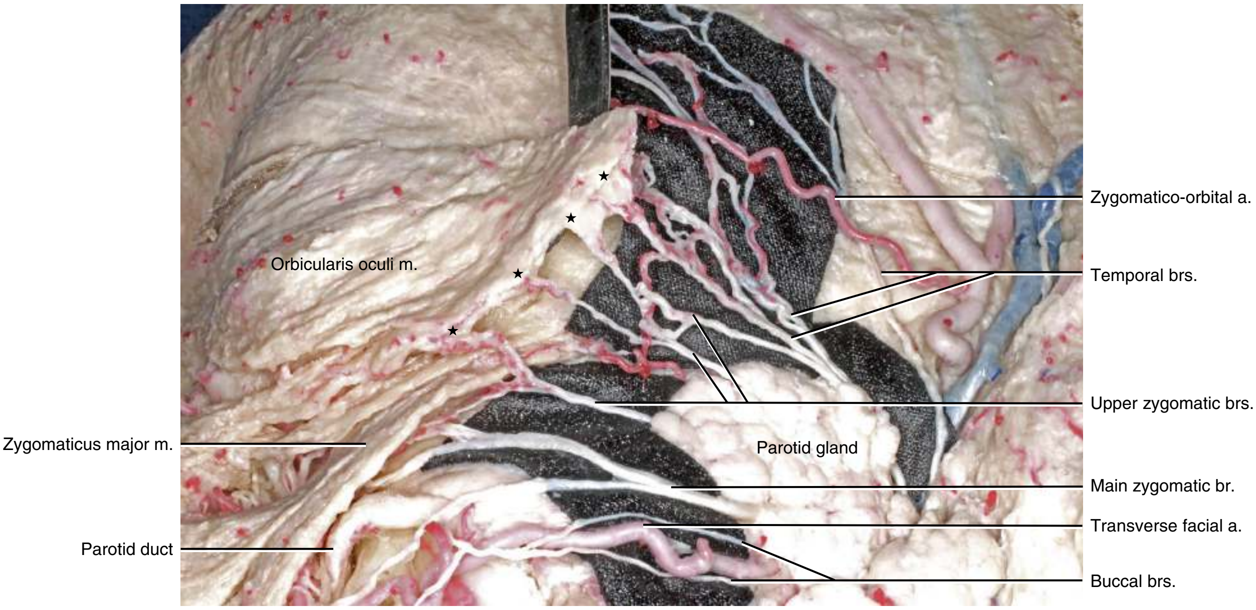


Fig. 8.4 Close-up view of the anterosuperior margin of the parotid gland. The lower lateral part of the orbicularis oculi muscle has been divided and elevated

The upper zygomatic branches and the anterior division of the temporal branches innervate the lower lateral part of the orbicularis oculi muscle (indicated by asterisks). Some upper zygomatic branches pass over the zygomatic major muscle, reaching the orbicularis oculi muscle. The inferior upper zygomatic branch, which innervates the orbicularis oculi muscle, often gives rise to a branch that innervates the zygomaticus major muscle. The upper zygomatic branch that purely innervates the orbicularis oculi muscle can be a donor motor source for contralateral orbicularis oculi muscle reanimation using a cross-face nerve graft and subsequent muscle transfer or direct neurorrhaphy.

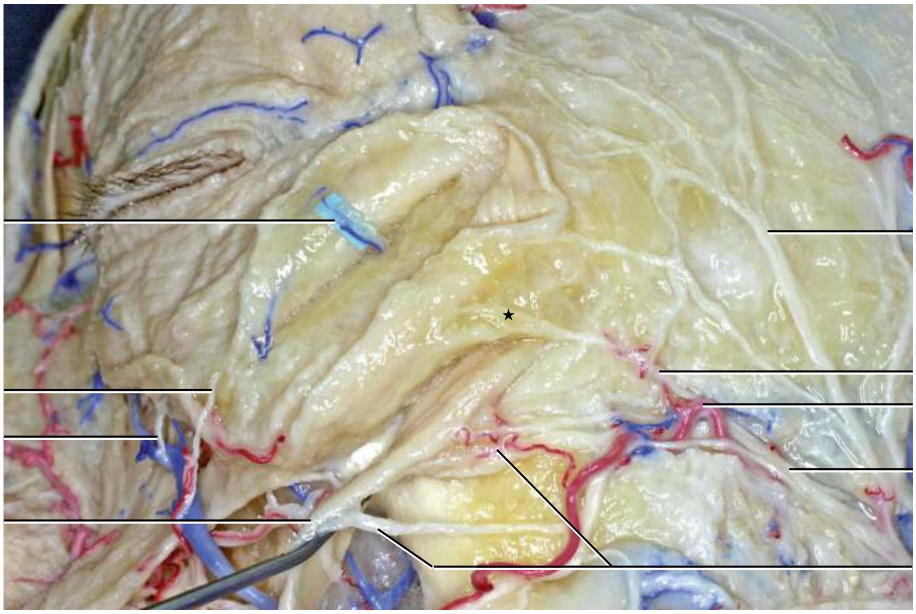


Fig. 8.5 Close-up view of the inferolateral part of the orbicularis oculi muscle and the cranial part of the zygomaticus major muscle

Innervation to the lower part of the orbicularis oculi muscle and the zygomaticus major muscle is shown. The upper zygomatic branch passes superficially over the zygomaticus major muscle, innervating the lower lateral part of the orbicularis oculi muscle (indicated by an asterisk). The main zygomatic branch innervates the zygomaticus major muscle.

The zygomaticofacial nerve (indicated by a blue sheet under it) is a sensory nerve that supplies a small region of the cheek. It arises from the zygomatic nerve in the orbit.

The transverse facial artery, which arises from the superficial temporal artery within the parotid gland, courses anteriorly beneath the masseteric fascia. It emerges superficially lateral to the zygomaticus major muscle and superior to the parotid duct.

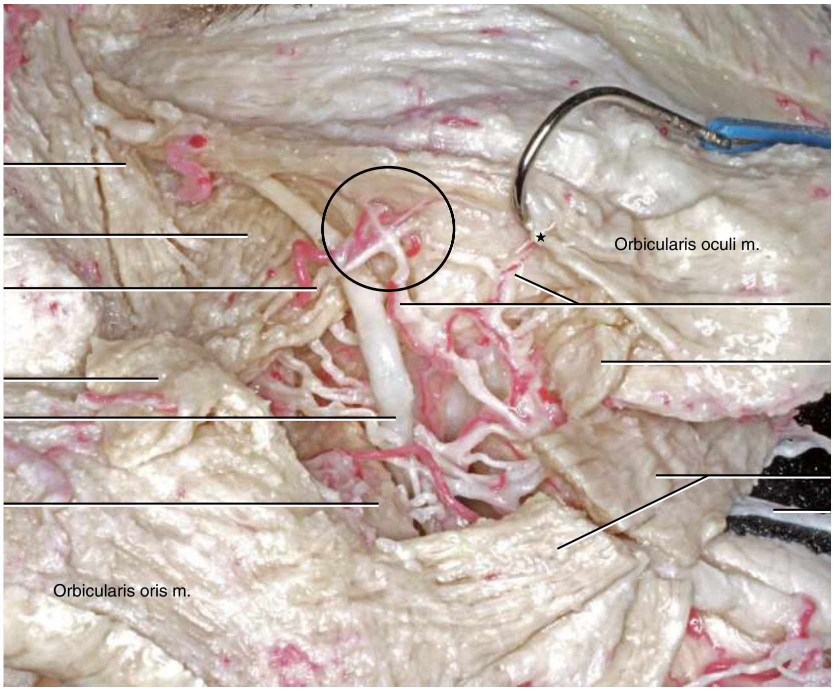


Fig. 8.6 Close-up view of the infraorbital region. The lower orbicularis oculi muscle has been elevated. The zygomaticus minor muscle has been transected and reflected

The lower middle part of the orbicularis oculi muscle is innervated by two branches of the facial nerve in this specimen. The lateral branch, from the zygomatic branch, passes under the zygomaticus minor muscle and enters the orbicularis oculi muscle (indicated by an asterisk). The medial branch, formed by a coalescence of the zygomatic branch and the infraorbital nerve that penetrates the levator labii superioris muscle, enters the orbicularis oculi muscle (indicated by a black circle).

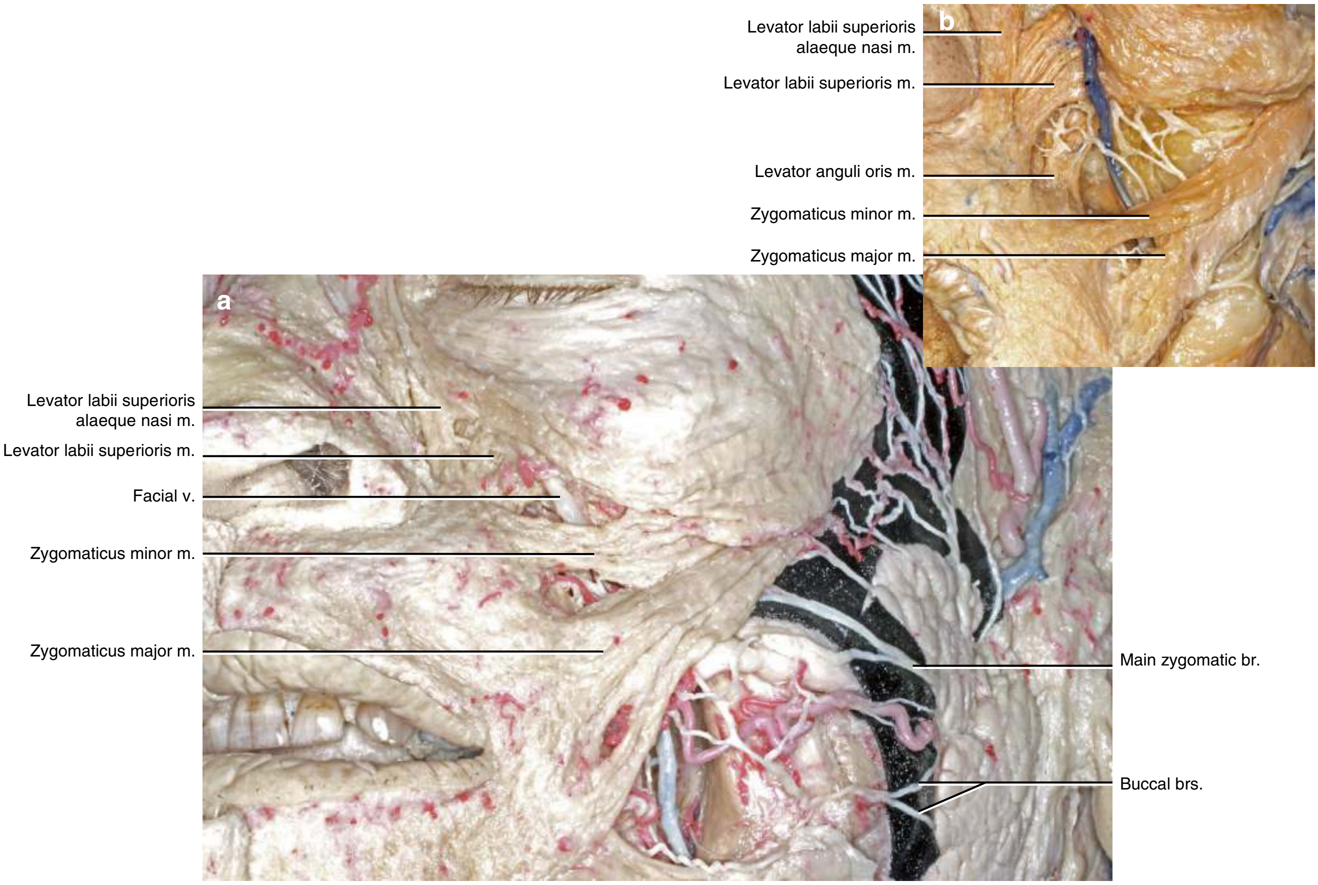


Fig. 8.7 (**a**, **b**) The midfacial region. (**a**) The zygomaticus major and minor muscles are shown. (**b**) The zygomaticus minor has a common origin with the major; the minor attaches to the orbicularis oris at a distance from the levator labii superioris muscle attachment

The zygomaticus major muscle arises from the lateral surface of the zygoma, just in front of the zygomaticotemporal suture, and attaches to the corner of the mouth. The zygomaticus major muscle pulls the corner of the mouth upward and outward. The shape of its attachment to the corner of the mouth varies and is often bifurcated.

The zygomaticus minor muscle arises from the zygoma, medial to the zygomaticus major, and commonly attaches to the upper lip musculature adjoining the levator labii superioris muscle attachment. The zygomaticus minor muscle pulls the upper lip upward and outward, exposing the upper teeth.

The orbicularis oculi muscle covers the proximal part of the zygomaticus major and minor muscles. The zygomaticus major and minor muscles have a common origin in this specimen (Fig. 8.7b). The shape of the zygomaticus major and minor muscles varies.

The modiolus is a fibromuscular mass on each side of the corner of the mouth, and its shape and dimensions vary. The modiolus may be fixed by the action of some of the muscles to provide a base for the movement of other forces. The depressor muscles of the modiolus—depressor anguli oris, platysma, risorius, and the lower part of the buccinator muscle—counteract the levator muscles, such as the zygomaticus major and levator anguli oris muscles.

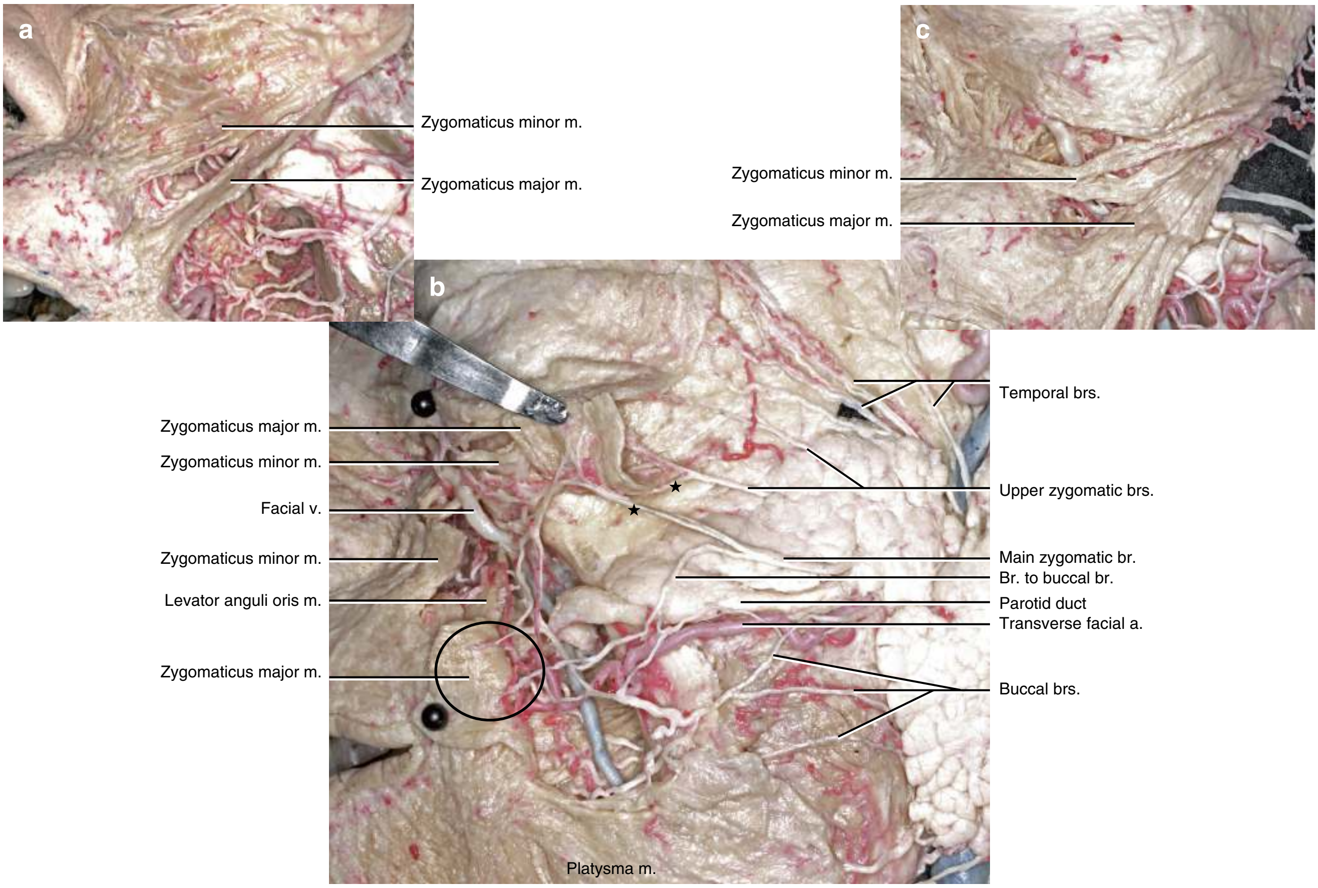


Fig. 8.8 (**a**–**c**) The midfacial region. (**a**) The zygomaticus minor muscle arises from the orbicularis oculi muscle. (**b**) The zygomaticus major and minor muscles have been transected and reflected. (Source: Reproduced from Yoshioka et al., "Nerve to the zygomaticus major muscle: An anatomical study and surgical application to smile reconstruction," *Clinical Anatomy*, Vol. 37(4), pp. 376–382, 2024, with permission from John Wiley and Sons) (**c**) The zygomaticus minor muscle arises from both the zygoma and the orbicularis oculi muscle

The upper half of the zygomaticus major muscle receives innervation from an average of two zygomatic branches. The most cranial branch (indicated by the upper asterisk in Fig. 8.8b) arises from the upper zygomatic branch. This upper zygomatic branch also gives off a branch to the orbicularis oculi muscle in this specimen. The second branch (indicated by the lower asterisk in Fig. 8.8b), from the main zygomatic branch, which is larger than the cranial one, passes under the zygomaticus major after innervating the muscle. This branch courses medially, giving off branches to the zygomaticus minor, lower part of the orbicularis oculi, and levator labii superioris muscles. This branch predominantly innervates the zygomaticus minor muscle. The lower half of the zygomaticus major muscle receives innervation from the buccal branch and branches of the zygomaticobuccal plexus (indicated by a black circle in Fig. 8.8b). These branches also innervate the buccinator muscle from its surface and pass under the zygomaticus major muscle medially.

Part of the zygomaticus minor muscle bundle is continuous with the orbicularis oculi muscle (Fig. 8.8a,c). These muscle bundles are called the malaris muscle and exist around the lower margin of the orbicularis oculi muscle. The peripheral orbicularis oculi muscle bundles sometimes blend with the zygomaticus major, zygomaticus minor, levator labii superioris, and levator labii superioris alaeque nasi muscles.

The sizable transverse facial artery substitutes for the hypoplastic facial artery in this specimen (Fig. 8.8b).

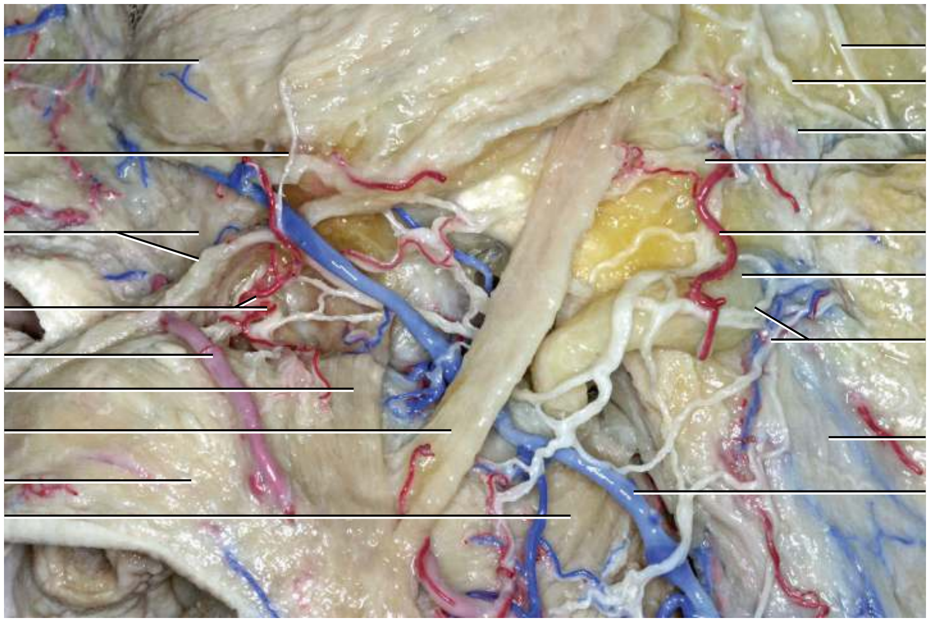


Fig. 8.9 The midfacial region. The medial course of the facial nerve branches after passing under the zygomaticus major muscle are shown

The zygomatic branches and the branches of the zygomaticobuccal plexus pass under the zygomaticus major muscle and then course medially. The interconnection between the zygomatic branches and the branches of the zygomaticobuccal plexus becomes plentiful medial to the zygomaticus minor muscle. These branches intermingle with the branches of the infraorbital nerve in the premaxillary region and then finally diverge into two directions: one toward the perinasal musculature and the other toward the medial canthal region. The former components are predominant.

The orbicularis oris muscle of the upper lip is predominantly innervated by the branches of the zygomaticobuccal plexus. These branches have multiple interconnections with the infraorbital nerve and reach the muscle surface medial to the zygomaticus major muscle.

The branches of the zygomaticobuccal plexus innervate the buccinator muscle from its surface.

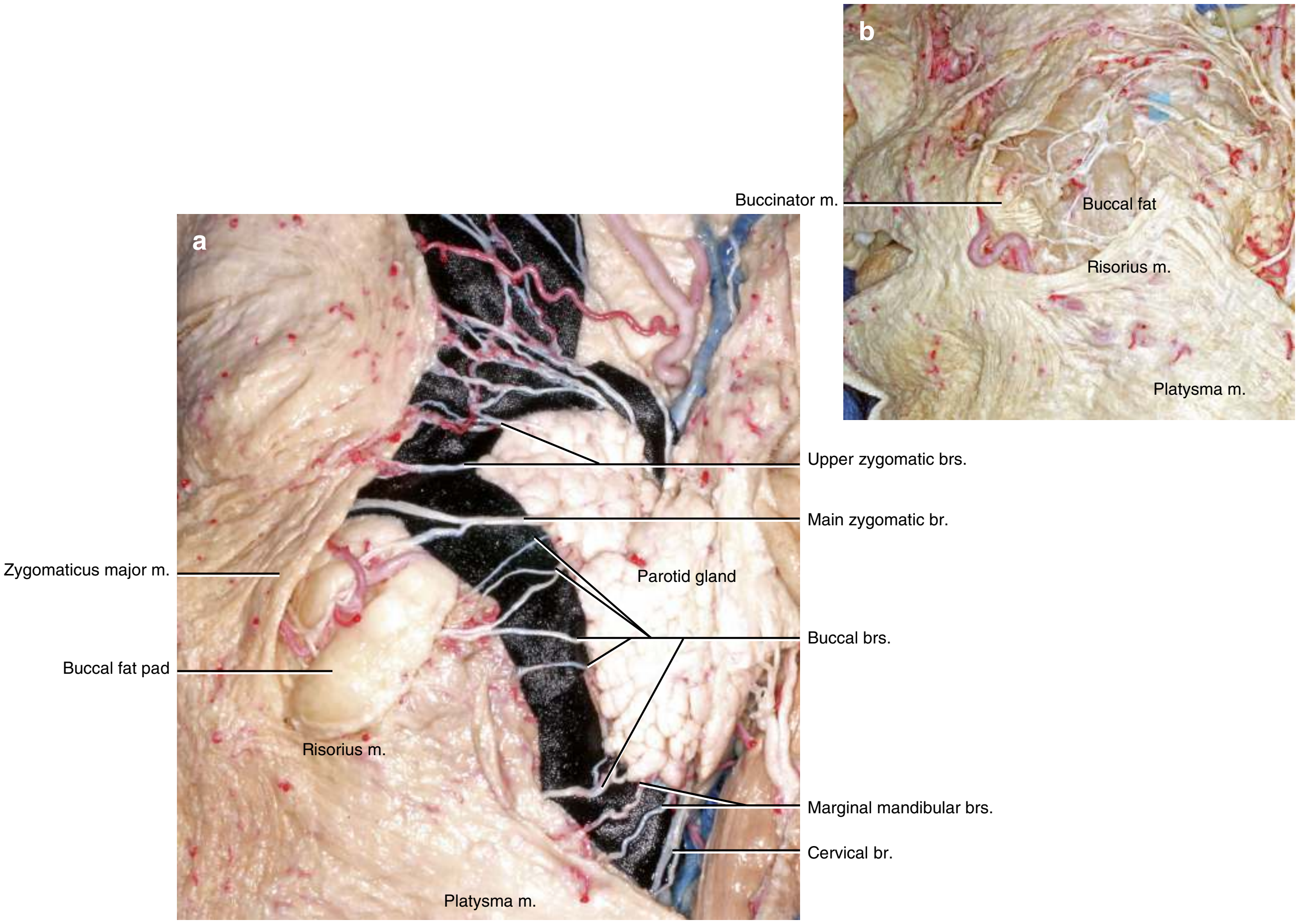


Fig. 8.10 (**a**, **b**) Lateral view of the buccal region. (**a**) The relationship between the buccal branch and the buccal fat pad are shown. (**b**) Most buccal branches travel over the buccal fat pad

The relationship between the buccal branches and the buccal fat pad varies. The buccal branches often pass over the buccal fat pad (Fig. 8.10b). However, they occasionally pass through the middle or deep to the buccal fat pad (Fig. 8.10a).

The buccal branch and the branches of the zygomatico-buccal plexus predominantly innervate the buccinator, risorius, upper lip orbicularis oris, and levator anguli oris muscles. The buccal branch may also innervate the platysma muscle.

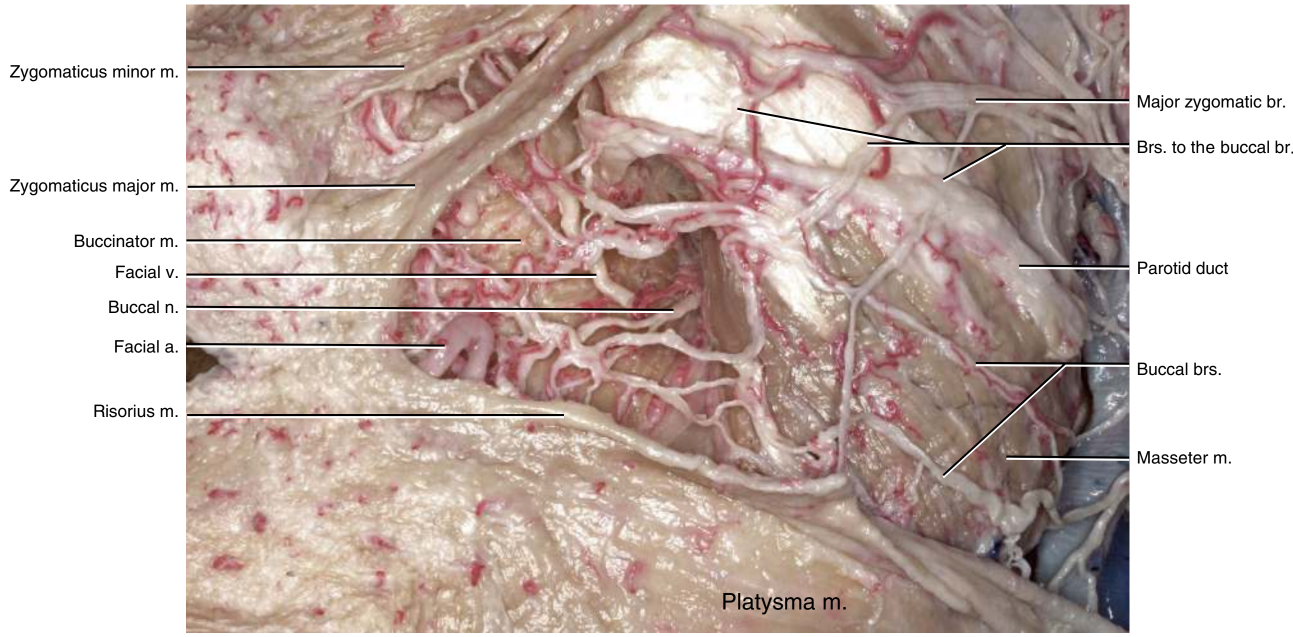


Fig. 8.11 Close-up view of the buccal region. The buccal fat pad has been removed

The buccinator muscle is in the deepest layer, adjacent to the oral mucosa, with the buccinator muscle and oral mucosa positioned back-to-back. Anteriorly, the buccinator muscle is continuous with the orbicularis oris muscle. This muscle has two main origins. First, it arises from the anterior margin of the pterygomandibular raphe. Second, it arises from the alveolar margins of the maxilla and mandible in the molar teeth region. The muscle fibers converge toward the corner of the mouth. It functions principally during mastication. This muscle compresses the cheek against the teeth and gingiva during mastication. In addition, it holds the cheek against the teeth. The paralysis of this muscle causes food accumulation in the cheek. The buccal branch and the branches of the zygomaticobuccal plexus innervate the buccinator muscle. The buccal branch also innervates the risorius and platysma muscles in this specimen.

The buccal nerve, a sensory nerve from the mandibular division of the trigeminal nerve, passes into the upper part of the retromolar fossa at the anterior border of the ramus of the mandible. It emerges on the buccinator muscle through the space between the masseter and buccinator muscles. The buccal nerve divides into several branches lateral to the buccinator muscle. It innervates the skin of the cheek and buccal mucosa. The buccal nerve communicates with the branches of the zygomaticobuccal plexus of the facial nerve. The buccal artery is a branch of the pterygoid segment of the maxillary artery. It emerges onto the face from the infratemporal fossa and crosses the buccinator muscle to supply the cheek.

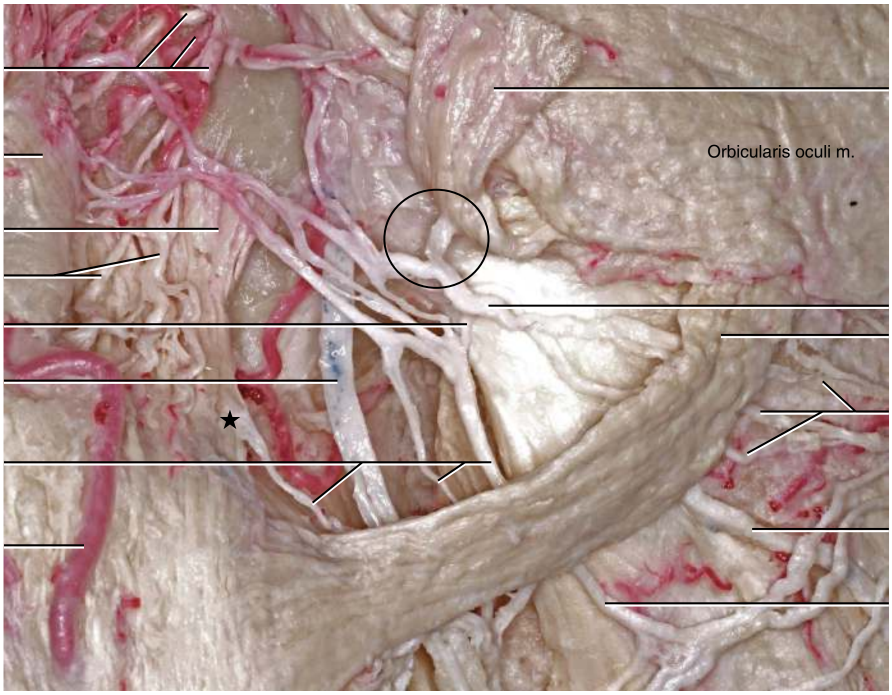


Fig. 8.12 The infraorbital region. The zygomaticus minor muscle has been transected and reflected to expose the levator anguli oris muscle

The levator anguli oris muscle arises from the canine fossa of the maxilla, immediately below the infraorbital foramen, and passes downward toward the corner of the mouth. It pulls the corner of the mouth upward and medially. The levator anguli oris muscle is innervated primarily by the branches of the zygomaticobuccal plexus from its lateral side or the superficial surface of the muscle (indicated by an asterisk). The zygomatic branches, which pass under the zygomaticus major muscle, primarily innervate the zygomaticus minor muscle (indicated by a black circle). The zygomaticus major, risorius, and buccinator muscles contribute to forming the lateral part of the nasolabial fold.

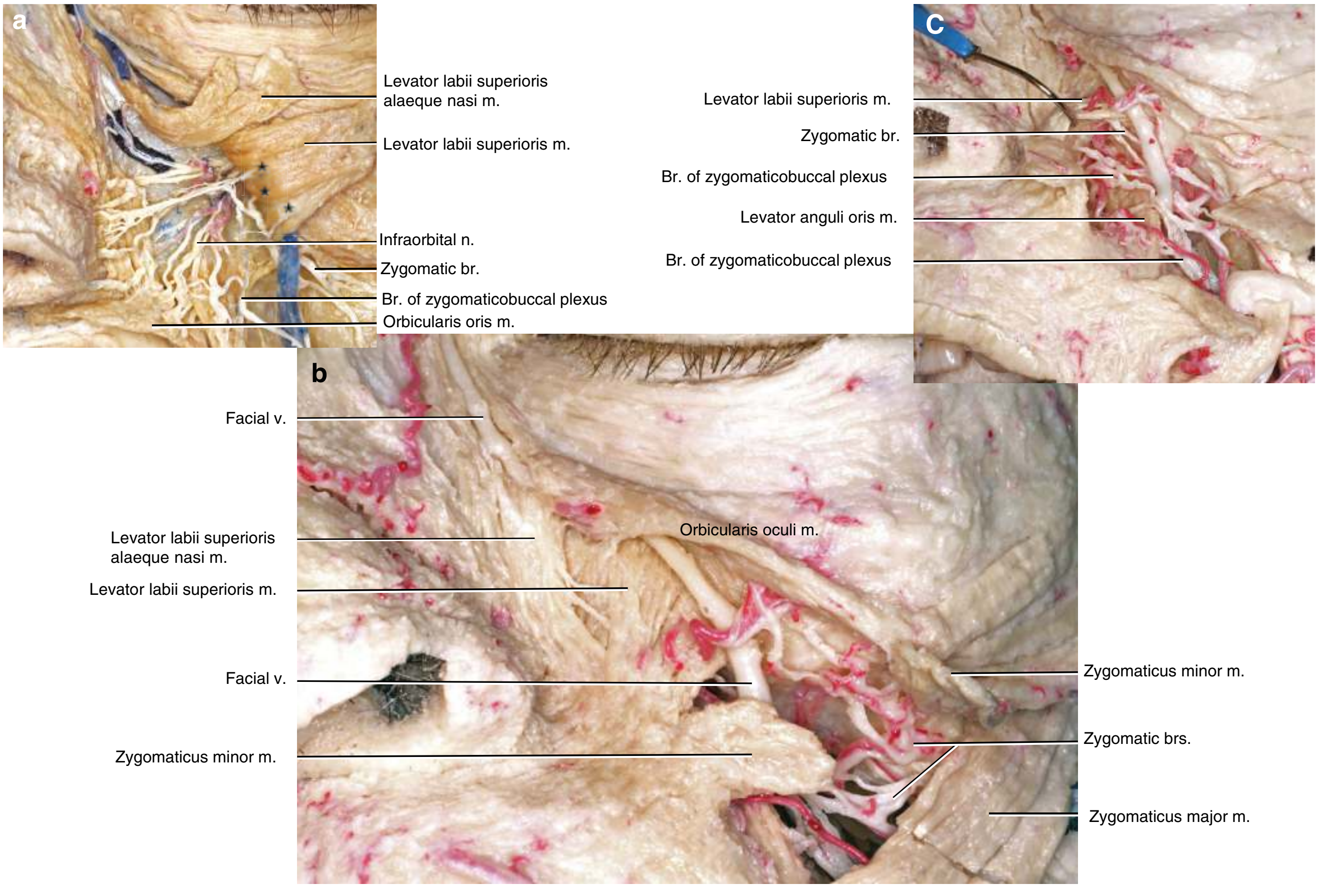


Fig. 8.13 (**a**–**c**) The infraorbital region. (**a**) The levator labii superioris and levator labii superioris alaeque nasi muscles have been detached and reflected. (**b**) The zygomaticus minor muscle has been transected and reflected. (**c**) The levator labii superioris muscle has been retracted medially

The levator labii superioris muscle arises from the maxilla at the infraorbital rim above the infraorbital foramen. The muscle extends downward and attaches to the perinasal musculature beneath and lateral to the levator labii superioris alaeque nasi muscle, which mingles with it. The muscle elevates and everts the upper lip. The levator labii superioris and the levator labii superioris alaeque nasi muscles have been detached and reflected to expose the deep surface of the muscles (Fig. 8.13a). The levator labii superioris muscle is innervated by the zygomatic branch and the branches of the zygomaticobuccal plexus from its deep surface (indicated by asterisks in Fig. 8.13a). The former component predominantly innervates the muscle in this specimen (Fig. 8.13a,c).

The zygomaticus minor muscle usually attaches to the lateral side of the levator labii superioris muscle attachment. The coalescence of the zygomatic branches and the branches of the zygomaticobuccal plexus passes under the levator labii superioris muscle and courses medially toward the lateral side of the nose. The orbicularis oris muscle of the upper lip is innervated from its surface by the branches of the zygomaticobuccal plexus that receive anastomotic branches from the infraorbital nerve (Fig. 8.13a).

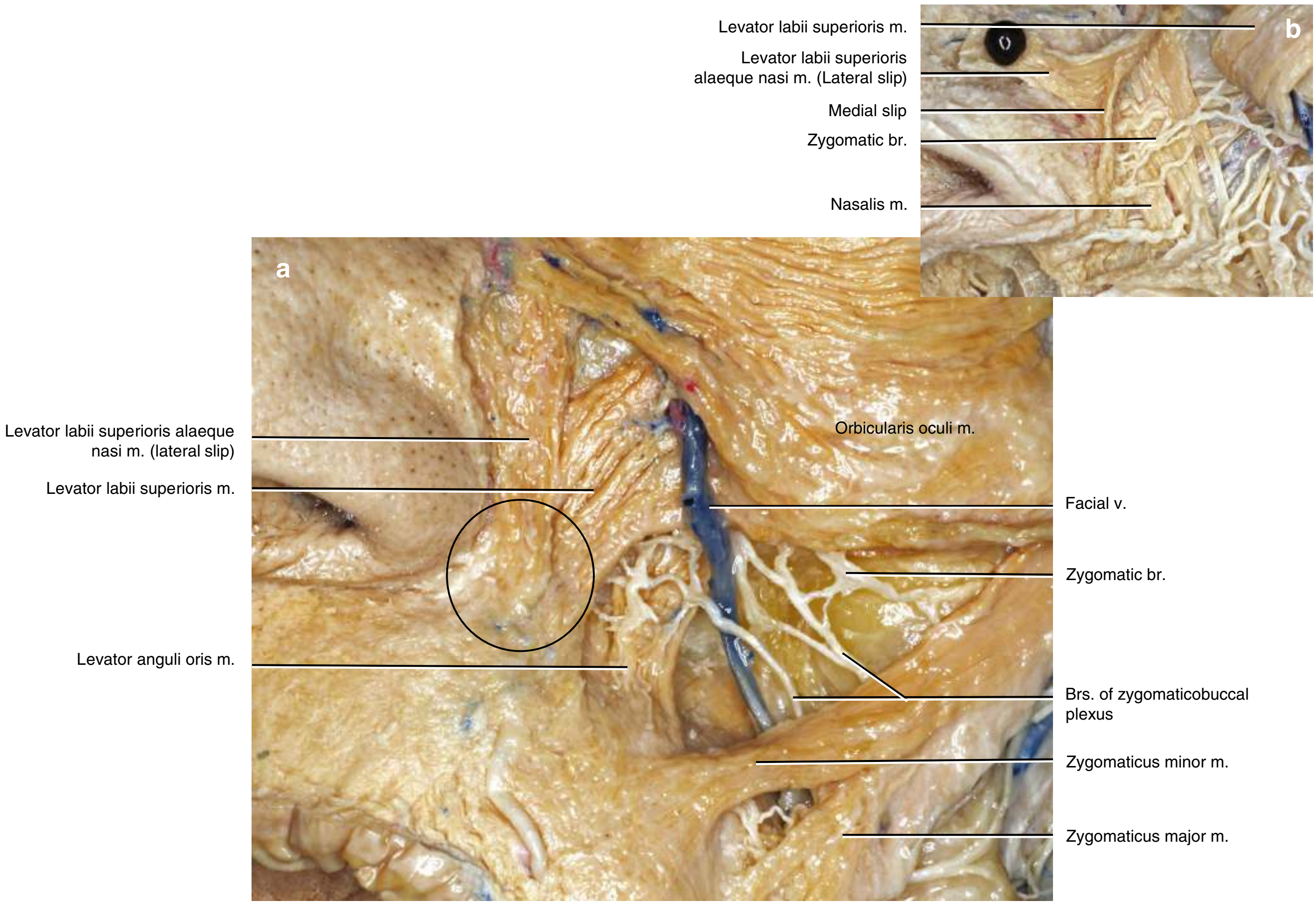


Fig. 8.14 (**a**, **b**) The infraorbital region. (**a**) The perinasal muscular confluence (black circle) is shown. (**b**) The lateral slip of the levator labii superioris alaeque nasi muscle has been reflected medially and the levator labii superioris muscle has been reflected laterally

The levator labii superioris alaeque nasi muscle arises from the frontal process of the maxilla. The muscle extends downward and divides into medial and lateral slips. The former inserts into the greater nasal cartilage and the latter into the upper lip perinasal muscular confluence (indicated by a black circle), where several mimetic muscles converge and interlace, a structure sometimes referred to in the literature as the perinasal modiolus due to its similarity in structure to the modiolus at the corner of the mouth. The lateral slip elevates the upper lip, and the nasal part dilates the nostril. The levator labii superioris alaeque nasi, levator labii superioris, zygomaticus minor, and levator anguli oris muscles elevate the upper lip and form the medial part of the nasolabial fold. The zygomaticus minor muscle usually attaches to the orbicularis oris muscle, adjacent to the attachment of the levator labii superioris muscle; however, the attachment is located at a distance from the perinasal muscular confluence in this specimen (Fig. 8.14a).

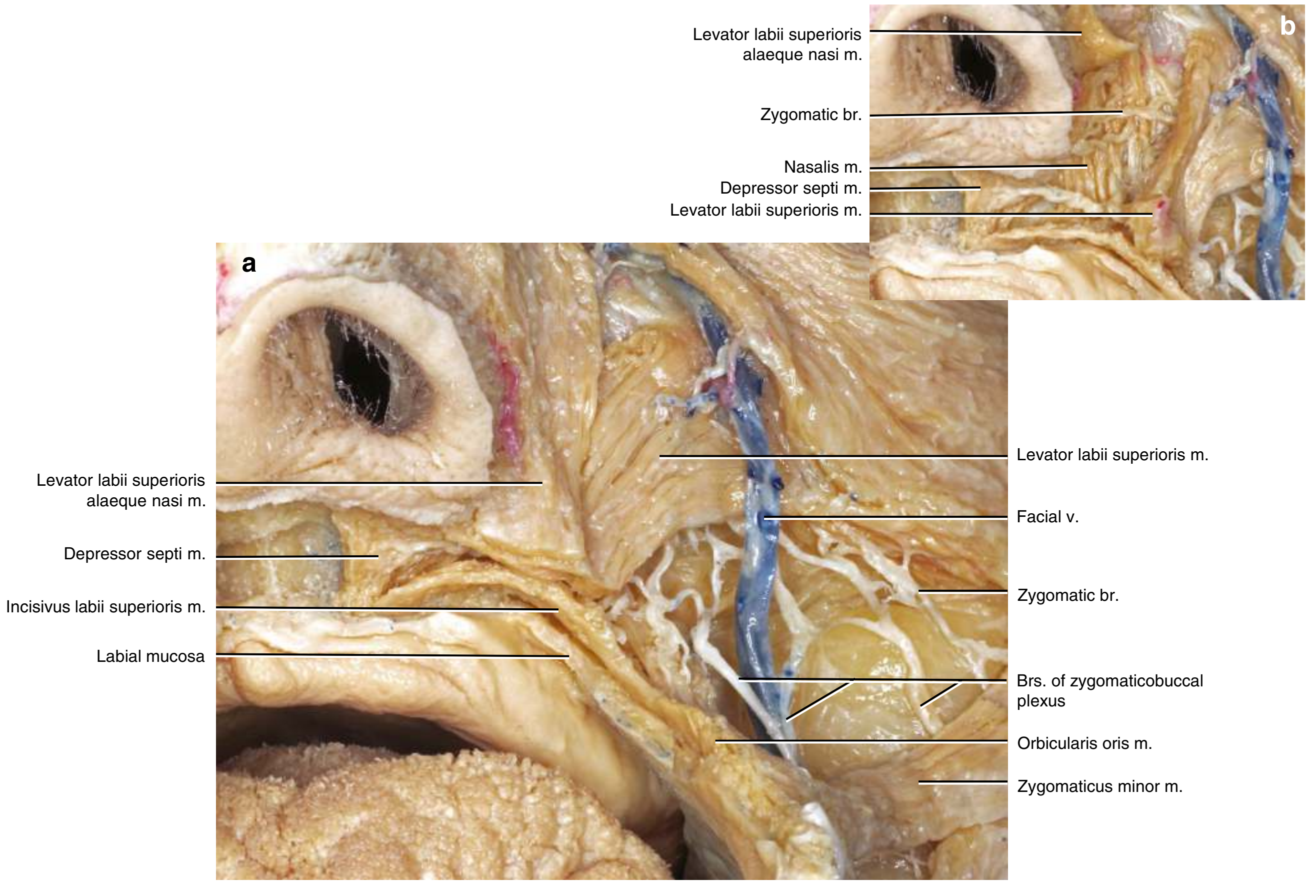


Fig. 8.15 (**a**, **b**) Close-up view of the perinasal muscular confluence. (**a**) The anterior view shows the perinasal muscular layers. (**b**) The levator labii superioris and levator labii superioris alaeque nasi muscles have been reflected to expose the nasalis muscle

The perinasal muscular confluence is composed of several mimetic muscles. The levator labii superioris alaeque nasi muscle is located in the superficial layer, mingled with the levator labii superioris muscle beneath. The orbicularis oris muscle lies under these muscles. The nasalis and depressor septi muscles arise from the maxilla in the deep layer and attach to the perinasal muscular confluence from below. The deeper muscles work against the lip levator muscles, fixing the alar base to the maxilla. The perinasal muscular confluence may be as essential for smiling as the modiolus at the corner of the mouth.

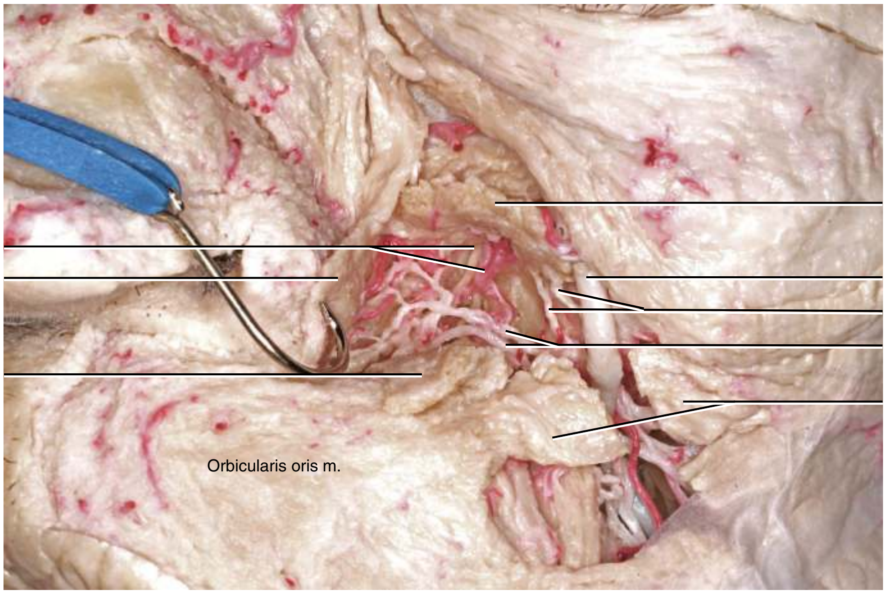


Fig. 8.16 The infraorbital region. The levator labii superioris muscle has been transected and reflected. The levator labii superioris alaeque nasi muscle has been reflected medially

The coalescence of the zygomatic branches and the branches of the zygomaticobuccal plexus innervates the levator labii superioris alaeque nasi muscle from its deep surface. The facial nerve branches course medially over the infraorbital nerve branches below the infraorbital foramen. The upper labial branches of the infraorbital nerve course inferiorly, and the nasal branches course inferomedially in the deep layer beneath the facial nerve branches.

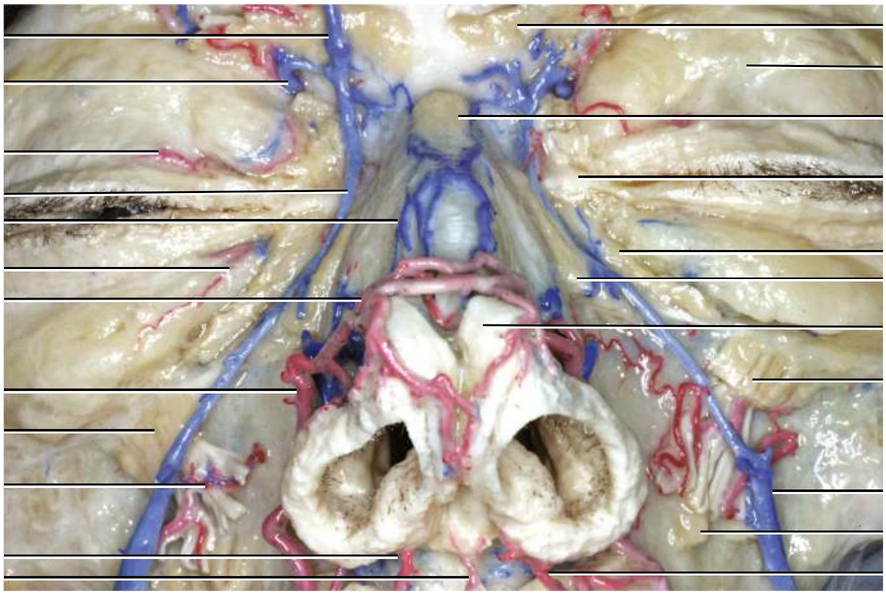


Fig. 8.17 Anterior view of the midfacial region. The attachments of the mimetic muscles and venous system are shown

The confluence of the supraorbital and supratrochlear veins in the medial eyelid area forms the angular vein. The angular vein becomes the facial vein at its junction with the superior labial vein, but the latter is not always present. The external nasal vein drains the external nose and empties into the angular or facial vein. The facial vein has venous valves at the level of the mandible. Communication between the facial vein and the cavernous sinus via the supratrochlear and superior ophthalmic veins exists. On the other hand, the infraorbital vein links the facial vein with the pterygoid venous plexus in the infratemporal fossa.

The septal and columellar arteries, which supply the nasal septum and columella, usually arise from the superior labial artery. The bilateral lateral nasal arteries form the alar arcade on the dorsum of the nose.

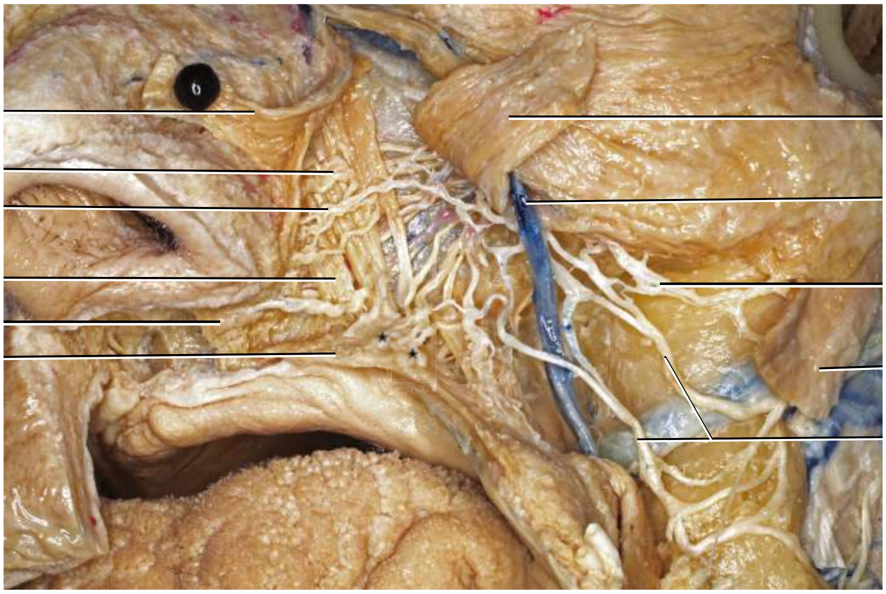


Fig. 8.18 The infraorbital region. The levator labii superioris muscle has been detached and reflected superiorly. The levator labii superioris alaeque nasi muscle has been detached and reflected medially

Interconnections between the facial and infraorbital nerves in the premaxillary region are shown. Three to four branches originating from the zygomatic branches and branches of the zygomaticobuccal plexus, with connecting branches among them, pass over the infraorbital nerves in the premaxillary area. There is a dense nerve anastomosis between the facial and the infraorbital nerves. The inferior branches of the facial nerve innervate the orbicularis oris muscle of the upper lip from its surface (indicated by asterisks). The superior branches innervate the zygomaticus minor, lower part of the orbicularis oculi, levator labii superioris, and the nasalis muscles in this specimen. The predominance of the superior or inferior component varies. The nasalis muscle is innervated from its surface.

The infraorbital nerve branches course deeper than the facial nerve branches. Internal nasal branches of the infraorbital nerve pass under the nasalis muscle, and external nasal branches pass over or through the nasalis muscle.

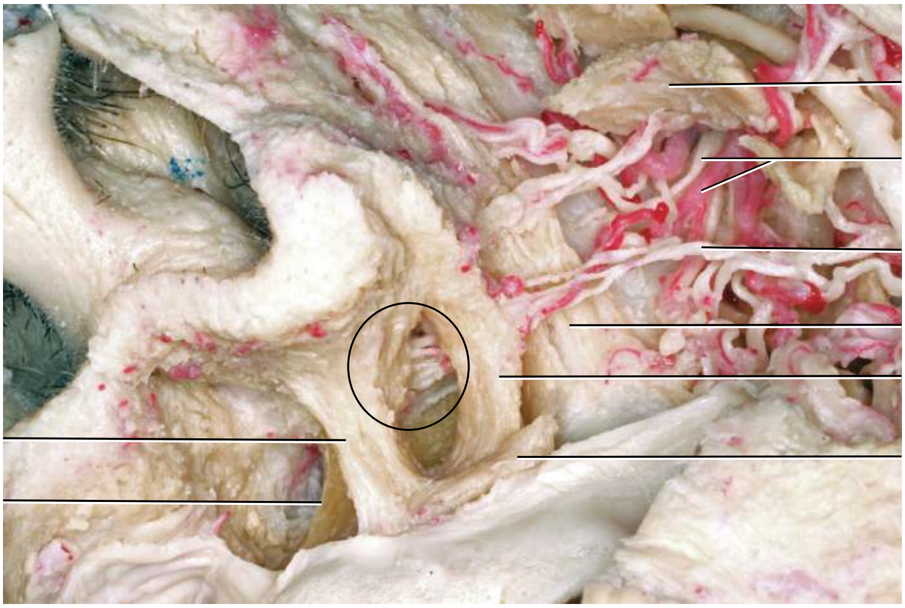


Fig. 8.19 Close-up view of the alar base. The origins of the alar and transverse parts of the nasalis muscle have been separated

The depressor septi muscle arises from the incisive fossa, medial to the origin of the incisivus labii superioris muscle. It extends upward to insert into the anterior nasal septum and attaches to the nostril floor. It pulls the nasal septum downward and constricts the nostril. One of the terminal branches of the coalescence of the zygomatic branches and the branches of the zygomaticobuccal plexus innervates the muscle from its deep posterior surface (indicated by a black circle).

The transverse part of the nasalis muscle arises from the canine eminence, while the alar part arises from the area adjacent to the origin of the transverse part, on the canine eminence. These muscle origins are conjoined. The transverse part inserts into the lateral nasal cartilage and passes over the dorsum of the nose to join the opposite side medially, mingling with the procerus superiorly. The alar part inserts into the greater alar cartilage. The former compresses the nasal aperture, and the latter draws the alar downward and laterally to dilate the nostrils. The branches of the coalescence of the zygomatic branches and the branches of the zygomaticobuccal plexus innervate these muscles. Facial nerve paralysis causes nasal obstruction due to the weakness of the nasalis and levator labii superioris alaeque nasi muscles.

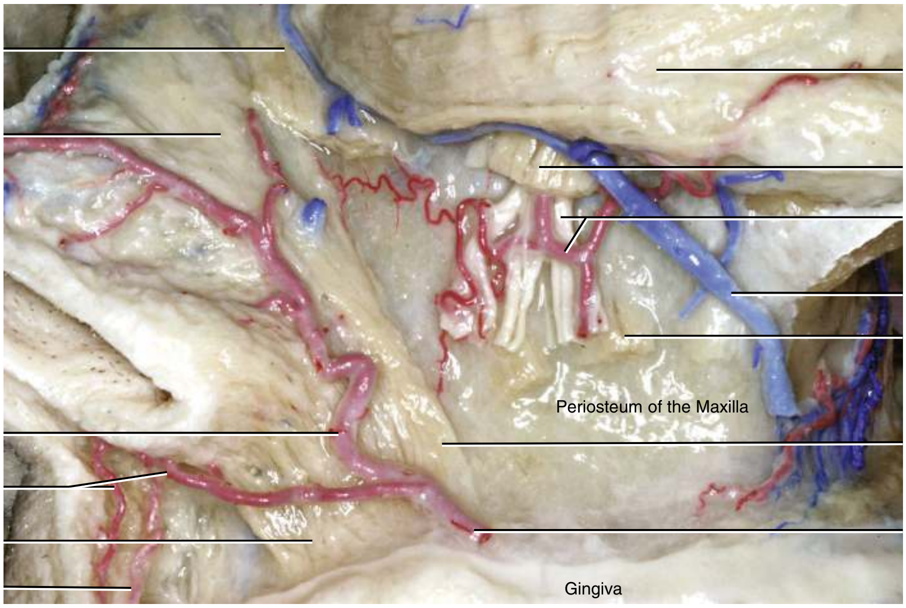
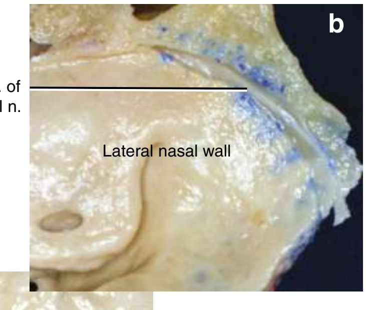


Fig. 8.20 The infraorbital region. The attachments of the levator muscles are shown. Note that the alar and transverse parts of the nasalis muscle are conjoined at their origin

The levator labii superioris muscle arises from the maxilla at the infraorbital rim, above the infraorbital foramen, and attaches to the perinasal muscular confluence. Its location is deep and lateral to the attachment of the levator labii superioris alaeque nasi muscle. The levator labii superioris alaeque nasi muscle arises from the frontal process of the maxilla and attaches to the alar cartilage and the perinasal muscular confluence. The levator anguli oris muscle arises from the canine fossa of the maxilla, immediately below the infraorbital foramen, and attaches to the corner of the mouth.

The infraorbital nerve emerges from the infraorbital foramen just below the origin of the levator labii superioris muscle. It divides into four branches: the inferior palpebral branch innervates the lower eyelid skin and conjunctiva; the external nasal branch innervates the lateral surface of the nose; the internal nasal branch innervates the nasal vestibule and nasal septum; and the superior labial branch innervates the upper lip skin and mucosa. The columellar artery arises from the superior labial artery and supplies the skin of the columella.



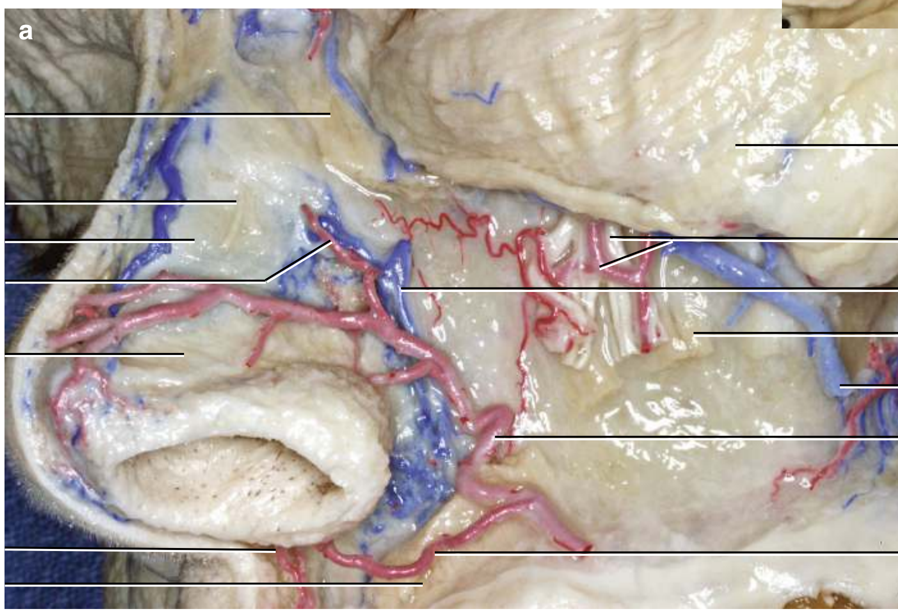


Fig. 8.21 (**a**, **b**) (**a**) The infraorbital region. The nasalis muscle has been removed to leave the attachment. (**b**) Medial view of the lateral nasal wall shows the external nasal nerve

The anterior ethmoidal nerve and artery enter the roof of the nasal cavity and give rise to lateral and medial internal nasal branches. The lateral internal nasal branch passes to the lateral wall of the nose, while the medial internal nasal branch passes to the nasal septum. These branches supply an area anterior to the nasal conchae and the anterior extremities of the middle and inferior conchae. The lateral internal nasal branch and its accompanying artery course under the surface of the nasal bone (Fig. 8.21b) and pass between the nasal bone and lateral nasal cartilage. When the anterior ethmoidal nerve and artery emerge at the inferior margin of the nasal bone, they become the external nasal nerve and artery, which supply the nasal tip except for the nasal alar region. The lateral nasal artery or superior labial artery gives off the septal artery to the nasal septum and terminates by communicating with the external nasal artery.

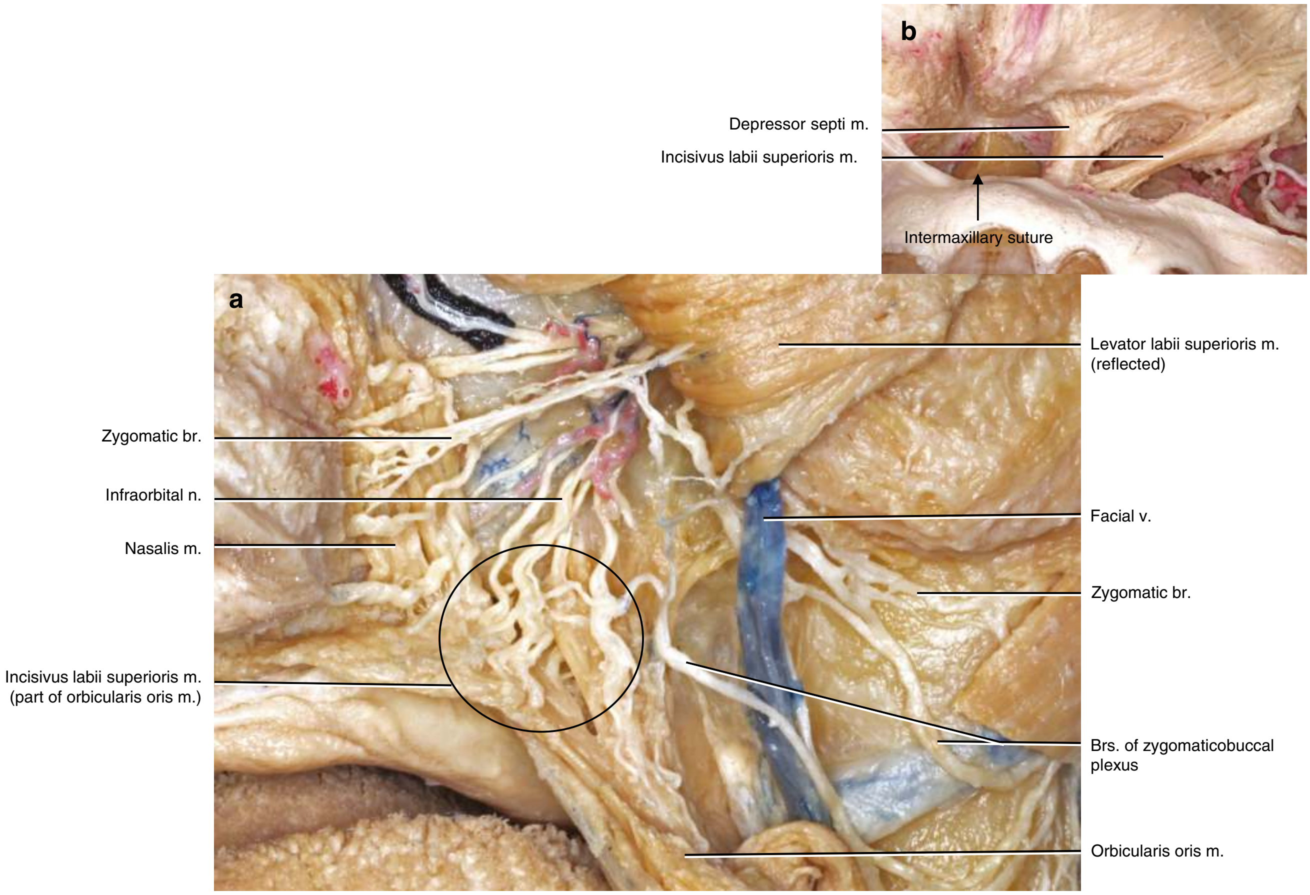


Fig. 8.22 (**a**, **b**) The infraorbital region. (**a**) Close-up view of the infraorbital region. (**b**) The incisivus labii superioris muscle is shown

The orbicularis oris muscle is a complex circular muscle in the lips that encircles the mouth. This muscle closes the mouth and puckers the lips when it contracts. The orbicularis oris muscle of the upper lip is innervated predominantly by the branches of the zygomaticobuccal plexus (indicated by a black circle in Fig. 8.22a), which interconnects with the infraorbital nerve. The incisivus labii superioris muscle arises from the incisive fossa of the maxilla. It lies adjacent to the depressor septi muscle at its origin and extends upward and laterally, blending with the orbicularis oris muscle (Fig. 8.22b). The incisivus labii superioris muscle is an accessory bundle of the orbicularis oris muscle. It draws the corner of the mouth medially.

9 Maxillary Region

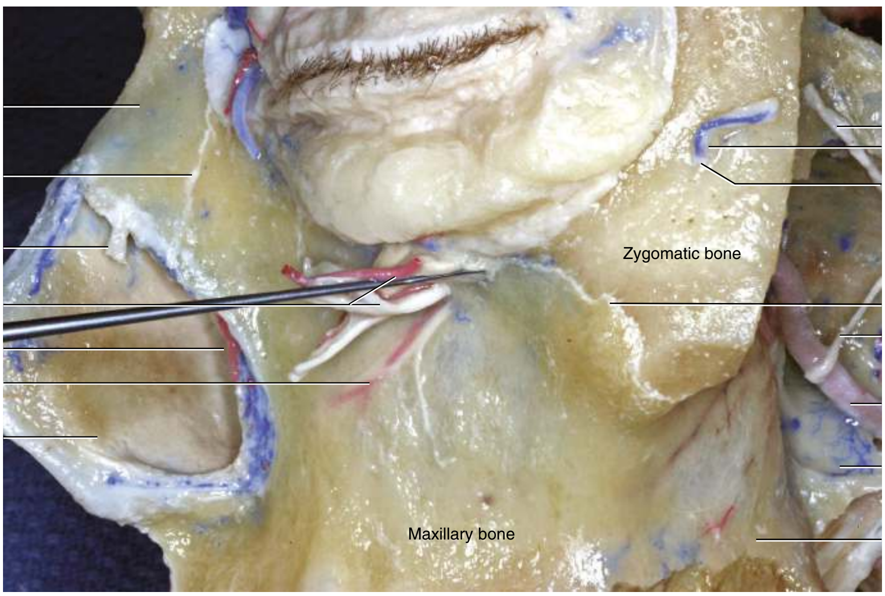


Fig. 9.1 Lateral view of the maxillary region. The mimetic muscles have been removed

The infraorbital and zygomaticofacial nerves pass through their respective foramina. The zygomaticofacial nerve supplies the skin over the prominence of the cheek.

The anterior superior alveolar nerve arises from the infraorbital nerve within the infraorbital canal, coursing within the bone of the anterior maxillary wall. It supplies the anterior third of one side of the teeth.

The middle superior alveolar nerve is an inconsistent branch that arises from the infraorbital or maxillary nerve. It supplies the sinus mucosa and the middle third of one side of the teeth when present. In most cases, it is nonexistent, and the posterior superior alveolar nerve alone innervates the posterior two-thirds of the teeth.

The infraorbital artery arises from the pterygopalatine segment of the maxillary artery. It enters the orbit through the inferior orbital fissure. It passes on the floor of the orbit in the infraorbital groove and canal to emerge onto the face at the infraorbital foramen.

The anterior superior alveolar artery arises from the infraorbital artery within the canal. It supplies the anterior teeth and the anterior part of the maxillary sinus.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_9

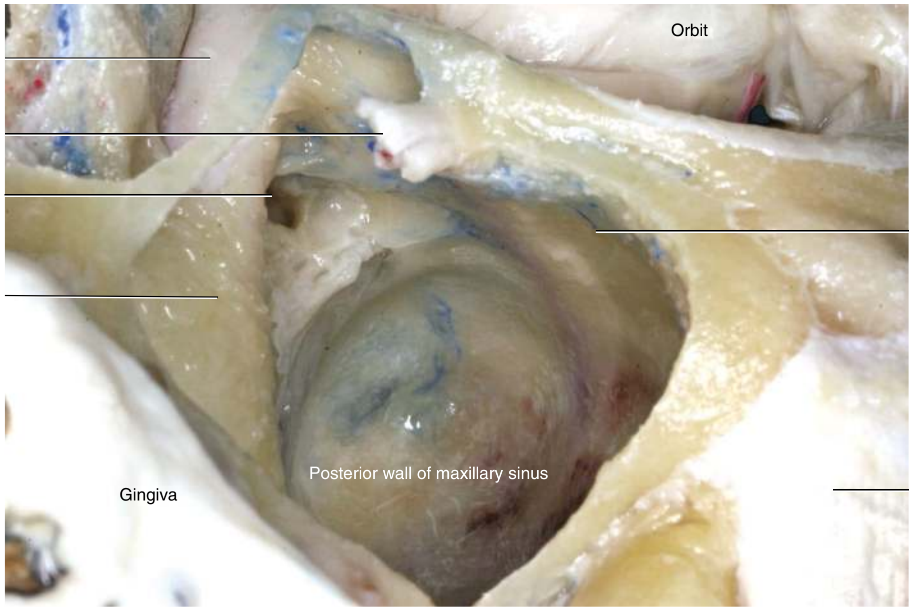


Fig. 9.2 Anterior view of the maxillary region. The anterior wall of the maxilla has been removed to expose the sinus and nasolacrimal duct

The infraorbital nerve and vessels pass on the roof of the maxillary sinus. The maxillary ostium is seen in a high position behind the nasolacrimal duct on the medial wall of the sinus. An accessory ostium is sometimes present behind the major ostium.

The innervation of the maxillary sinus is derived from the maxillary nerve via its infraorbital and anterior, middle, and posterior superior alveolar nerves.

The bony canal for the nasolacrimal duct has been partially opened to expose the nasolacrimal duct. The duct forms the nasolacrimal torus on the medial wall of the maxillary sinus.

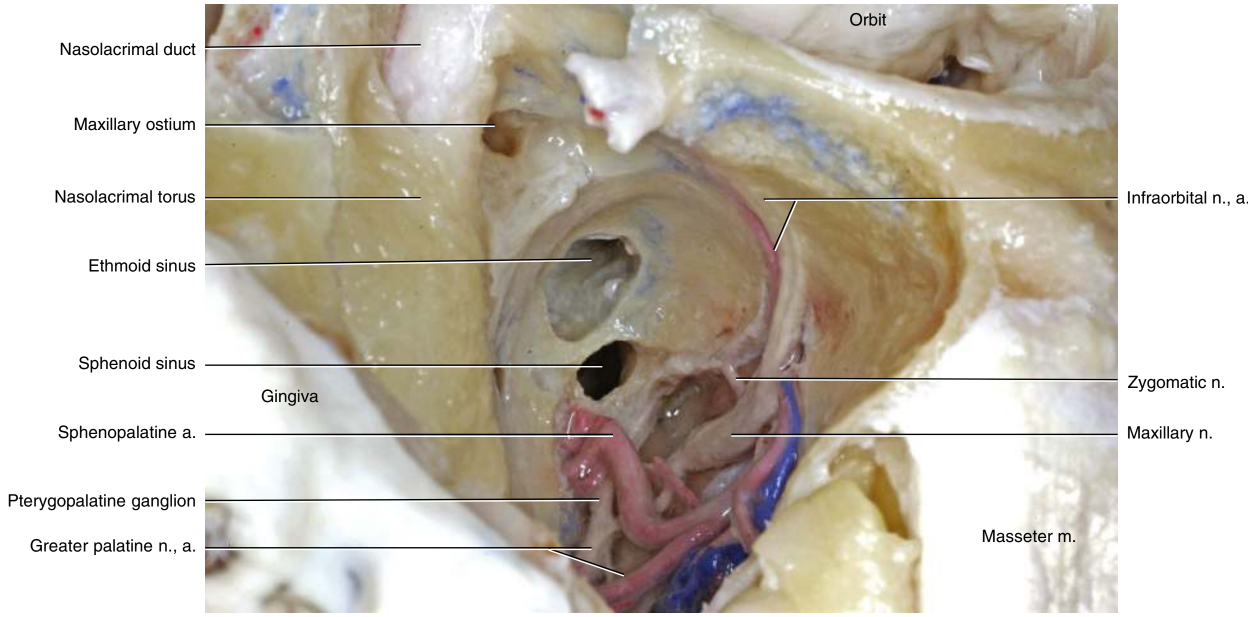


Fig. 9.3 Anterior view of the maxillary region. The posterior and medial walls of the maxillary sinus have been opened

The ethmoid and sphenoid sinuses have been opened through the medial wall of the maxillary sinus. The infraorbital nerve and vessels are exposed by removing the bony roof of the maxillary sinus.

The sphenopalatine artery enters the lateral wall of the nose through the sphenopalatine foramen. The artery accompanies the posterior superior nasal nerve, supplying the posterior part of the lateral nasal wall, and then crosses the roof of the nasal cavity, accompanying the nasopalatine nerve to supply the posterior-inferior part of the nasal septum.

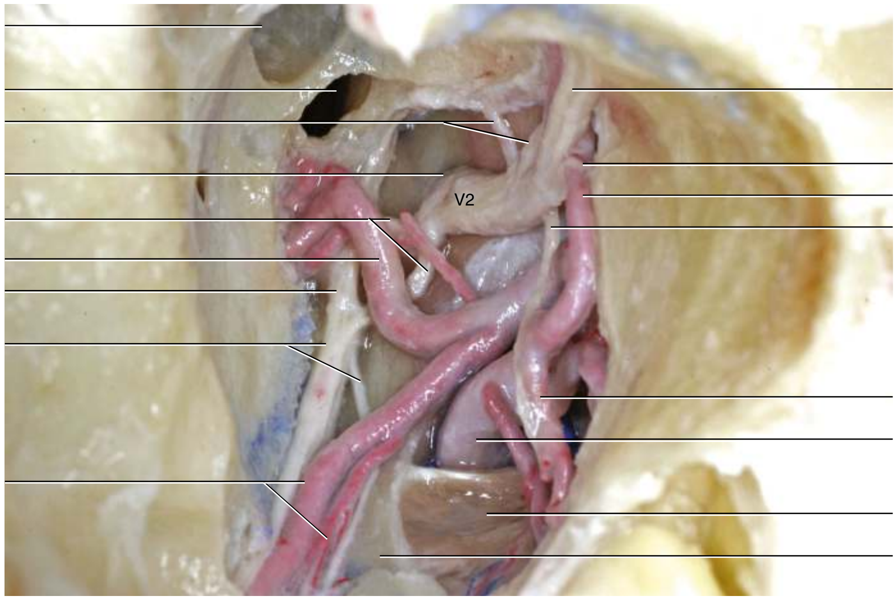


Fig. 9.4 Anterior view of the maxillary region. The veins have been removed

The pterygopalatine ganglion is a parasympathetic ganglion found in the pterygopalatine fossa primarily innervated by the greater superficial petrosal nerve. It is situated just below the maxillary nerve. The ganglionic branches, usually two in number, connect the maxillary nerve to the pterygopalatine ganglion. The pterygopalatine ganglion supplies the lacrimal gland, paranasal sinuses, glands of the mucosa of the nasal cavity, and the mucous membrane and glands of the hard palate.

The pterygopalatine fossa contains the blood vessels and nerves supplying the nose, palate, and maxilla: the maxillary division of the trigeminal nerve, which passes through the foramen rotundum; the nerve of the pterygoid canal and accompanying vessels, which pass through the pterygoid canal; the nasopalatine and posterior superior nasal nerves and the sphenopalatine vessels, which pass through the sphenopalatine foramen; and the greater and lesser palatine nerves, together with accompanying vessels, which pass through the greater and lesser palatine foramina. The pharyngeal branch of the pterygopalatine ganglion passes through the palatovaginal canal to supply the nasopharyngeal mucosa.

The nasopalatine nerve and sphenopalatine vessels enter the nasal cavity through the sphenopalatine foramen and course across the roof of the nasal cavity to reach the nasal septum and supply the posteroinferior part of the nasal septum.

The zygomatic nerve arises from the maxillary nerve in the pterygopalatine fossa. It passes through the inferior orbital fissure to course along the lateral wall of the orbit, where it divides into zygomaticofacial and zygomaticotemporal nerves. The zygomatic nerve carries sensory fibers from the cheek and temporal skin.

The third segment of the maxillary artery is the pterygopalatine segment. It has five branches: the posterior superior alveolar artery, infraorbital artery, artery of the pterygoid canal, descending palatine artery, and sphenopalatine artery.

Fig. 9.5 Inferior view of the palate. The palatal mucosa has been removed on the right side. The soft palate has been removed on the left side

The greater and lesser palatine nerves and arteries pass from the pterygopalatine fossa down the greater palatine canal at the back of the lateral wall of the nose. The greater palatine nerve and artery descend through the greater palatine foramen to reach the back of the hard palate. They course toward the front of the hard palate, supplying the palatal mucosa and palatal gingiva. Within the greater palatine canal, the nerve and artery give off nasal branches that innervate the posteroinferior part of the lateral wall of the nasal cavity. The lesser palatine nerve and artery emerge from the lesser palatine foramina onto the palate and course back into the soft palate.

The nasopalatine nerve terminates as the incisive nerve, which passes through the incisive canal onto the hard palate with its accompanying artery to supply the oral mucosa around the incisive papilla. It communicates with the corresponding nerve of the opposite side and the greater palatine nerve.

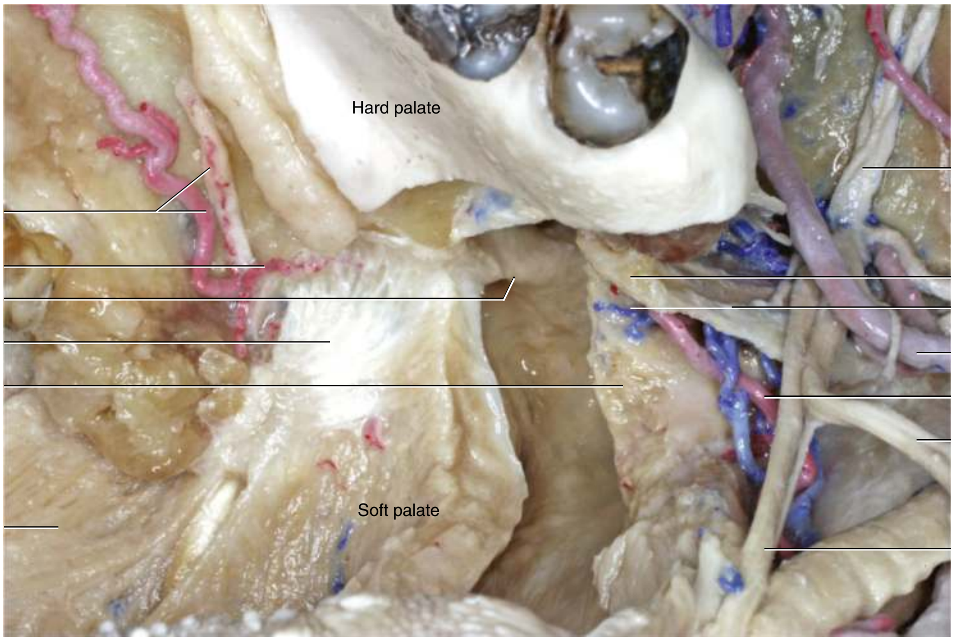


Fig. 9.6 Inferolateral view of the palate. The levator and tensor veli palatini muscles are shown on the left side

The tensor veli palatini muscle arises from the scaphoid fossa of the sphenoid bone (at the root of the pterygoid plate) and the lateral side of the cartilaginous part of the Eustachian tube. The fibers converge toward the pterygoid hamulus, where the muscle becomes tendinous. The tendon bends at right angles around the hamulus to become the palatine aponeurosis. The aponeurosis is attached to the posterior border of the hard palate. This muscle pulls the soft palate laterally and is innervated by a branch of the mandibular nerve via the nerve to the medial pterygoid muscle.

The levator veli palatini muscle arises from the base of the skull at the apex of the petrous part of the temporal bone and the medial side of the cartilaginous part of the Eustachian tube. The muscle curves downward, medially, and forward to enter the palate immediately below the opening of the Eustachian tube. This muscle produces upward and backward movement of the soft palate. The vagus nerve innervates this muscle via the pharyngeal plexus.

The ascending palatine artery arises from the facial artery in the neck. It divides near the levator veli palatini muscle into two branches. One branch supplies and courses along this muscle, winding over the upper border of the superior pharyngeal constrictor to supply the soft palate and the palatine glands. The other branch pierces the superior pharyngeal constrictor to supply the palatine tonsil and the Eustachian tube, anastomosing with the tonsillar branch of the facial artery and the ascending pharyngeal artery.

10 Masseteric Region

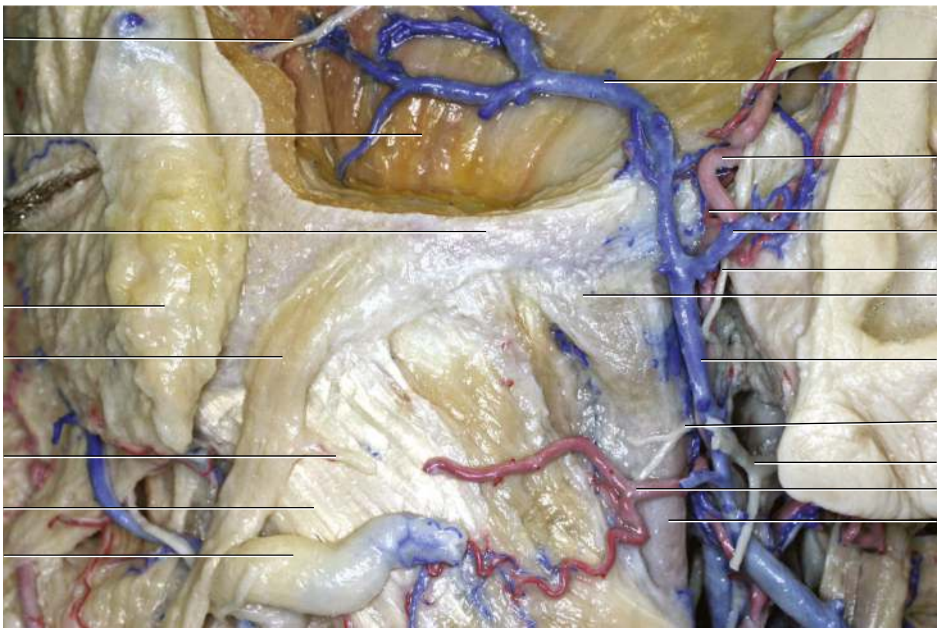


Fig. 10.1 Lateral view of the masseteric region. The parotid gland and the facial nerve branches have been removed

The zygomaticus major muscle, masseter muscle, temporal fascia, and lateral ligament attach to the zygomatic arch.

The origin of the zygomaticus major muscle is the subzygomatic fossa, which is posterior and inferior to the malar eminence and anterior to the zygomaticotemporal suture. The subzygomatic fossa is an easily palpable landmark.

The retromandibular vein usually divides into anterior and posterior branches near the lower border of the parotid gland. Outside the gland, the anterior branch joins the facial vein to form the common facial vein. The posterior branch unites with the posterior auricular vein to form the external jugular vein. The common facial vein drains into the internal jugular vein.

The temporomandibular joint has one major ligament, the temporomandibular ligament, also termed the lateral ligament. This ligament is the thickened lateral portion of the capsule. It has two parts: an outer oblique and an inner horizontal portion. The base of this triangular ligament is attached to the zygomatic process of the temporal bone and the articular tubercle. Its apex is attached to the lateral side of the neck of the mandible.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_10

Fig. 10.2 Lateral view of the masseteric region. The superficial part of the masseter muscle has been reflected inferiorly

The masseter muscle is one of the muscles of mastication. It is quadrilateral in shape and consists of three layers. The layers are fused anteriorly but diverge posteriorly. The most pronounced layer is the superficial layer. It arises from the anterior two-thirds of the inferior border of the zygomatic arch up to the zygomatic process of the maxilla. Initially, it is aponeurotic and passes obliquely in an inferomedial direction. It inserts into the inferior border of the external surface of the angle of the mandible. Its insertion extends anteriorly to the junction of the ramus with the body of the mandible.

The chief muscles of mastication are the temporalis, masseter, medial pterygoid, and lateral pterygoid muscles. The first three muscles raise the mandible against the maxilla with great force. The lateral pterygoid muscle assists in opening the mouth, but its main action is to draw the condyle and articular disc forward so that the mandible protrudes and the inferior incisors project in front of the upper incisors. The medial pterygoid muscle assists in this action. The posterior fibers of the temporalis muscle retract the mandible. If the medial and lateral pterygoid muscles of one side contract, the corresponding side of the mandible is drawn forward, while the opposite condyle remains comparatively fixed, creating side-to-side movement.

Transferring functionally innervated musculature into the face offers the possibility of restoring meaningful facial movement. The temporalis and masseter muscles are used for dynamic facial reanimation.

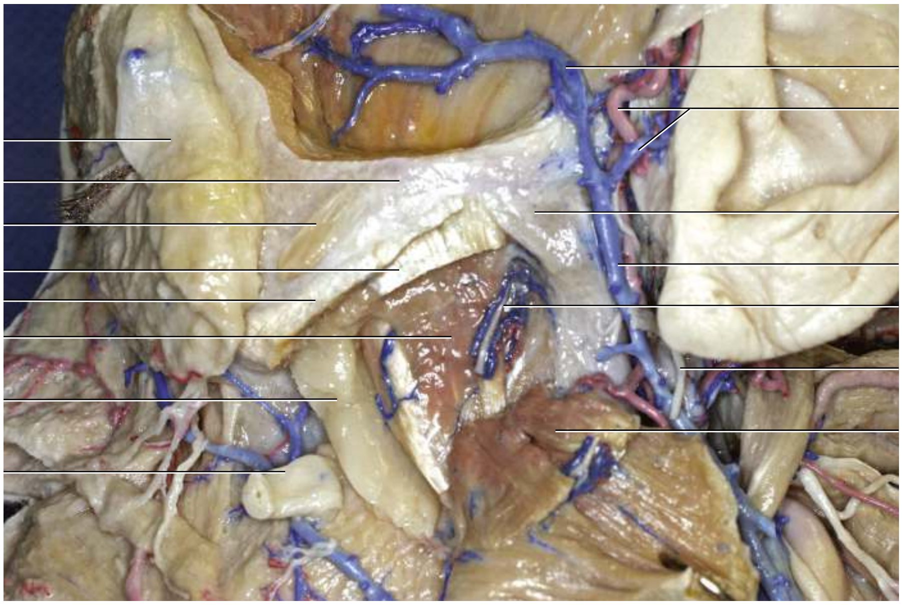


Fig. 10.3 Lateral view of the masseteric region. The middle part of the masseter muscle has been reflected inferiorly

After passing the mandibular notch, the masseteric nerve and vessels course anteroinferiorly on the deep part of the masseter muscle. The middle part of the masseter muscle arises from the middle third of the zygomatic arch. It blends with the superficial part at the mandibular insertion and anteriorly. The posterior divergence of fibers between the superficial and deep parts of the masseter muscle permits the entry of its blood supply—the masseteric artery—which is a branch of the maxillary artery. The deep part of the masseter muscle has a similar course to the middle part but is separated from it by the masseteric nerve. Similar to the artery, the nerve enters posteriorly where the layers diverge. The masseteric artery is a branch of the pterygoid segment of the maxillary artery, and it courses close to the masseteric nerve as it descends anteroinferiorly through the masseter muscle.

Fig. 10.4 Lateral view of the masseteric region. Every part of the masseter muscle has been reflected inferiorly

The upper border of the ramus of the mandible is thin. It is surmounted by two processes: the coronoid process anteriorly and the condylar process posteriorly. These processes are separated by a deep concavity, the mandibular or sigmoid notch, which allows the passage of the masseteric nerve, artery, and vein.

The masseteric nerve leaves the infratemporal fossa through the mandibular notch. At this level, the nerve may have one or more branches. There are several intraoperative landmarks used to identify the masseteric nerve. The mandibular notch is a palpable and reliable bony landmark for identifying the masseteric nerve. The nerve is located just above the notch on the deep part of the masseter muscle. The masseteric nerve is a potential source of axons for facial reinnervation. The nerve is used for facial reanimation by connecting to the zygomatic branches that control the movement of the smile or as a donor nerve for a free functional muscle transfer. Severing the nerve at this level results in approximately 30% muscle volume reduction due to muscle atrophy.

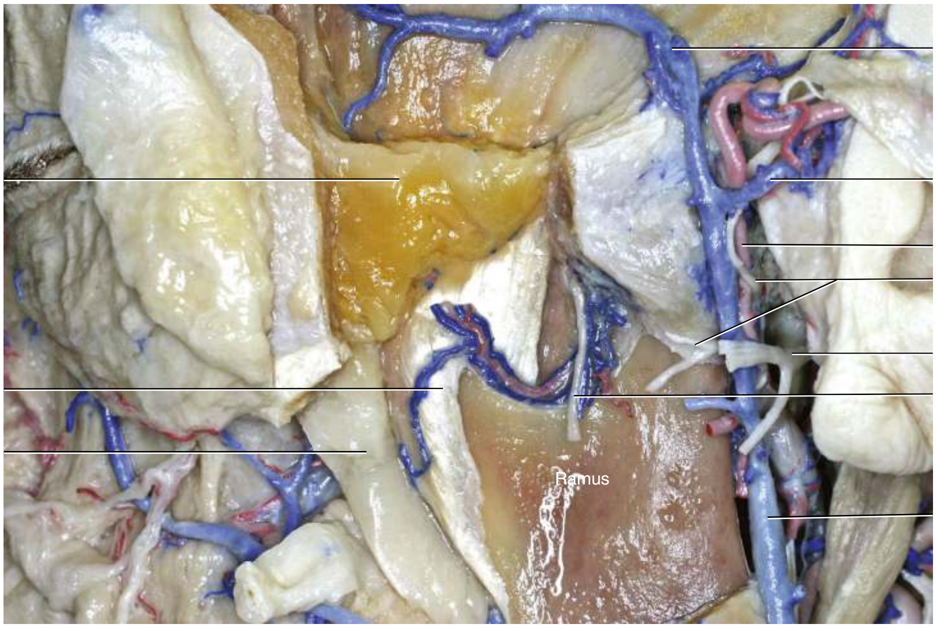


Fig. 10.5 Lateral view of the masseteric region. The zygomatic arch has been removed

The buccal fat pad is located superficial to the buccinator muscle at the anterior edge of the masseter muscle and provides fullness to the cheek inferior to the malar prominence. It has three main extensions: buccal, pterygoid, and temporal. These extensions are each contained within a separate capsule. The role of this fat pad is believed to be providing a surface for the gliding motion of the muscles of mastication. The temporal extension of the buccal fat pad is identical to the deep temporal fat pad, which lies between the temporalis muscle and the deep layer of the temporal fascia.

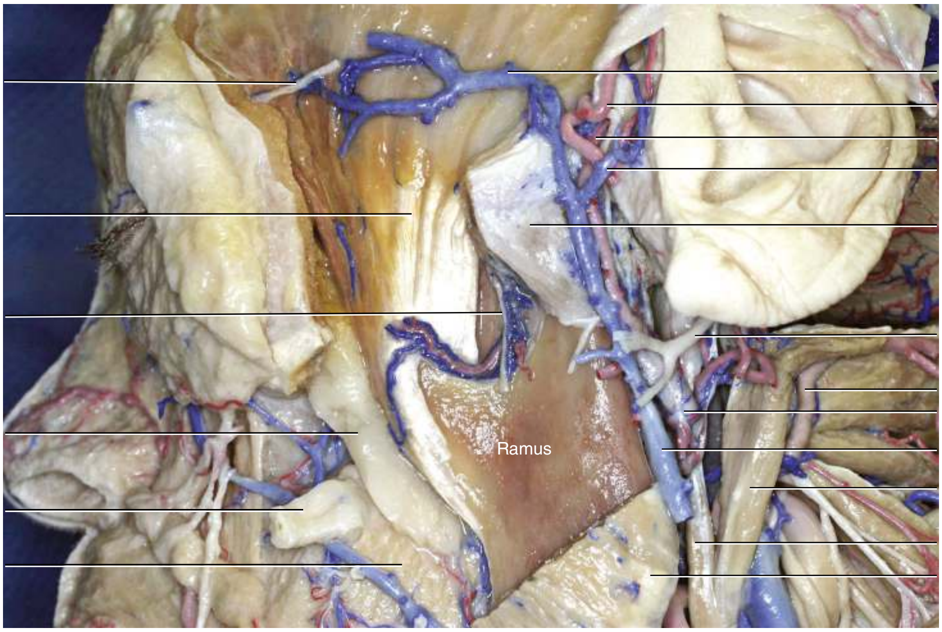


Fig. 10.6 Lateral view of the masseteric region. The deep fat pad has been removed

The temporalis muscle arises from the floor of the temporal fossa and the overlying temporal fascia. The fibers converge toward their insertion onto the apex, the anterior and posterior borders, the medial surface of the coronoid process, and the anterior border of the ramus almost reaching the third molar tooth. Many of the fibers have a tendinous insertion. The anterior (vertical) fibers of the temporalis muscle elevate the mandible, and its posterior (horizontal) fibers retract it. The temporalis muscle is an alternative muscle for the reanimation of the smile. It can support the oral commissure and provide trigeminally controlled dynamic movement.

The middle temporal artery arises immediately above the zygomatic arch as a branch of the superficial temporal artery, then perforates the temporal fascia, and gives off branches to the temporalis muscle, anastomosing with the deep temporal artery. It supplies the posterior and upper parts of the temporalis muscle.

Deep Structures in the Midfacial Region

11

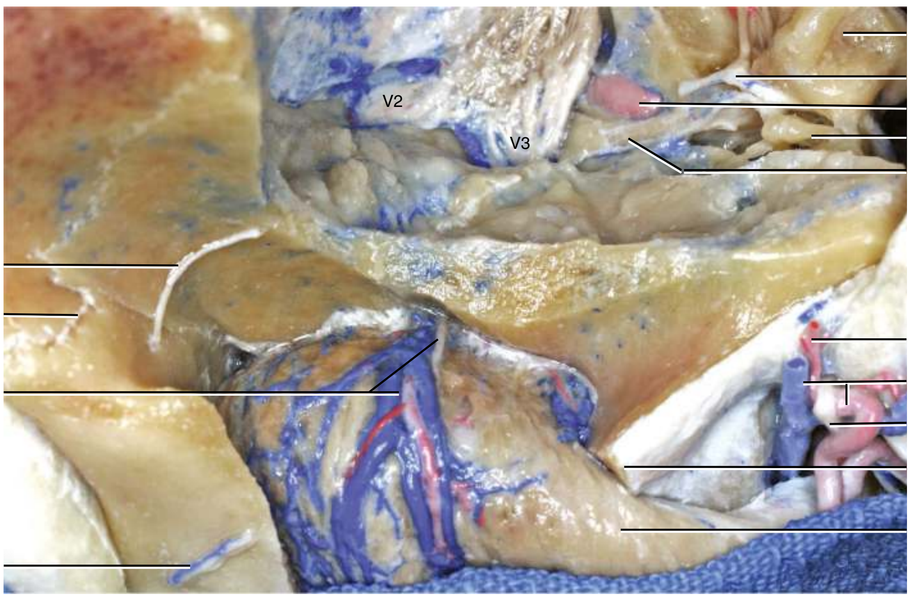


Fig. 11.1 Superior view of the middle cranial fossa and temporal fossa

The neurovascular bundle of the temporalis muscle is shown on its deep surface. Dissection of the muscle from the temporal bone can lead to muscle atrophy due to damage to its motor nerves.

The zygomaticotemporal nerve is a terminal branch of the maxillary division of the trigeminal nerve. The zygomatic nerve enters the orbit through the inferior orbital fissure, where it divides into the zygomaticotemporal and zygomaticofacial nerves along the lateral wall of the orbit. The zygomaticotemporal nerve passes through the foramen in the lateral orbital wall into the temporal fossa. It then penetrates the temporalis muscle and the temporal fascia to reach the skin. This nerve provides sensation to the temporal skin.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_11

Fig. 11.2 Superior view of the middle cranial fossa after bone removal

The buccal and the anterior deep temporal nerves usually pass between the upper and lower heads of the lateral pterygoid muscle. In contrast, the middle and posterior deep temporal nerves and the masseteric nerve pass over the upper head of the muscle. The temporalis muscle is primarily innervated by the deep temporal nerves, which arise from the anterior division of the mandibular nerve. Typically, there are two deep temporal nerves (anterior and posterior), but occasionally, a third may be present.

Three main arteries supply the temporalis muscle: the anterior and posterior deep temporal arteries and the middle temporal artery. The anterior deep temporal artery, which arises from the pterygoid segment of the maxillary artery, enters the anterior portion of the muscle and supplies about 30% of the muscle. The posterior deep temporal artery, which arises from the same segment of the maxillary artery, enters the central part of the muscle and supplies about 50% of it. The middle temporal artery, which arises from the superficial temporal artery, supplies the temporal fascia and approximately 20% of the posterior and upper parts of the temporalis muscle.

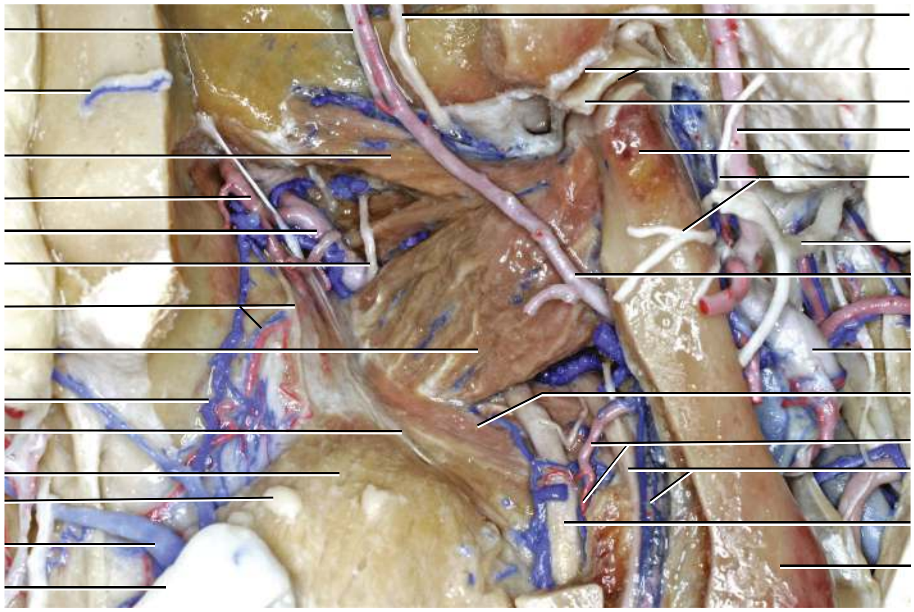


Fig. 11.3 Lateral view of the infratemporal fossa. The temporalis muscle and the coronoid process have been removed to expose the infratemporal fossa

The lingual nerve is a branch of the posterior trunk of the mandibular nerve. It is a sensory nerve. It emerges from the inferior border of the lateral pterygoid muscle and curves downward and forward in the space between the ramus of the mandible and the medial pterygoid muscle.

The maxillary artery arises from the external carotid artery as a terminal branch at the level of the posterior border of the mandibular neck. It is divided into three segments. The first segment, the mandibular segment, lies behind the mandible and passes horizontally between the neck of the mandible and the sphenomandibular ligament. This segment has five branches: the deep auricular, anterior tympanic, middle meningeal, accessory meningeal, and inferior alveolar arteries, all of which enter the bone.

The inferior alveolar artery and vein descend downward and forward to join the inferior alveolar nerve. The artery, vein, and nerve descend to the mandibular foramen on the medial surface of the ramus of the mandible and pass along the mandibular canal in the substance of the bone. Opposite the first premolar tooth, they divide into two branches: the incisor and mental branches.

The temporomandibular joint (TMJ) is formed by the condyle of the mandible articulating in the mandibular (glenoid) fossa of the temporal bone. The joint cavity is divided into two by an intra-articular disc, whose margins merge with the joint capsule. The TMJ is a hinge joint; however, it also allows for some gliding movements. Sensory innervation of the temporomandibular joint is provided by the auriculotemporal nerve, the articular branch of the masseteric nerve, and the deep temporal nerves.

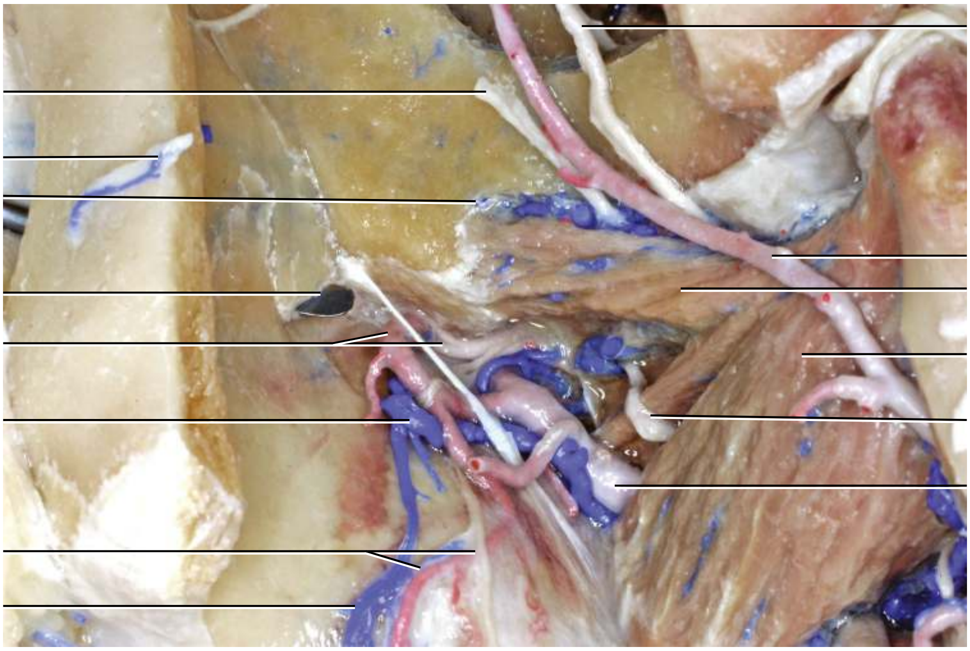


Fig. 11.4 Lateral view of the infratemporal fossa. The probe passes through the inferior orbital fissure

The lateral pterygoid muscle extends in a horizontal plane and occupies most of the infratemporal fossa. It has two heads: a smaller upper infratemporal head and a lower pterygoid head. The infratemporal head arises from the lateral surface of the greater sphenoid wing and the infratemporal crest of the sphenoid bone. It extends parallel to the floor of the middle cranial fossa and merges posteriorly with the pterygoid head. The pterygoid head arises from the lateral surface of the lateral pterygoid plate and extends upward and laterally. Both heads attach to a depression at the anterior aspect of the neck of the mandible. The muscle assists in opening the jaws by pulling the mandibular condyle and articular disc of the temporomandibular joint forward. The mandibular nerve innervates the muscle.

The posterior superior alveolar artery arises from the maxillary artery (pterygopalatine segment), frequently in conjunction with the infraorbital artery, just as the maxillary artery passes into the pterygopalatine fossa. It courses onto the maxillary tuberosity and supplies the maxillary molar and premolar teeth through the alveolar canal, their buccal gingiva, and the maxillary sinus. The posterior superior alveolar vein drains into the pterygoid venous plexus or the maxillary vein.

The inferior orbital fissure transmits the maxillary nerve and its zygomatic branch, the infraorbital vessels, ascending branches from the pterygopalatine ganglion, and a vein that connects the inferior ophthalmic vein with the pterygoid venous plexus. The orbitalis muscle (Müller's muscle) occupies the lateral part of the inferior orbital fissure and forms a lamina of smooth muscle fibers that cover the inferior orbital fissure. The orbitalis muscle is a rudimentary smooth muscle that crosses from the infraorbital groove and sphenomaxillary fissure and unites with the periosteum of the orbit. It lies at the back of the orbit and spans the infraorbital fissure.

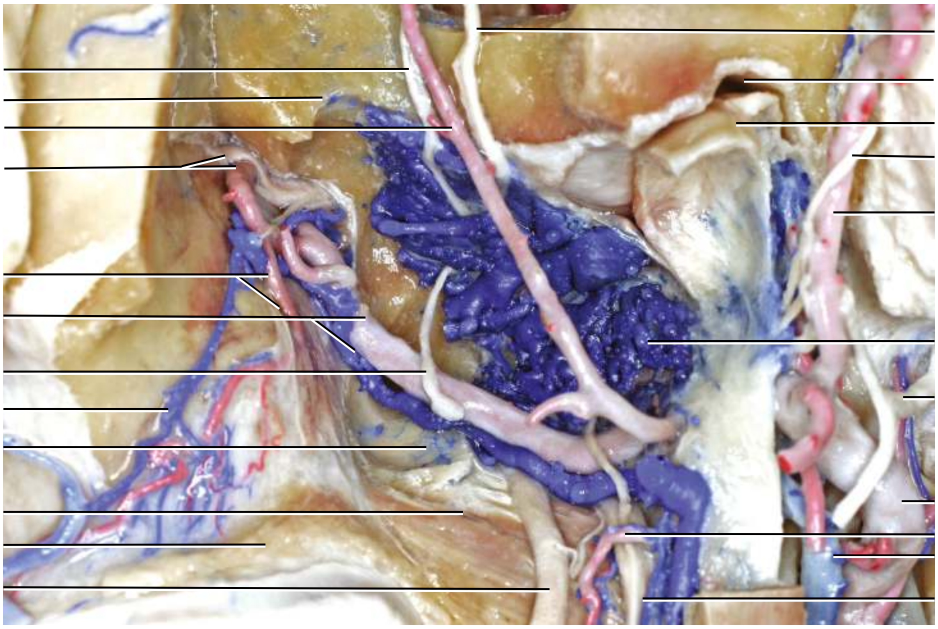


Fig. 11.5 Lateral view of the infratemporal fossa. The condylar process and lateral pterygoid muscle have been removed

The medial pterygoid muscle arises from the medial surface of the lateral pterygoid plate in the pterygoid fossa. Its fibers pass inferiorly to attach to the medial surface of the ramus and the angle of the mandible. It elevates the mandible.

The pterygoid segment, the second segment of the maxillary artery, is related to the pterygoid head of the lateral pterygoid muscle. It passes between the infratemporal and pterygoid heads of the lateral pterygoid muscle or laterally to the pterygoid head of the lateral pterygoid muscle. It has five branches: the deep temporal (anterior and posterior), pterygoid, masseteric, and buccal arteries, as well as a small lingual branch.

The pterygoid venous plexus has superficial and deep components. The latter is more prominent and is located between the lateral and medial pterygoid muscles, posterior to the lateral pterygoid plate, and around the lingual and inferior alveolar nerves. It communicates with the cavernous sinus; the facial, retromandibular, and inferior ophthalmic veins; and the pharyngeal plexus. The primary drainage of the pterygoid venous plexus is posteriorly through the retromandibular vein via the maxillary vein. The deep facial vein connects the facial vein with the pterygoid venous plexus in the infratemporal fossa.

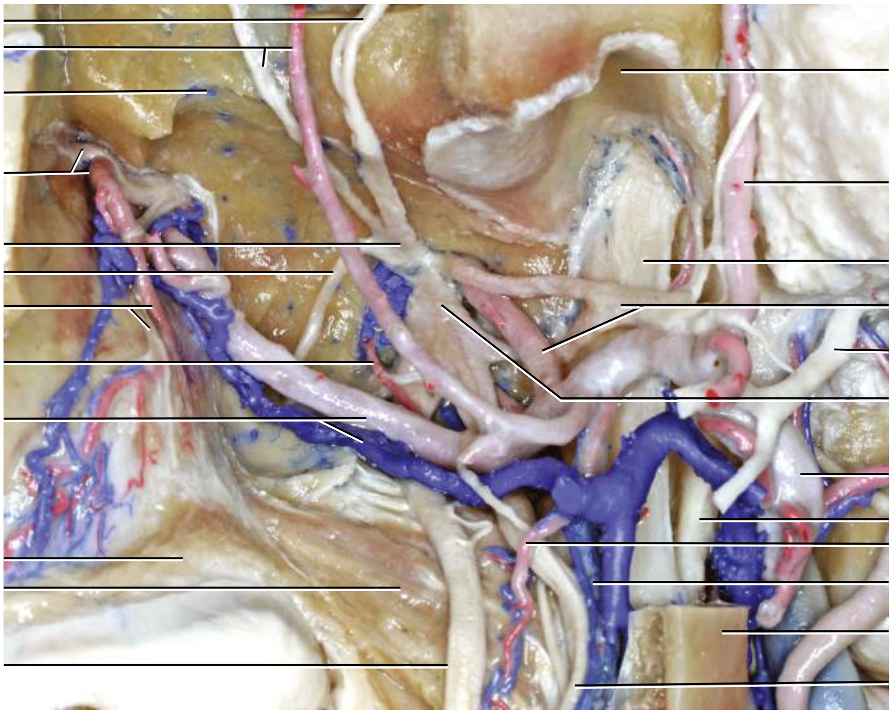


Fig. 11.6 Lateral view of the infratemporal fossa. The pterygoid venous plexus has been removed

The auriculotemporal nerve arises from the posterior trunk of the mandibular nerve, typically as two roots. These roots encircle the middle meningeal artery and then converge to form a single nerve. This nerve is essentially sensory but also carries autonomic fibers to the parotid gland. The auriculotemporal nerve crosses medial to the neck of the mandible and changes its direction upward in the parotid gland between the temporomandibular joint and the external acoustic meatus.

The infratemporal fossa is a space located below the floor of the middle cranial fossa and posterior to the maxilla. The roof is the infratemporal surface of the greater sphenoid wing. The medial wall consists of the lateral pterygoid plate anteriorly and the tensor veli palatini and medial pterygoid muscles posteriorly. The anterior wall is the posterior surface of the maxilla. The fossa extends posteriorly to the glenoid fossa and the temporomandibular joint. Superiorly and laterally, the fossa blends into the temporal fossa and the belly of the temporalis muscle. The infratemporal crest is a transverse ridge of the greater sphenoid wing that separates the temporal fossa from the infratemporal fossa. The inferior boundary of the fossa is open.

Fig. 11.7 Lateral view of the infratemporal fossa. The accessory ligaments of the temporomandibular joint are shown

The accessory ligaments of the temporomandibular joint are the stylomandibular and sphenomandibular ligaments and the pterygomandibular raphe. The stylomandibular ligament extends from the tip of the styloid process to the angle and posterior border of the mandible. The sphenomandibular ligament attaches to the spine of the sphenoid bone and descends to the lingula near the mandibular foramen on the medial surface of the ramus of the mandible. The pterygomandibular raphe extends from the pterygoid hamulus of the sphenoid bone to the posterior end of the mylohyoid line on the mandible.

The deep auricular artery is the first branch of the mandibular segment of the maxillary artery. It supplies the skin of the external acoustic meatus and part of the tympanic membrane.

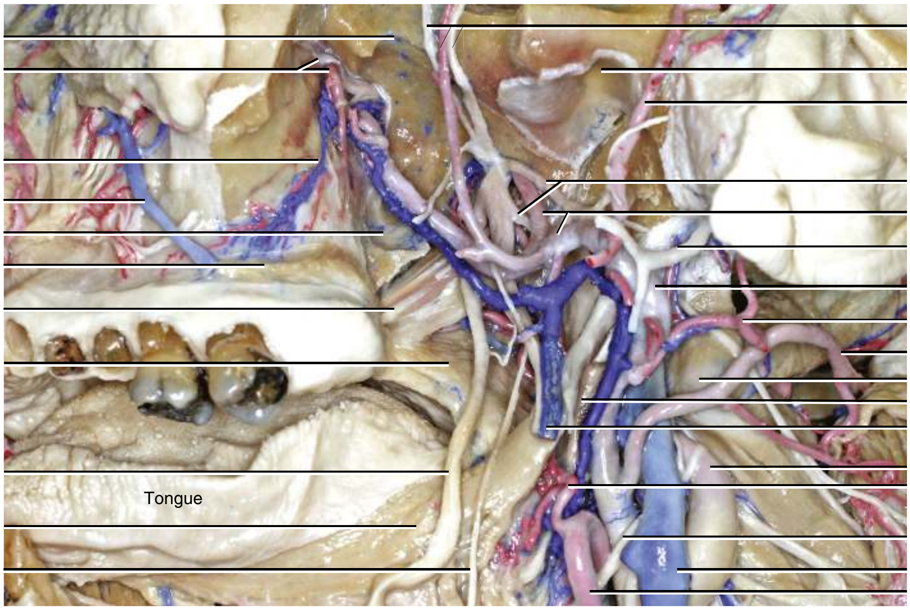


Fig. 11.8 Lateral view of the infratemporal fossa. The medial pterygoid muscle and the mandible have been removed

The tensor veli palatini muscle pulls the soft palate laterally. When this muscle and the levator veli palatini muscle act together, the palatine aponeurosis becomes tensed and provides a horizontal platform upon which other palatine muscles may act to change the position of the soft palate.

The facial artery gives rise to the ascending palatine artery, tonsillar artery, branches to the submandibular gland, and the submental artery in the neck.

The pterygomandibular raphe serves as an attachment site for the buccinator muscle anteriorly and the superior pharyngeal constrictor posteriorly. The superior pharyngeal constrictor muscle arises from the posterior border of the pterygomandibular raphe, constricts the upper part of the pharynx, and is innervated by the vagus nerve via the pharyngeal plexus.

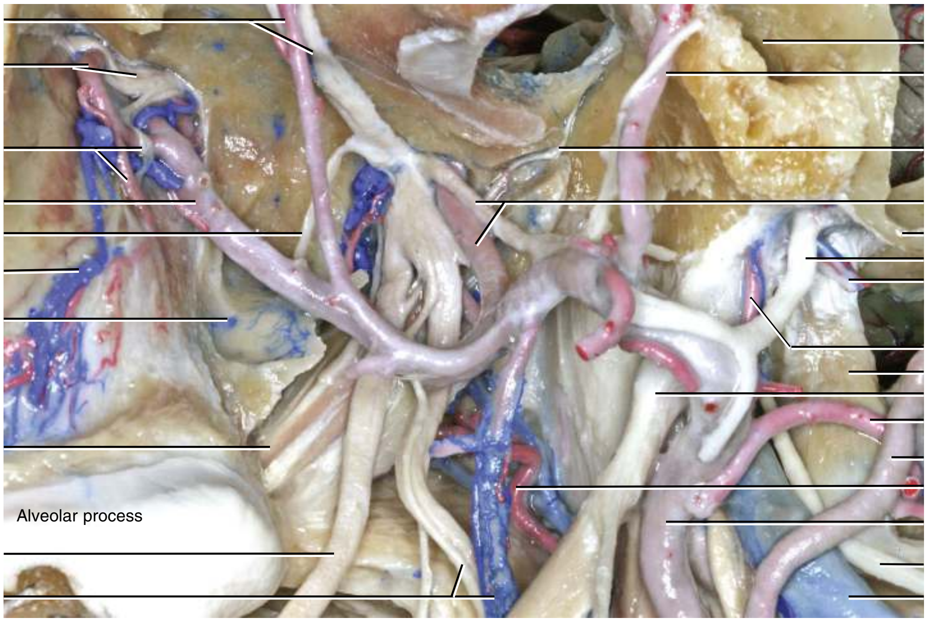


Fig. 11.9 Lateral view of the infratemporal fossa. The mandibular fossa has been opened. The spine of the sphenoid bone has been removed to expose the chorda tympani nerve

The mandibular nerve is the largest division of the trigeminal nerve and has motor and sensory fibers. The sensory fibers supply the mandibular teeth, the anterior two-thirds of the tongue and the floor of the mouth, the skin of the lower part of the face, and parts of the temporal and auricular regions. The mandibular nerve lies on the tensor veli palatini muscle after passing through the foramen ovale. After a short distance, the nerve divides into a smaller anterior trunk and a larger posterior trunk. Before this division, the main trunk gives off a meningeal branch and the nerve to the medial pterygoid muscle.

The anterior trunk has four branches: the masseteric nerve, the deep temporal nerve, the nerve to the lateral pterygoid muscle, and the buccal nerve. The posterior trunk has three nerve branches: auriculotemporal, lingual, and inferior alveolar nerves.

The lingual nerve is essentially sensory, but after its union with the chorda tympani branch of the facial nerve, it also contains parasympathetic fibers. The nerve courses over the tensor veli palatini muscle, deep to the lateral pterygoid muscle. Then, the chorda tympani nerve, which enters the infratemporal fossa via the petrotympanic fissure, joins the posterior surface of the lingual nerve.

The tensor veli palatini muscle lies lateral to the Eustachian tube. It extends downward toward the pterygoid hamulus at the inferior border of the medial pterygoid plate, and its tendon inserts into the soft palate.

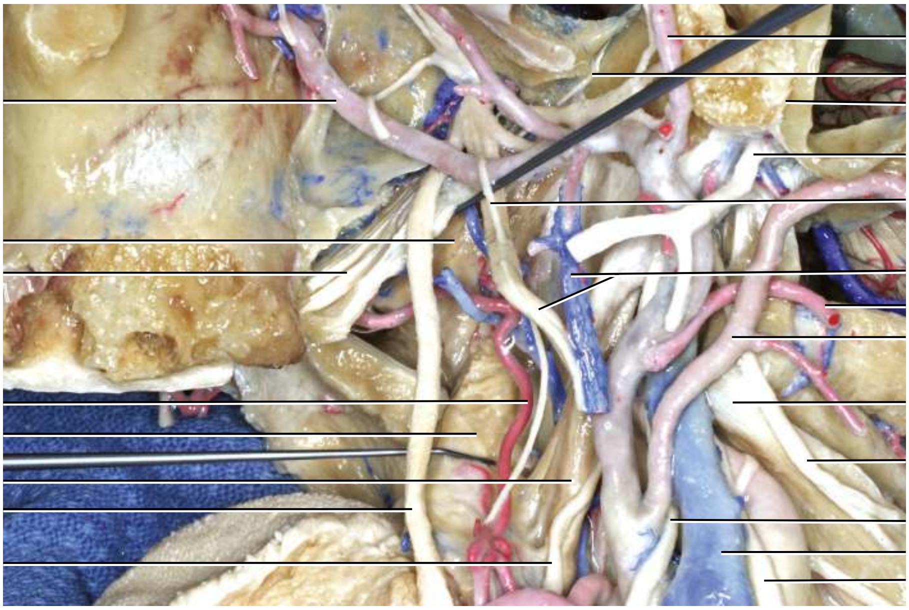


Fig. 11.10 Lateral view of the infratemporal fossa. The tensor veli palatini muscle has been elevated by the probe to expose the levator veli palatini muscle

The levator veli palatini muscle is medial and posterior to the tensor veli palatini muscle. It spreads to attach widely to the soft palate. This muscle forms a U-shaped muscular sling. When the tensor muscles stiffen the palatine aponeurosis, contraction of the levator muscles produces an upward and backward movement of the soft palate. Branches of the pharyngeal plexus innervate this muscle.

The ascending palatine artery arises near the origin of the facial artery. It ascends between the styloglossus and stylopharyngeus muscles to the side of the pharynx. It passes between the superior pharyngeal constrictor and the medial pterygoid muscle up to near the skull base.

The stylopharyngeus muscle elevates the pharynx and larynx and is innervated by the glossopharyngeal nerve.

The styloglossus muscle draws up the sides of the tongue to create a trough for swallowing. It is innervated by the hypoglossal nerve, like all intrinsic and extrinsic tongue muscles except the palatoglossus muscle, which is innervated by the pharyngeal plexus of the vagus nerve.

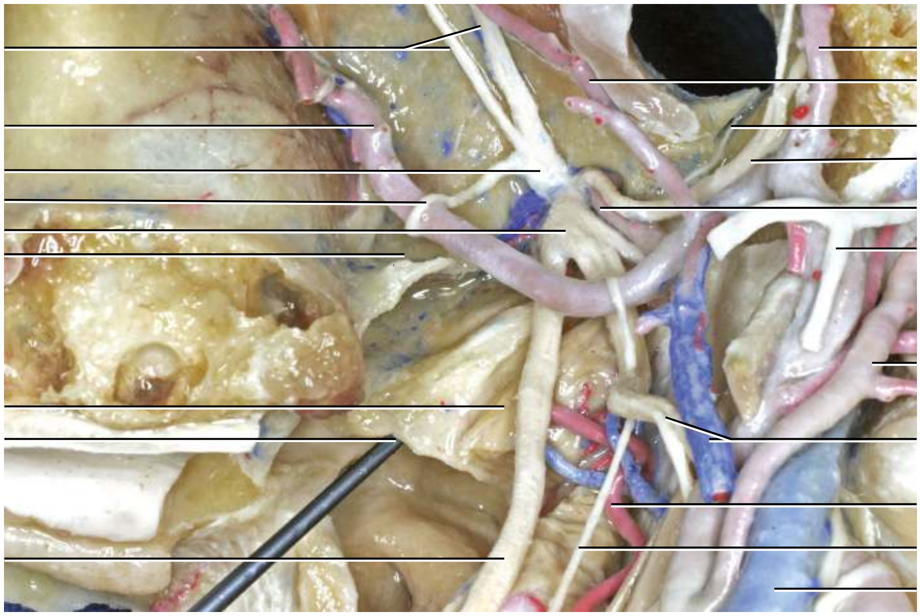


Fig. 11.11 Inferior view of the infratemporal fossa. The tensor veli palatini muscle has been removed

The inferior alveolar nerve gives rise to the mylohyoid branch before the mandibular foramen. It has motor and sensory components. It supplies the mylohyoid muscle and the anterior belly of the digastric muscle. It also gives a few sensory filaments to supply the skin of the mentum.

The Eustachian tube is also called the auditory tube or pharyngotympanic tube. It links the lateral wall of the nasopharynx to the anterior wall of the tympanic cavity. The Eustachian tube runs anteriorly and inferiorly from the middle ear to the nasopharynx. It has a bony part in the petrous portion of the temporal bone and a cartilaginous part in the infratemporal fossa. The cartilaginous part provides attachment to the tensor and levator veli palatini muscles and the salpingopharyngeus muscles. The tensor veli palatini muscle intervenes between the tube and the mandibular nerve, the otic ganglion, the chorda tympani nerve, and the middle meningeal artery. The functions of the Eustachian tube are pressure equalization and mucus drainage. Under normal circumstances, the human Eustachian tube is closed. However, it can open to let a small amount of air through to prevent damage by equalizing pressure between the middle ear and the atmosphere. The Eustachian tube drains mucus from the middle ear.

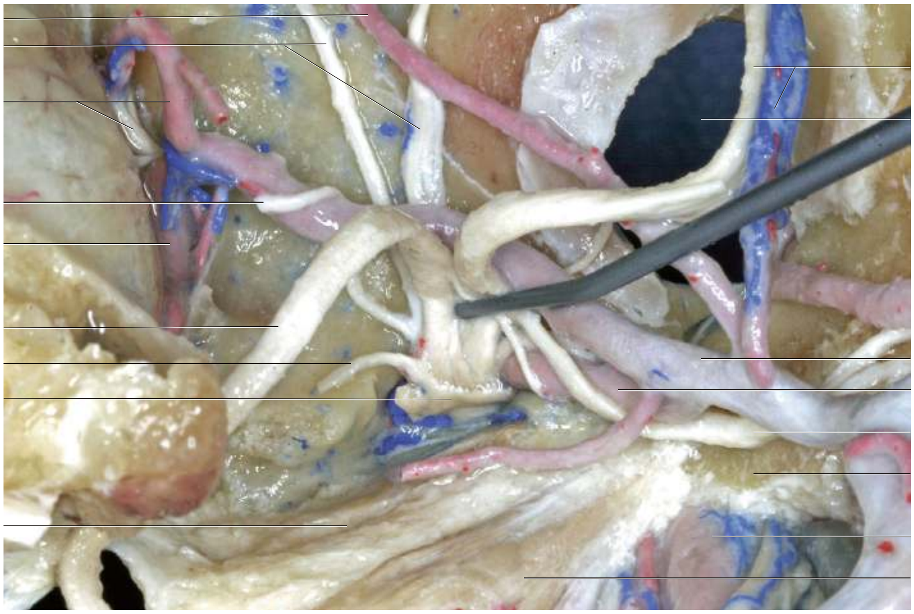


Fig. 11.12 Inferior view of the infratemporal fossa. The mandibular nerve has been elevated to expose the otic ganglion

The otic ganglion is a parasympathetic ganglion that lies on the medial surface of the main trunk of the mandibular nerve immediately below the foramen ovale. It is primarily involved in supplying the parotid gland. The parasympathetic, sympathetic, and sensory components reach the parotid gland through the auriculotemporal nerve. The preganglionic parasympathetic fibers originate from the inferior salivatory nucleus in the brain stem. These fibers travel in the glossopharyngeal nerve and then emerge as the lesser petrosal nerve from the tympanic plexus in the middle ear cavity. The lesser petrosal nerve carries these fibers to the otic ganglion, where they synapse with postganglionic fibers. The postganglionic parasympathetic fibers then join the auriculotemporal nerve to reach the parotid gland. The sympathetic postganglionic fibers consist of a filament from the plexus surrounding the middle meningeal artery, also pass through the otic ganglion without synapsing, and join the auriculotemporal nerve to innervate the parotid gland.

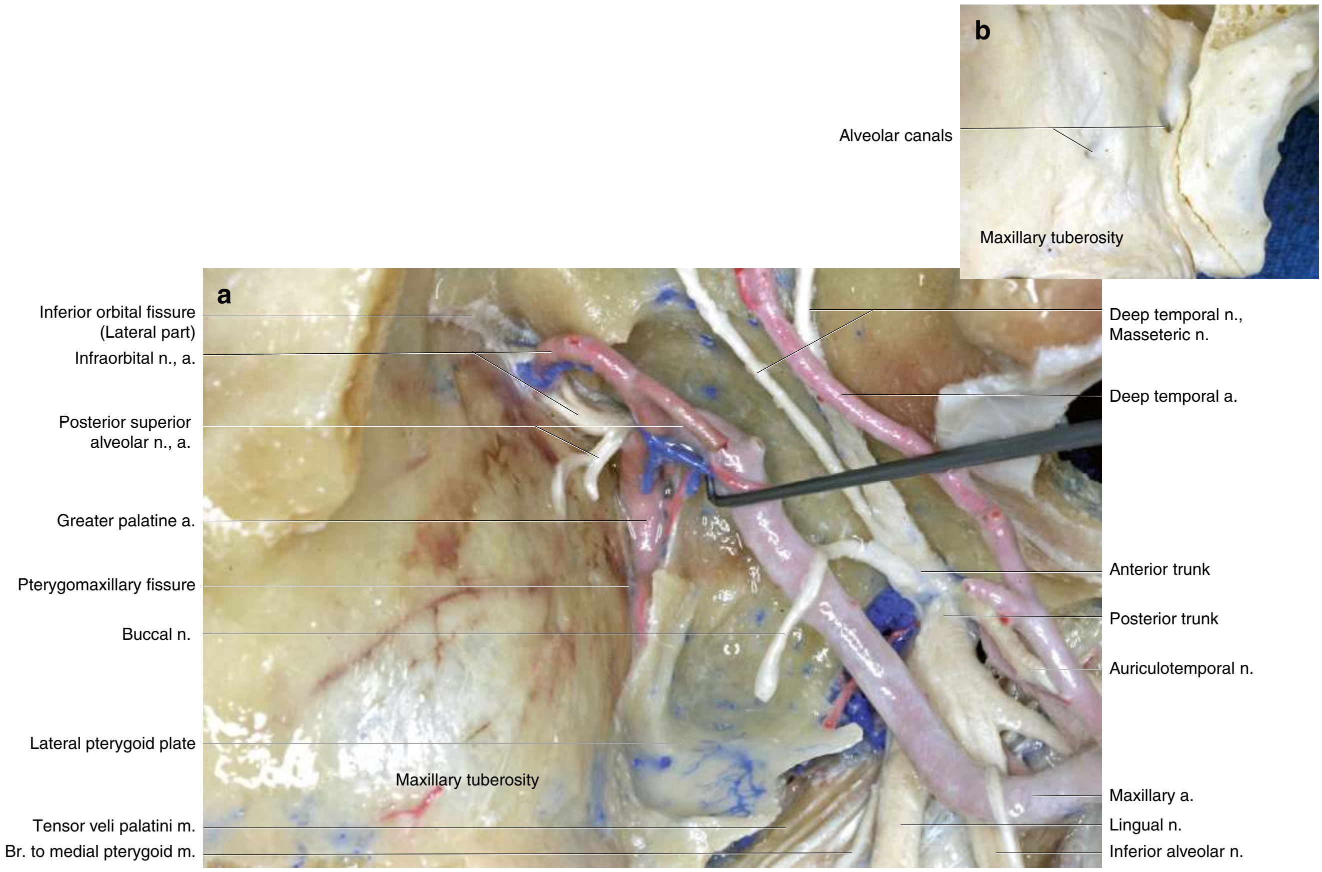


Fig. 11.13 (**a**, **b**) Lateral view of the infratemporal fossa. (**a**) The maxillary artery has been elevated to expose the greater palatine artery. (**b**) Lateral view of the skull with the maxillary tuberosity highlighted.

The posterior superior alveolar nerve arises from the maxillary nerve in the pterygopalatine fossa. It descends onto the posterior wall of the maxilla and divides into dental and gingival branches. The dental branches and vessels enter the maxilla through the posterior alveolar canals (Fig. 11.13b) above the roots of the molar teeth. The three superior alveolar nerves—anterior, middle, and posterior superior alveolar nerves—form a plexus just above the roots of the maxillary teeth.

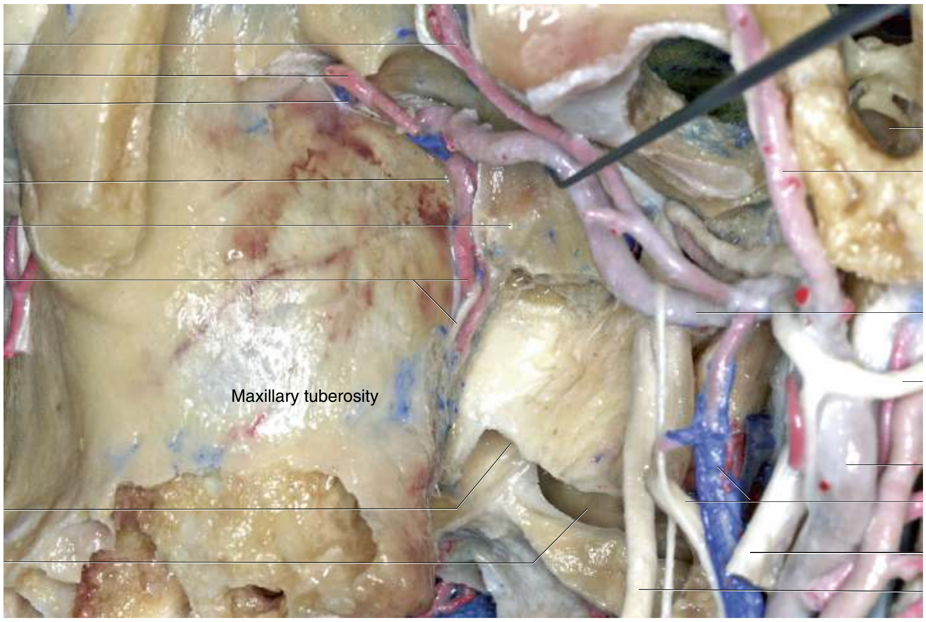


Fig. 11.14 Posterolateral view of the infratemporal fossa. The pterygoid plate has been partially removed

The pterygopalatine fossa communicates with the infratemporal fossa through the pterygomaxillary fissure. At the base of the pterygopalatine fossa, the greater and lesser palatine nerves, which arise from the pterygopalatine ganglion, and accompanying vessels (greater and lesser palatine arteries), pass through the hard palate to emerge at the greater and lesser palatine foramina.

The pterygomaxillary fissure transmits the maxillary artery from the infratemporal fossa. The fissure is continuous with the lateral part of the inferior orbital fissure.

Fig. 11.15 Lateral view of the nerve of the pterygoid canal. The pterygoid canal, orbit, and maxillary sinus have been opened

The Vidian nerve, also known as the nerve of the pterygoid canal, is formed by the union of the greater superficial petrosal nerve and the deep petrosal nerve within the pterygoid canal. The pterygoid canal (Vidian canal) is a passage in the skull leading from the foramen lacerum in the middle cranial fossa to the pterygopalatine fossa. The greater superficial petrosal nerve (preganglionic parasympathetic) and deep petrosal nerve (postganglionic sympathetic), and the accompanying artery (artery of the pterygoid canal), which arises from the pterygopalatine segment of the maxillary artery, enter the pterygoid canal. On exiting the pterygoid canal, the Vidian nerve emerges into the pterygopalatine fossa and joins the ganglion. From the superior cervical ganglion, sympathetic fibers pass to the internal carotid plexus and appear as the deep petrosal nerve. The deep petrosal nerve innervates the blood vessels of the lacrimal gland. The fibers do not synapse at the ganglion and pass to the lacrimal gland along the same course as the parasympathetic innervation.

The buccal nerve passes between the two heads of the lateral pterygoid muscle, underneath the tendon of the temporalis muscle, and then under the masseter muscle to connect with the branches of the zygomaticobuccal plexus of the facial nerve on the surface of the buccinator muscle.

Fig. 11.16 Anteroinferior view of the facial nerve trunk. The styloid process and the spine of the sphenoid bone have been removed

The stylomastoid artery, which arises from the posterior auricular or occipital artery, supplies the facial nerve trunk and enters the skull through the stylomastoid foramen.

The hypoglossal nerve descends through the hypoglossal canal between the internal jugular vein and the internal carotid artery to the level of the transverse process of the atlas, where it turns abruptly forward along the lateral surface of the internal carotid artery toward the tongue, leaving only the branch to the ansa cervicalis to descend with the major vessels. It then courses anteriorly, lateral to the external carotid artery, and onto the stylopharyngeus muscle. It passes below the submandibular gland and continues over the hyoglossus muscle to innervate the tongue muscles. The hypoglossal nerve is one of the standard motor sources for facial reinnervation.

The accessory nerve descends through the jugular foramen, crosses the internal jugular vein obliquely, frequently on its lateral surface, and passes backward and downward to reach the upper part of the sternocleidomastoid muscle. It provides motor innervation to two muscles of the neck: the sternocleidomastoid and trapezius muscles.

The glossopharyngeal nerve leaves the skull through the jugular foramen and passes between the internal jugular vein and the internal carotid artery. The glossopharyngeal nerve is primarily sensory, with a single motor component. It carries sensations of pain, temperature, and touch from the tongue, ear, and pharynx, as well as taste from the posterior one-third of the tongue. The motor component of the glossopharyngeal nerve innervates the stylopharyngeus muscle, which elevates the pharynx during swallowing and speaking.

The pharyngeal plexus, composed of fibers from the glossopharyngeal nerve, vagus nerve, and the cranial part of the accessory nerve, innervates all the pharyngeal muscles except the stylopharyngeus muscle. The plexus provides sensory innervation to the oropharynx and laryngopharynx.

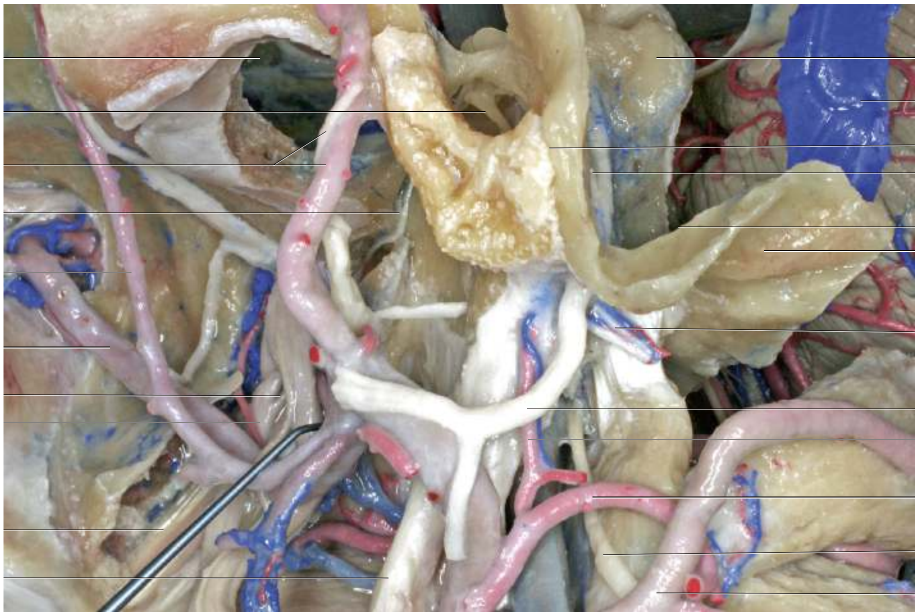


Fig. 11.17 Inferolateral view of the facial nerve trunk. The tympanic membrane has been removed to expose the course of the chorda tympani nerve

The chorda tympani nerve arises from the mastoid segment of the facial nerve just before the stylomastoid foramen. It is a branch of the nervus intermedius and contains parasympathetic fibers that travel to the submandibular ganglion and taste fibers from the anterior two-thirds of the tongue. The nerve initially passes through its own canal before entering the tympanic cavity. It courses through the middle ear, passing from posterior to anterior between the malleus and the incus, on the medial surface of the neck of the malleus. The nerve then passes through the petrotympanic fissure, emerging from the skull into the infratemporal fossa, where it soon joins the lingual nerve.

The digastric ridge, which is a ridge of bone, corresponds to the digastric groove and marks the location of the facial canal just anterior to it.

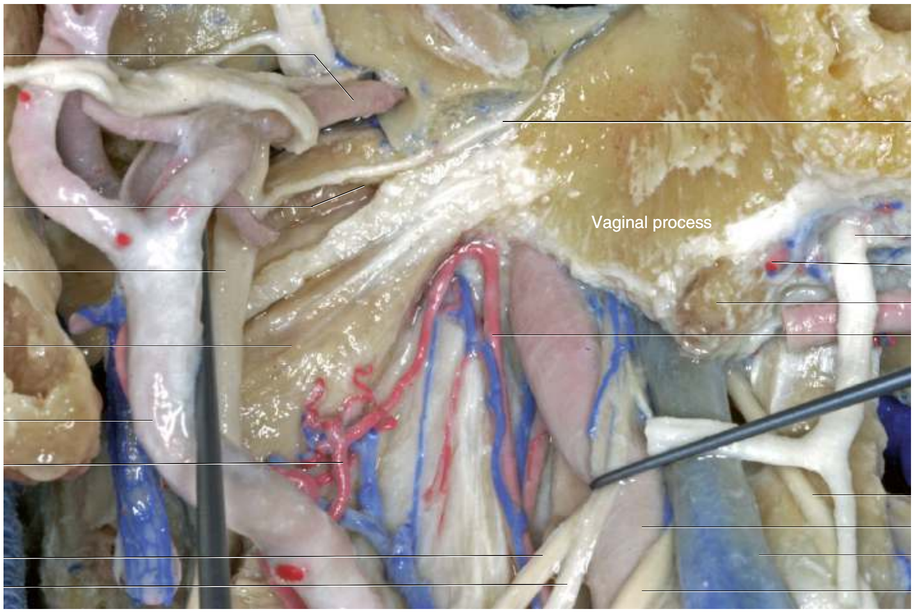


Fig. 11.18 Anteroinferior view of the facial nerve trunk. The Eustachian tube has been opened

The ascending pharyngeal artery is the smallest branch of the external carotid artery. It arises from the posterior surface of the external carotid artery and ascends along the pharynx. It terminates near the skull base, anastomosing with the ascending palatine artery, a branch of the facial artery. The meningeal branches of the ascending pharyngeal artery enter the cranial fossa through the foramen lacerum and the hypoglossal canal.

The middle meningeal artery is the primary source of blood to the meninges and the bones of the skull vault. It ascends between the two roots of the auriculotemporal nerve and enters the cranial cavity through the foramen spinosum.

The meningeal branch of the mandibular division of the trigeminal nerve innervates the middle cranial fossa. It enters the cranial cavity through the foramen spinosum.

The jugular foramen and carotid canal are situated behind the vaginal process, which encloses the root of the styloid process and forms the posterior wall of the condylar fossa.

Part IV

Lower Facial and Posterolateral Neck Regions

Overview of Lower Facial Region

12

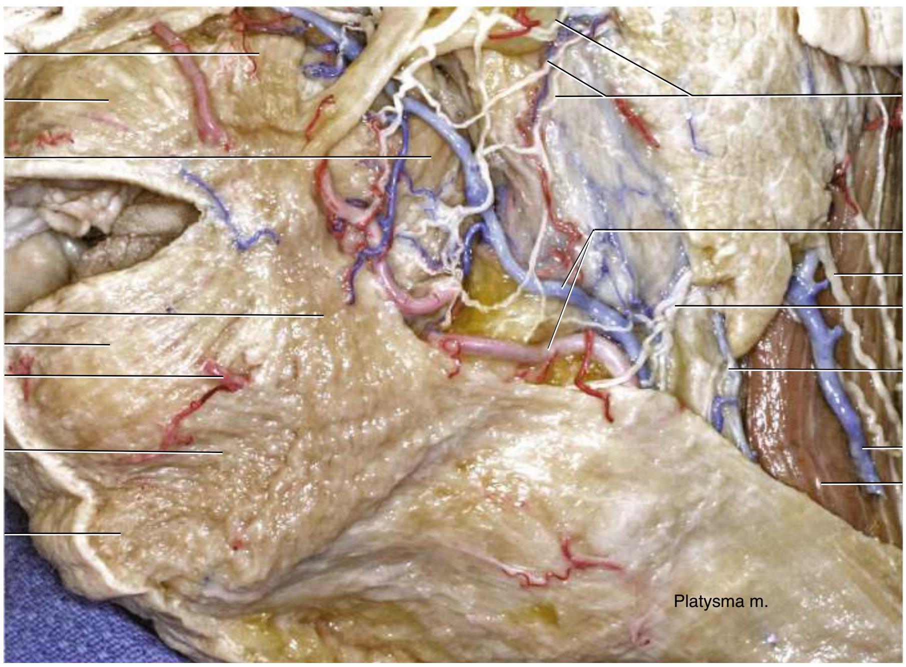


Fig. 12.1 Anterolateral view of the lower facial region. The mimetic muscles involved in lower lip movement are shown

The platysma, risorius, depressor labii inferioris, and depressor anguli oris muscles are innervated from their deep surface by branches of the facial nerve. The deep-seated muscles—the orbicularis oris and mentalis muscles—are innervated from their superficial or lateral surfaces.

The facial artery and vein course independently from the mandibular angle obliquely toward the face. The facial artery passes over the buccinator muscle, lateral to the depressor anguli oris muscle, toward the corner of the mouth. The inferior labial artery, branching off from the facial artery, reaches the lower lip medial to the depressor anguli oris muscle.

The facial vein descends independently behind the facial artery and then comes close to the artery at the inferior border of the mandible.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_12

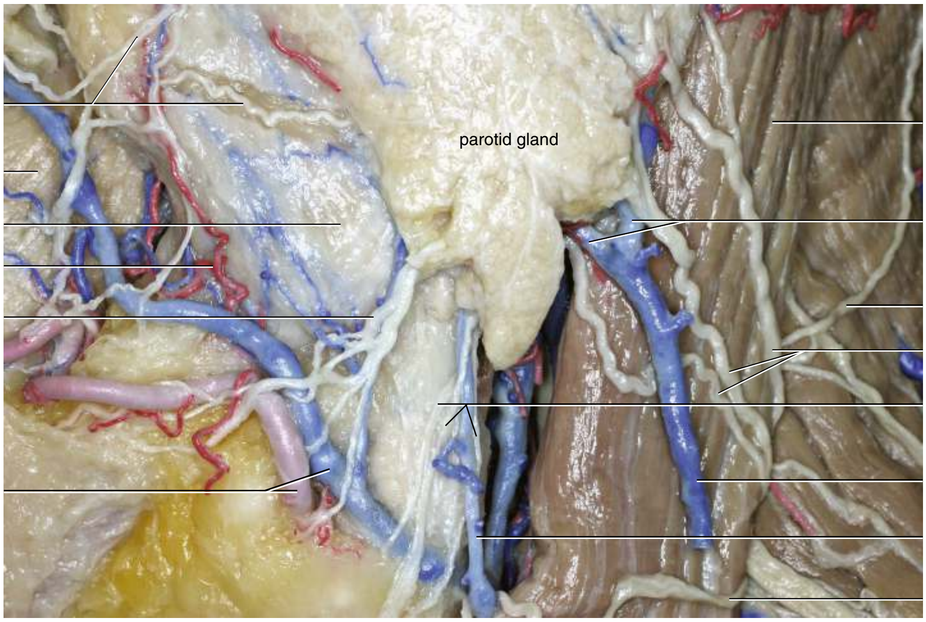


Fig. 12.2 Lateral view of the lower facial region. The branches of the cervicofacial division of the facial nerve are shown

At the inferior border of the mandible near the anterior edge of the masseter muscle, the facial artery and the vein course closely together. The premasseteric artery arises from the facial artery at the lower border of the mandible and ascends along the anterior edge of the masseter muscle.

The great auricular nerve perforates the deep cervical fascia and ascends upon the sternocleidomastoid muscle beneath the platysma to the parotid gland, where it divides into approximately three branches. It has communicating branches with the cervical branch and the posterior auricular nerve of the facial nerve. It provides sensory innervation to the skin over the parotid gland and mastoid process and both surfaces of the inferior region of the auricle.

The buccal branches frequently pass beneath the masseteric fascia. However, the marginal mandibular branches sometimes pass over the fascia.

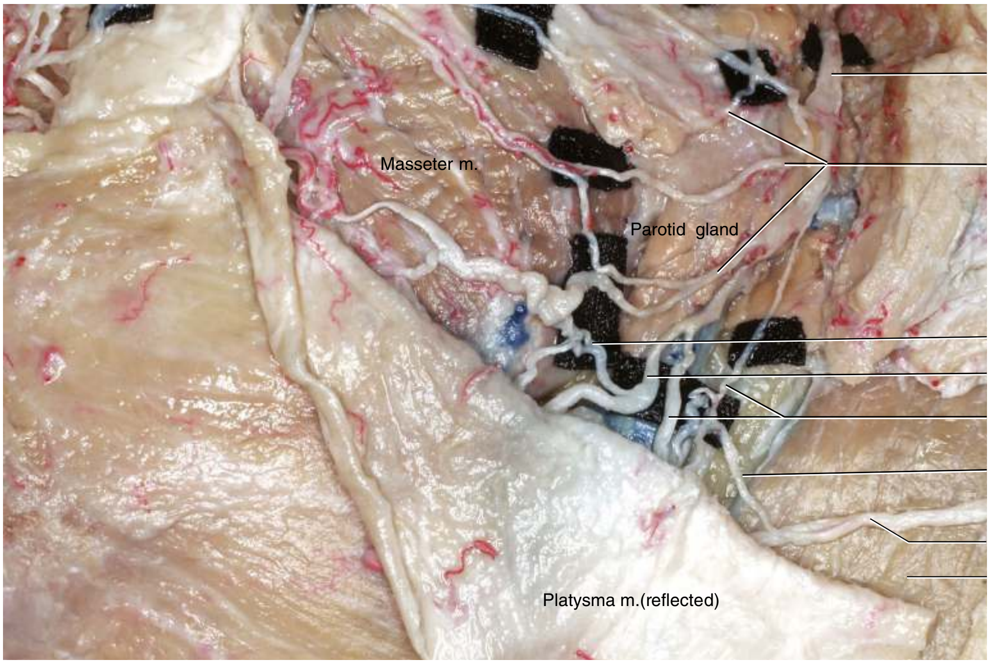


Fig. 12.3 Lateral view of the lower facial region. The cervicofacial division of the facial nerve is shown. The superficial lobe of the parotid gland and the masseteric fascia have been removed

The marginal mandibular branch consists of one or two branches emerging at the anteroinferior border of the parotid gland and courses close to the mandibular angle toward the neck. It has communicating branches with the buccal branch above and the cervical branches below after leaving the parotid gland. Initially, it often descends into the neck below the angle of the mandible. However, after crossing the facial vessels, usually over the vein and both over and under the artery, it ascends above the lower border of the mandible to the lower lip. It innervates the platysma, depressor labii inferioris, depressor anguli oris, lower lip orbicularis oris, and mentalis muscles.

The cervical branch consists of one or two branches emerging from the inferior border of the parotid gland and descends almost vertically anterior to the sternocleidomastoid muscle toward the neck. It supplies the platysma muscle and has an anastomotic branch with the great auricular nerve and/or the transverse cervical nerve.

13 Lower Facial Region

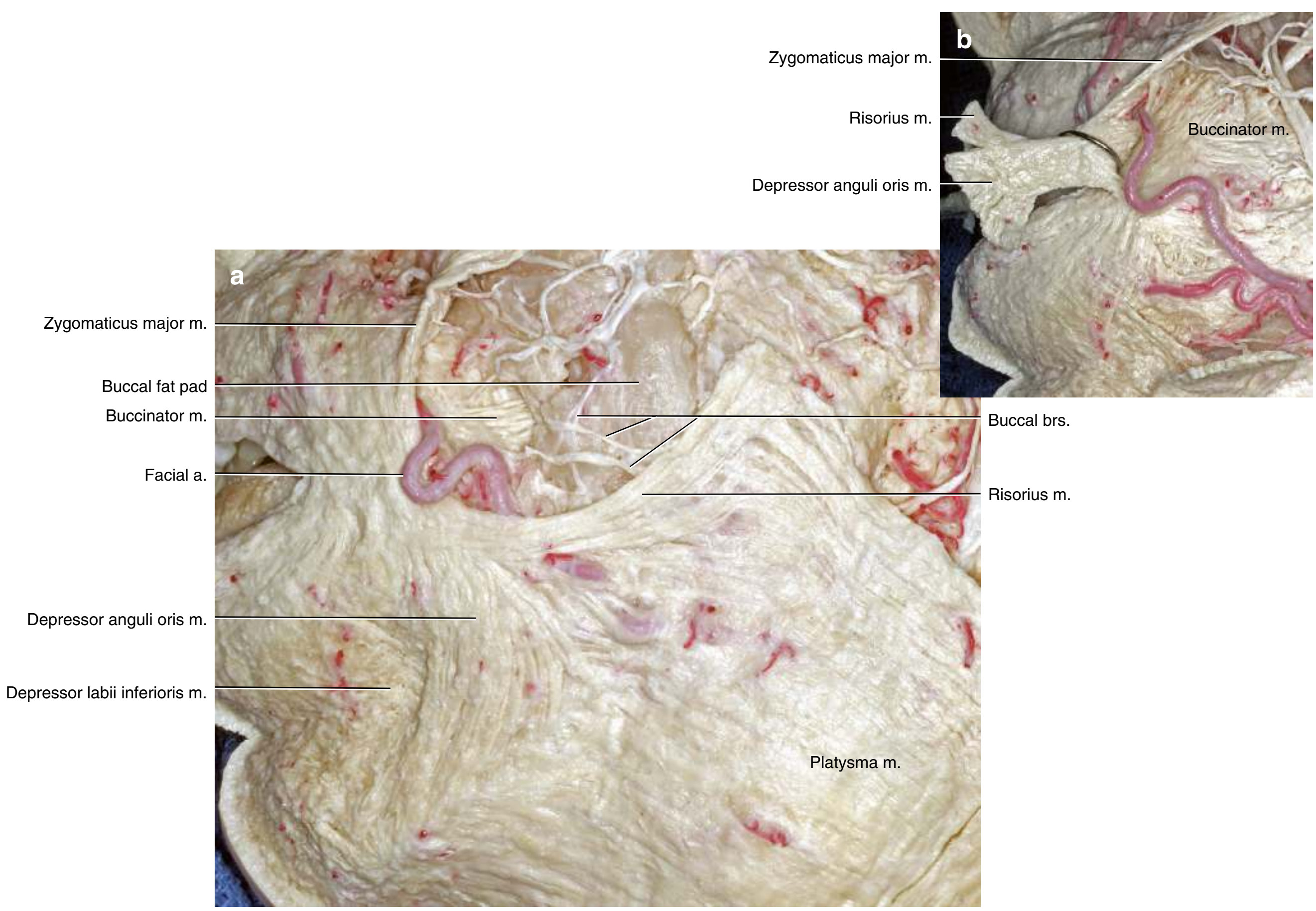


Fig. 13.1 (**a**, **b**) Lateral view of the lower facial region. (**a**) The lower lip depressor and risorius muscles are shown. (**b**) The superficial part of the modiolus has been reflected medially

The risorius muscle is a thin, slender muscle that arises around the parotid fascia. It is continuous with the platysma muscle below and attaches to the corner of the mouth. The muscle extends almost horizontally across the cheek and pulls the corner of the mouth laterally. The buccal branch of the facial nerve innervates the muscle.

The lip levator and depressor muscles meet at the modiolus. At least seven mimetic muscles converge and intertwine at the modiolus, including the zygomaticus major and levator anguli oris from above, the risorius from the lateral side, the upper lateral part of the platysma, and the depressor anguli oris from below. The other two muscles, the orbicularis oris and the buccinator, are intermingled and lie beneath this layer (Fig. 13.1b).

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_13

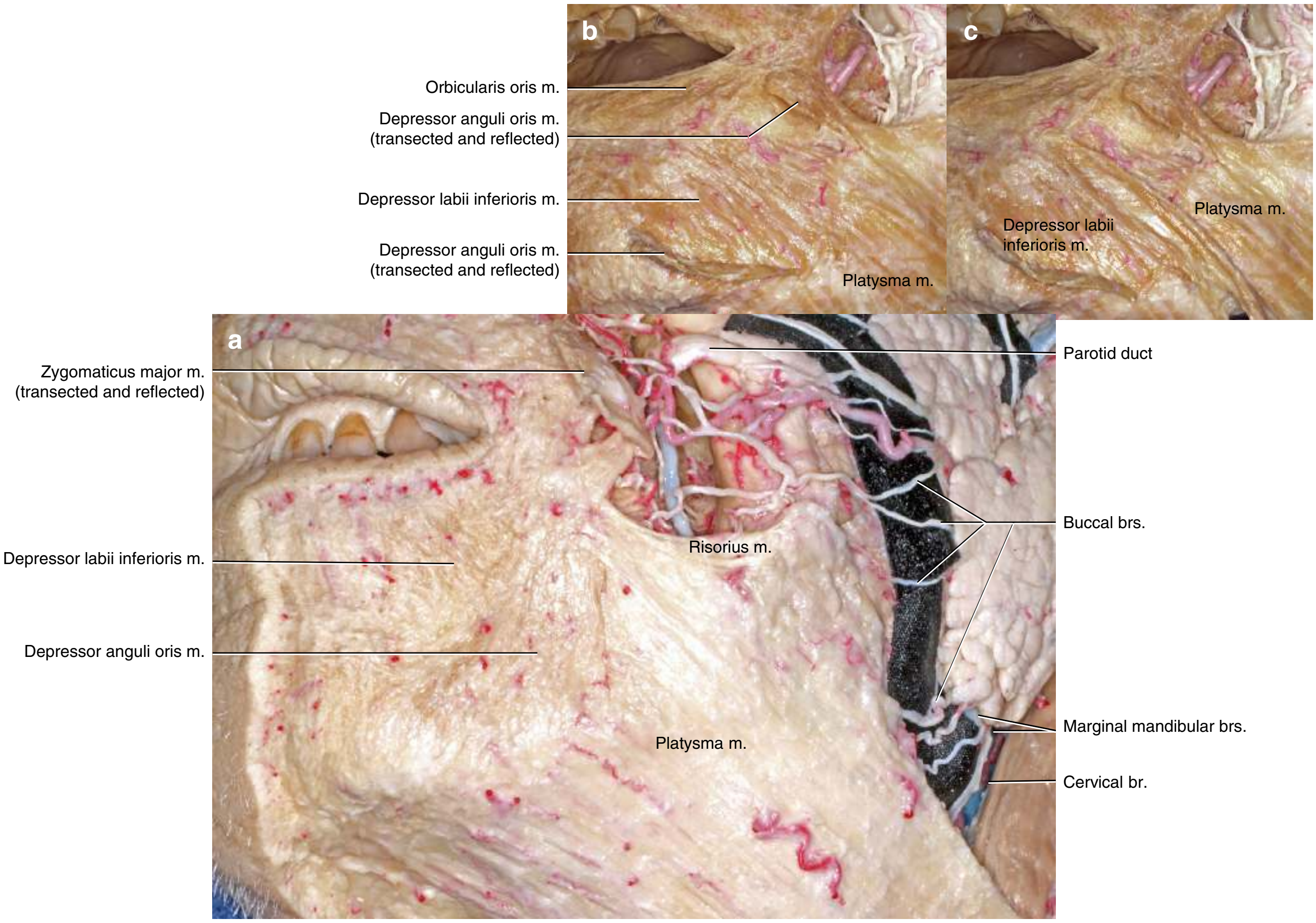


Fig. 13.2 (**a**–**c**) Anterolateral view of the lower facial region. (**a**) The lower lip depressor muscles are shown. (**b**, **c**) The platysma muscle extends and attaches to the modiolus and the orbicularis oris muscle of the lower lip

The platysma muscle is a flat muscle that arises from the fascia covering the upper parts of the pectoralis major and deltoid muscles. It ascends upward and medially. The upper lateral muscle belly attaches to the orbicularis oris muscle of the lower lip and the modiolus. This muscle is a lower lip depressor innervated by the cervical and marginal mandibular branches of the facial nerve. Injury to the platysma muscle or the cervical branch often results in weakness in lower lip depression. The lower medial muscle belly attaches to the lower margin of the mandible, where the other lower lip depressor muscles intermingle.

The superficial layer of the depressor labii inferioris muscle may be continuous with the platysma, or the platysma muscle may extend to the orbicularis oris muscle of the lower lip independently (Fig. 13.2b, c). The contribution of the platysma muscle to the depression of the lower lip depends on its cranial musculature. The depressor anguli oris muscle lies superficially over the depressor labii inferioris and platysma muscles.

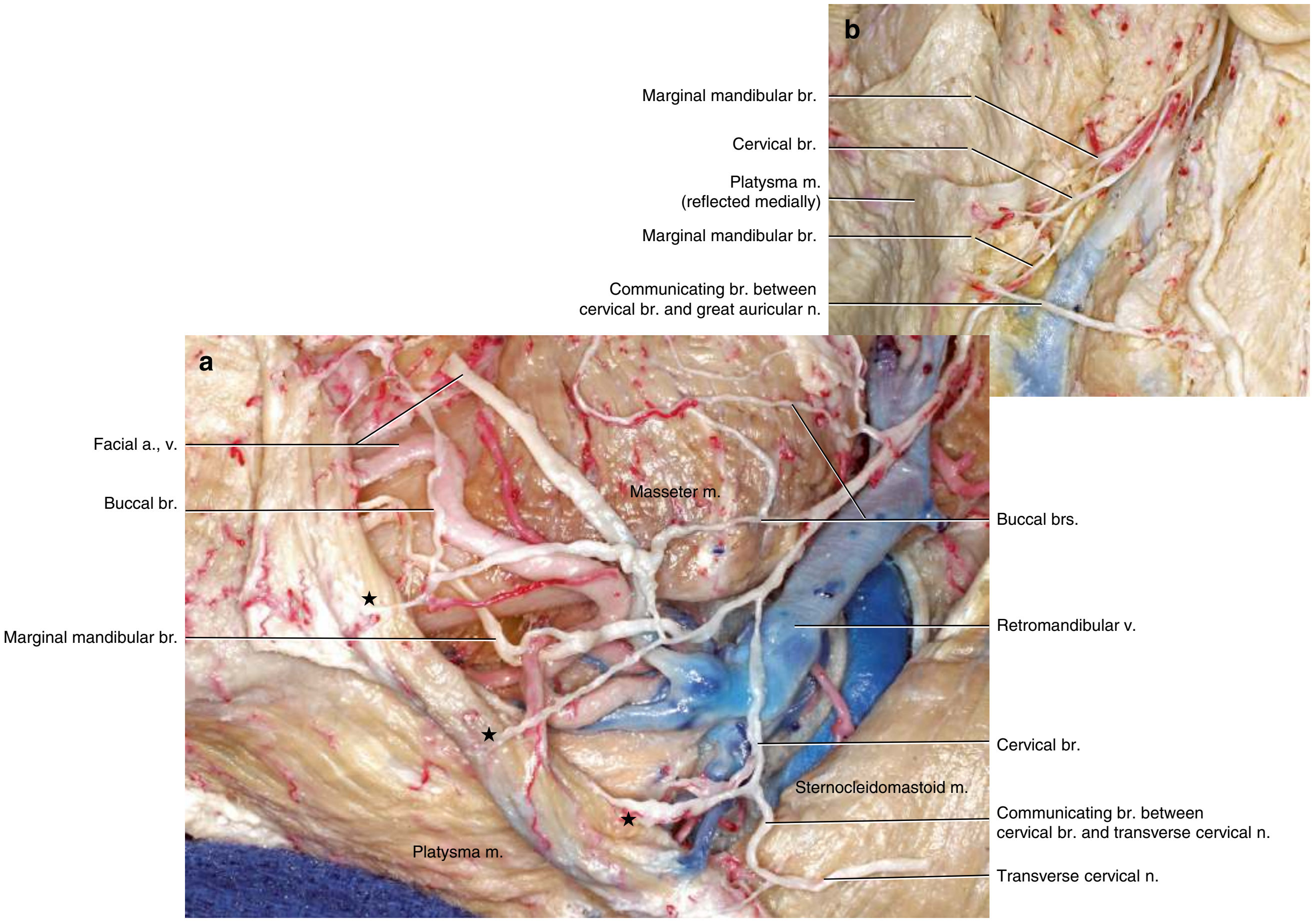


Fig. 13.3 (**a**, **b**) Lateral view of the lower facial region. (**a**) The innervation of the platysma muscle is shown. (**b**) The innervation to the platysma muscle by the cervical and marginal mandibular branches is shown

The marginal mandibular branch consists of one or two branches emerging from the parotid gland. It has communicating branches with the buccal and cervical branches around the angle of the mandible. It courses close to the lower border of the mandible and gives rise to branches that innervate the platysma muscle.

The marginal mandibular and cervical branches usually innervate the platysma muscle (indicated by the lower and middle asterisks in Fig. 13.3a, b). The buccal branch also innervates the platysma muscle in this specimen (indicated by the upper asterisk in Fig. 13.3a). The great auricular and/or transverse cervical nerve has a communicating branch with the cervical branch.

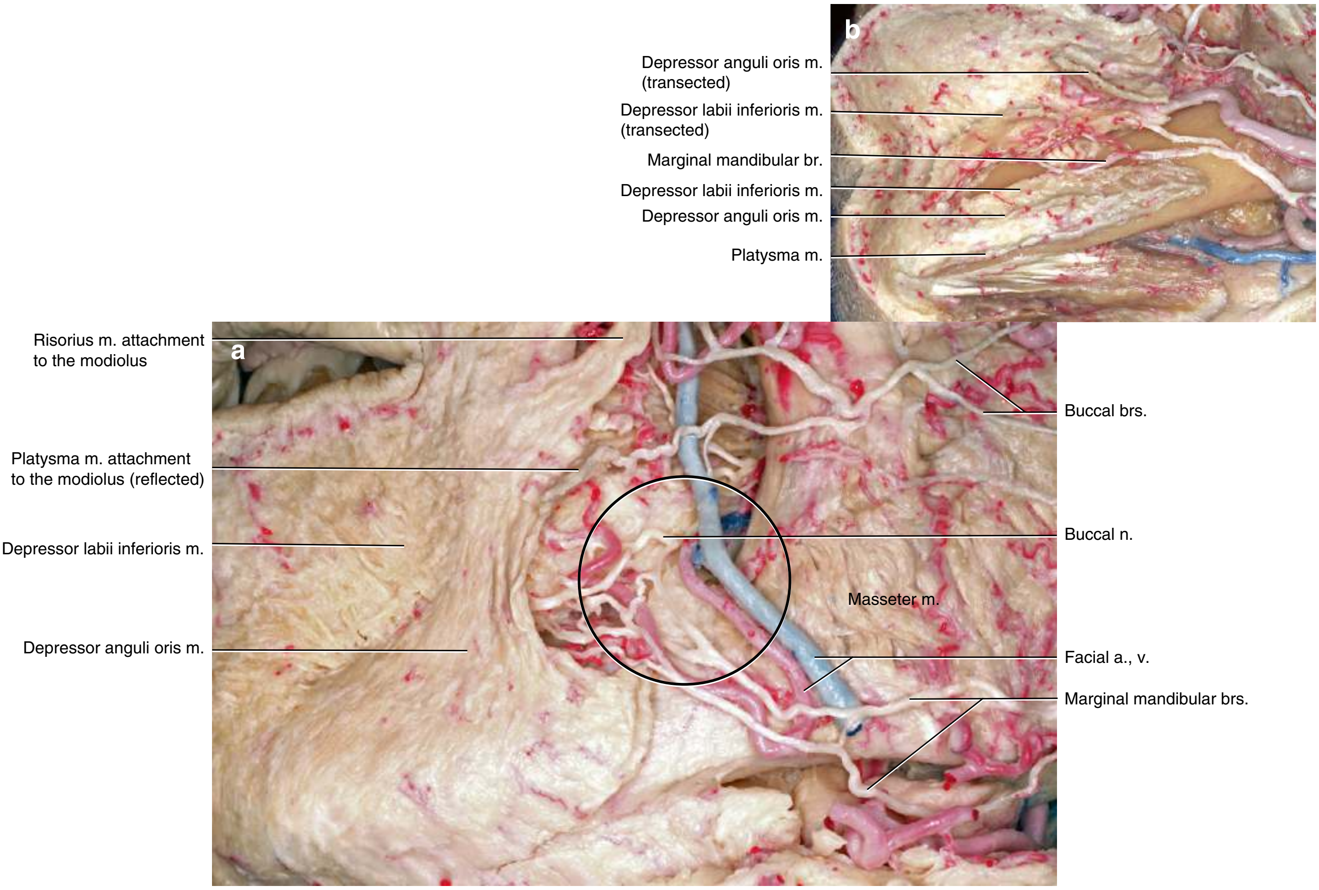


Fig. 13.4 (**a**, **b**) Lateral view of the lower facial region. (**a**) The platysma muscle has been removed, leaving its attachment to the modiolus. (**b**) The attachments of the mimetic muscles on the lower border of the mandible are shown

The marginal mandibular branch and the buccal nerve have connections medial to the anterior margin of the masseter muscle, deep to the platysma muscle (indicated by a black circle in Fig. 13.4a).

The depressor labii inferioris muscle arises from the mandible just above the depressor anguli oris muscle attachment. The fibers ascend upward and medially to converge with the orbicularis oris muscle, medial to the modiolus. The marginal mandibular branch innervates the depressor labii inferioris muscle from its deep surface. This muscle pulls the lower lip downward and laterally.

The depressor anguli oris muscle arises along the lower margin of the mandible between the attachments of the depressor labii inferioris and platysma muscles, intermingling with their attachments. The fibers pass upward over the depressor labii inferioris and platysma muscles to the corner of the mouth. The marginal mandibular branch innervates the muscle from its deep surface via the depressor labii inferioris muscle. Several studies in the literature have reported that the buccal branch also innervates the muscle. This muscle pulls the corner of the mouth downward and laterally.

The platysma muscle attaches to the lower margin of the mandible. The attachments of these three depressors are intermingled (Fig. 13.4b).

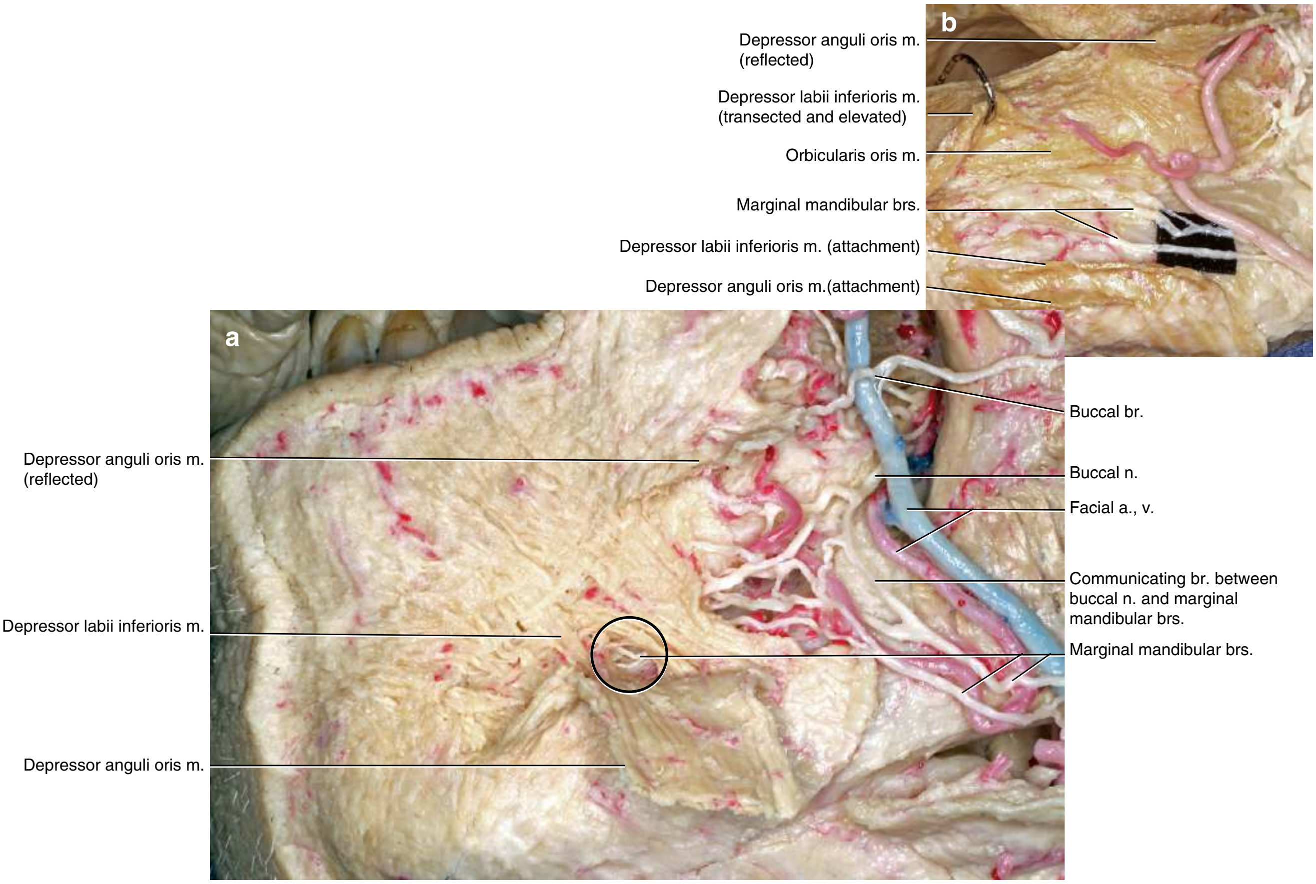


Fig. 13.5 (**a**, **b**) Lateral view of the lower facial region. (**a**) The depressor anguli oris muscle has been transected and reflected. (**b**) The marginal mandibular branches are shown

The marginal mandibular branches pass into the space between the mandible and the depressor labii inferioris muscle. Three or more branches course medially, superficial to the branches of the mental nerve, toward the mentalis muscle. The branches have connections with the mental nerve in the space. The marginal mandibular branches have been exposed after dividing the fibers of the depressor labii inferioris muscle (indicated by a black circle in Fig. 13.5a). The superior marginal mandibular branch innervates the orbicularis oris muscle of the lower lip (indicated by asterisks in Fig. 13.5b).

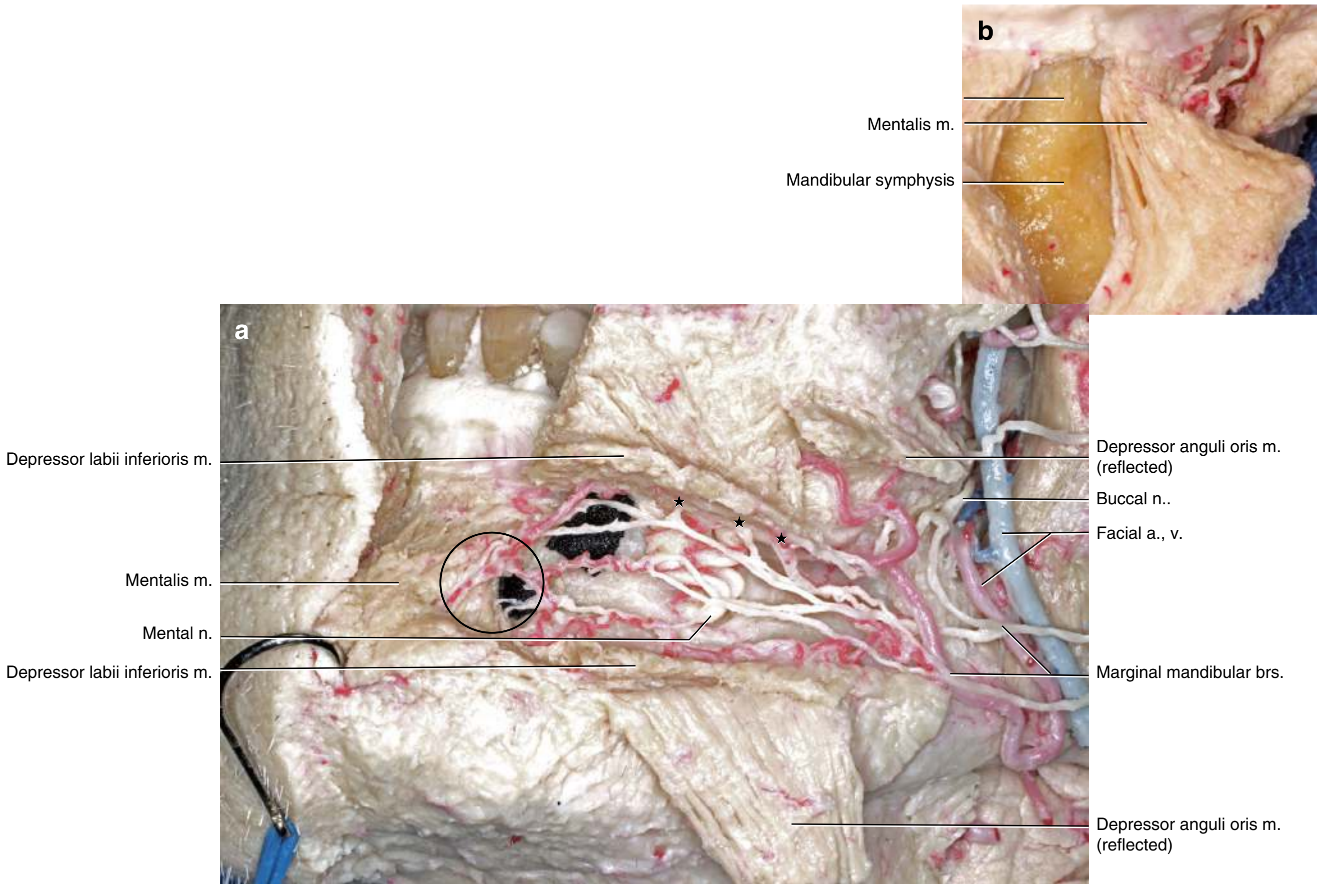


Fig. 13.6 (**a**, **b**) Anterolateral view of the lower facial region. (**a**) The depressor labii inferioris and depressor anguli oris muscles have been transected. (**b**) Medial view of the mentalis muscle

The marginal mandibular branches innervate the depressor labii inferioris and orbicularis oris muscles of the lower lip (indicated by asterisks in Fig. 13.6a).

The mentalis muscle arises from the incisive fossa of the mandible. Its fibers descend to insert into the skin of the chin. This muscle raises and protrudes the lower lip, creating wrinkles and a dimple over the mentum. The terminal branch of the marginal mandibular branch innervates the mentalis muscle from its lateral surface (indicated by a black circle in Fig. 13.6a) after giving off branches to the orbicularis oris muscle of the lower lip, depressor labii inferioris, and depressor anguli oris muscles.

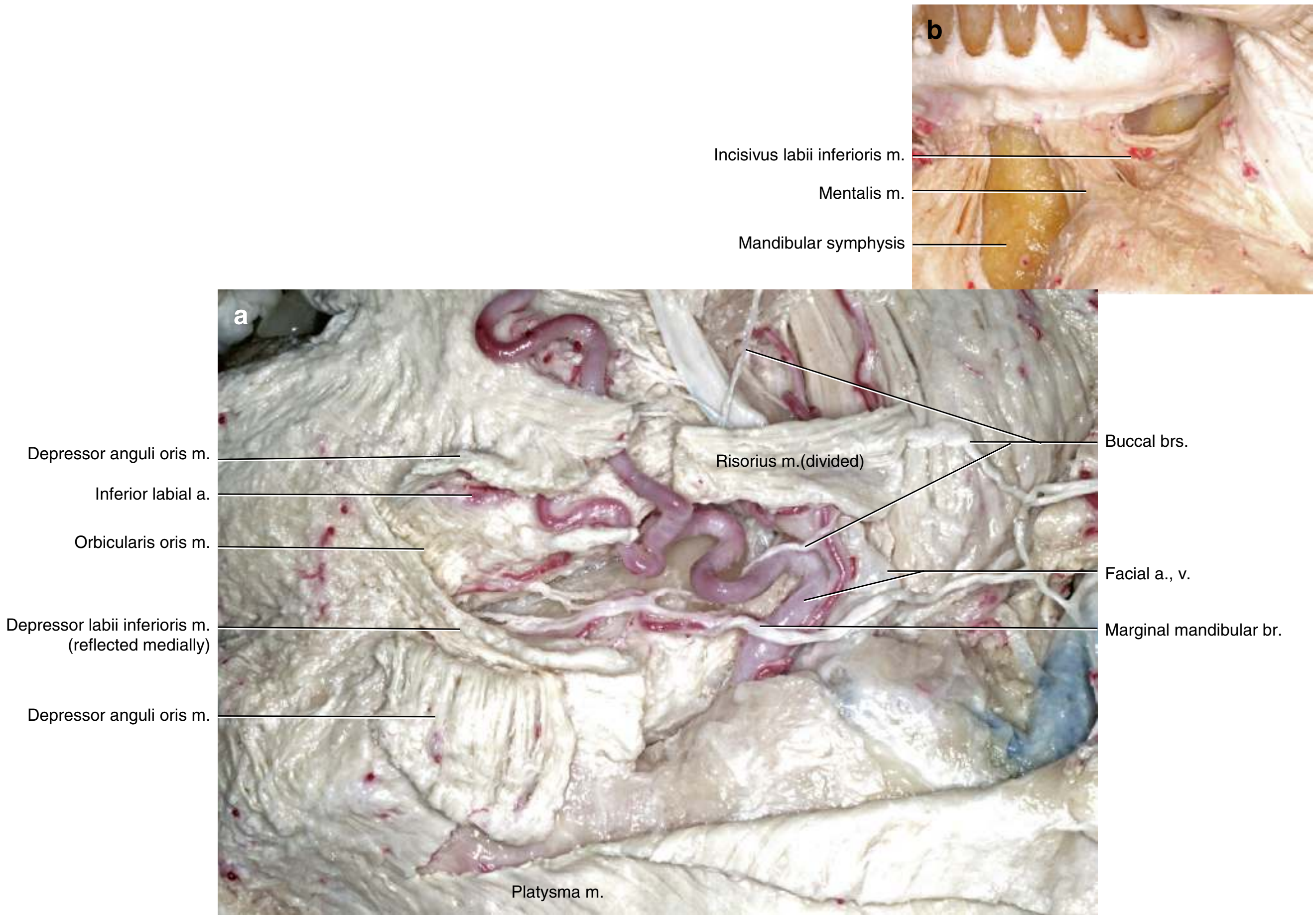


Fig. 13.7 (**a**, **b**). Lateral view of the lower facial region. (**a**) The depressor anguli oris muscle has been transected and reflected. (**b**) The incisivus labii inferioris muscle is shown

The marginal mandibular branches innervate the orbicularis oris muscle of the lower lip from below (indicated by an asterisk in Fig. 13.7a). The buccal branch gives off a branch inferiorly, which crosses under the facial artery and joins the marginal mandibular branch in this specimen. The buccal branch also innervates the risorius muscle (Fig. 13.7a).

The incisivus labii inferioris muscle arises from the incisive fossa of the mandible, lateral to the mentalis muscle attachment, and extends laterally and inferiorly, merging with the orbicularis oris muscle (Fig. 13.7b). The incisivus labii inferioris muscle is an accessory bundle of the orbicularis oris muscle. It pulls the corner of the mouth medially.

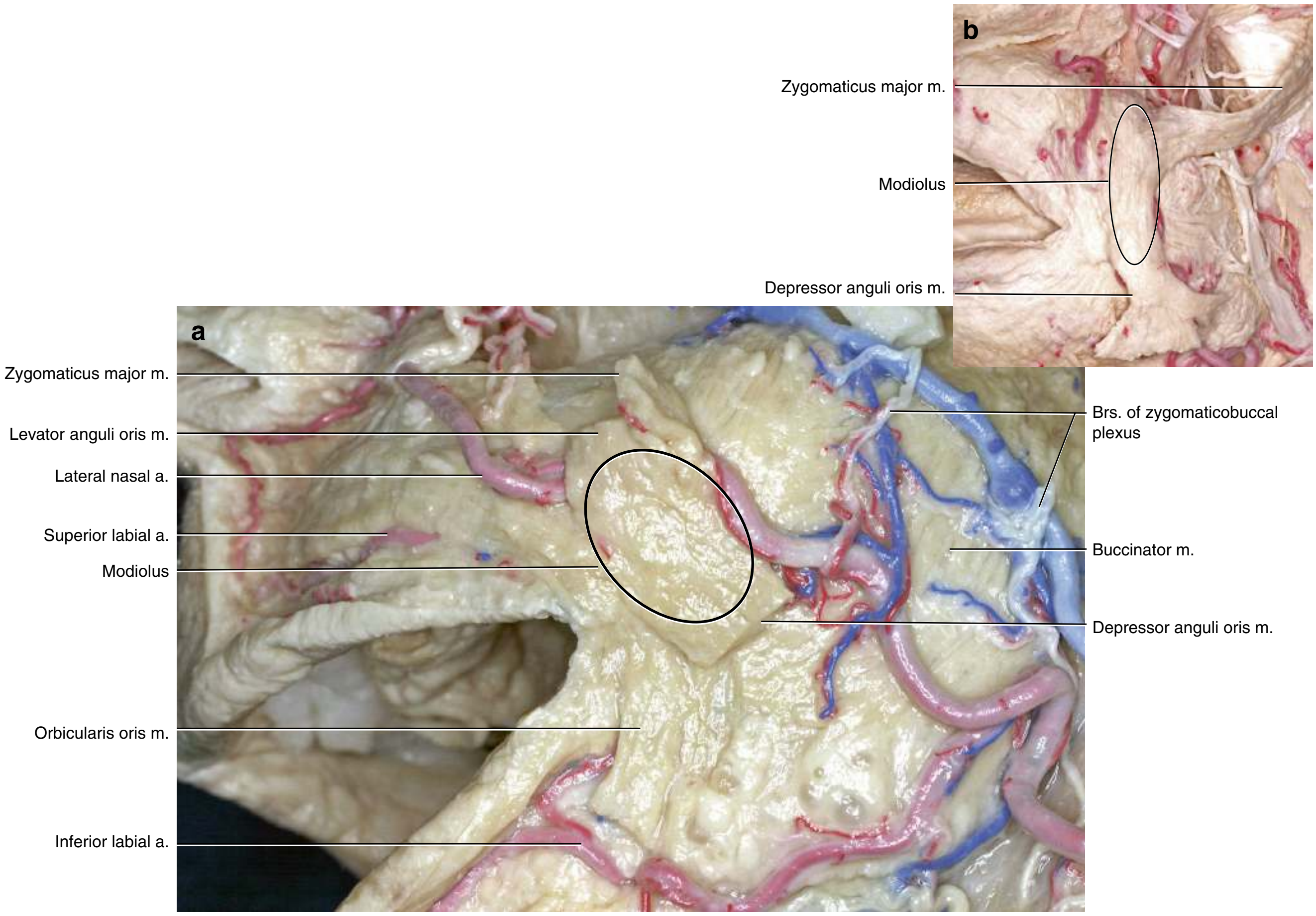


Fig. 13.8 (**a**, **b**) Close-up view of the oral commissure. (**a**) The attachments of the mimetic muscles to the modiolus have been transected. (**b**) The vertically elongated elliptical modiolus is shown

The layers of the mimetic muscles at the corner of the mouth and the shape of the modiolus vary (indicated by a black ellipse in Fig. 13.8a, b). However, the buccinator and orbicularis oris muscles are always in the deepest layer, attached to the oral mucosa.

The facial artery ascends upward and anteriorly from the mandible, running superficial to the buccinator muscle and deep to the zygomaticus major muscle. The facial artery gives rise to the inferior labial artery and bifurcates into the lateral nasal artery and superior labial artery at the corner of the mouth. This artery ascends either superficially or deeply to the levator anguli oris muscle. The terminal branch of the facial artery is the angular artery, which communicates with the dorsal nasal artery, a terminal branch of the ophthalmic artery.

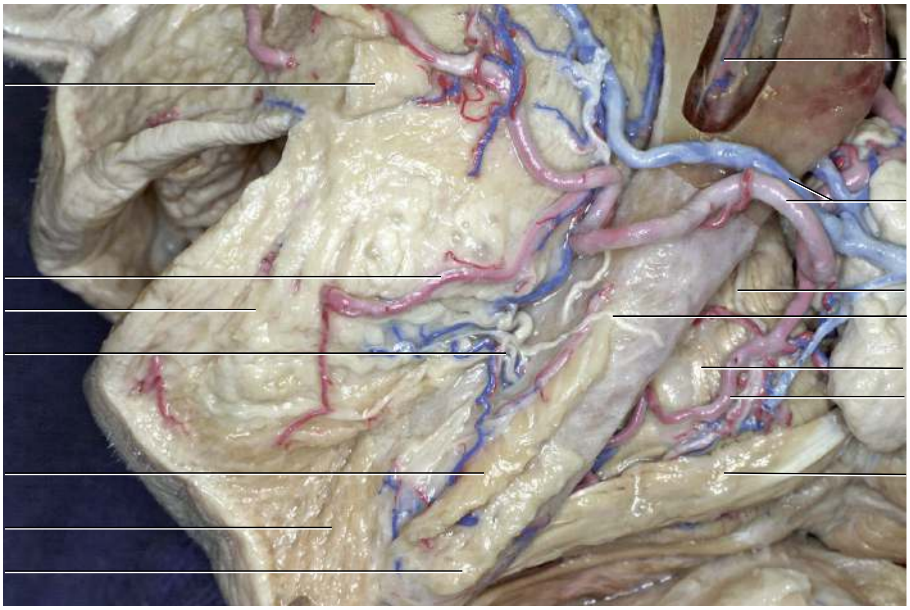


Fig. 13.9 Lateral view of the lower facial region. The mental nerve and the attachments of the mimetic muscles are shown. The mandibular canal has been opened

The mental nerve emerges from the mental foramen and gives rise to three to four branches, fanning out and supplying sensation to the labial gingiva of the lower lip and the skin of the lower lip and chin.

The digastric muscle consists of two bellies: the posterior belly and the anterior belly. The posterior belly arises from the mastoid process of the temporal bone and extends toward the mandible. As it travels toward the mandible, it becomes a tendon that passes through a tendinous pulley attached to the hyoid bone. The anterior belly of the digastric muscle arises from a depression on the inner side of the lower border of the mandible called the digastric fossa, close to the symphysis, and passes downward and backward. The two bellies are connected by an intermediate tendon, which is anchored to the hyoid bone by a fibrous loop.

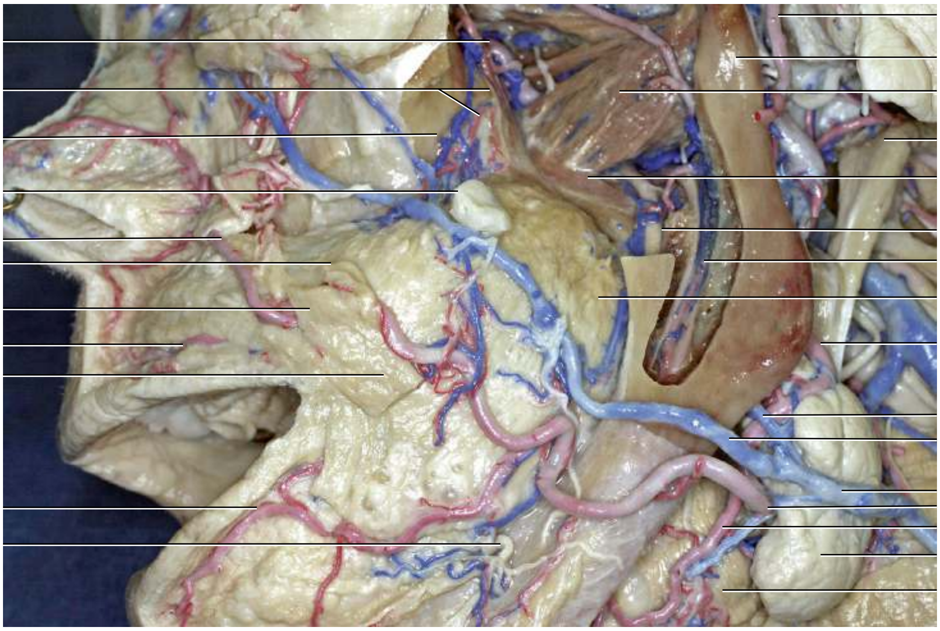


Fig. 13.10 Lateral view of the lower facial region. The course of the inferior alveolar nerve is shown

The parotid duct pierces the buccinator muscle opposite the maxillary third molar and then runs forward to open into the oral cavity opposite the maxillary second molar.

The inferior alveolar nerve arises from the mandibular nerve and emerges beneath the lateral pterygoid muscle. It then gives off a mylohyoid branch, which has motor and sensory components. Next, it enters the mandible with the vessels via the mandibular foramen. While in the mandibular canal within the mandible, the main trunk of the inferior alveolar nerve divides near the premolars into mental and incisive nerves. The mental nerve and vessels pass for a short distance through a mental canal before leaving the body of the mandible at the mental foramen to emerge onto the face. The mental nerve supplies the skin and mucosa of the lower lip and the labial gingivae of the mandibular anterior teeth. The mental nerve and the marginal mandibular branch have interconnections. The mental artery arises as a terminal branch of the inferior alveolar artery, a branch of the mandibular segment of the maxillary artery.

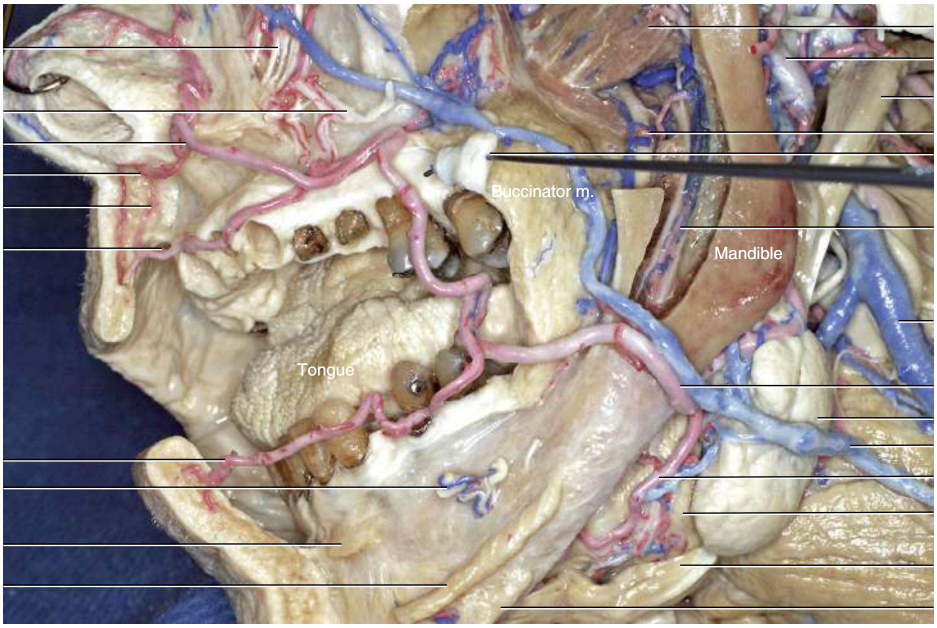


Fig. 13.11 Lateral view of the lower facial region. The inferior and superior labial arteries are shown

The facial artery lies anterior to the vein throughout its course, initially running closely together along the mandible, and then they course separately, with the vein running close to the anterior margin of the masseter muscle.

The superior labial artery is larger than the inferior labial artery. It courses along the edge of the upper lip, lying between the mucous membrane and the orbicularis oris muscle, and anastomoses with the artery on the opposite side. It supplies the upper lip and, in its course, gives rise to two branches that ascend to the nose: the septal branch, which ramifies on the nasal septum, and the columellar branch, which supplies the columella of the nose.

The inferior labial artery arises from the facial artery near the corner of the mouth. It passes upward and forward, deep to the depressor anguli oris muscle, and penetrates the orbicularis oris muscle. It travels in a tortuous course along the edge of the lower lip between this orbicularis oris muscle and the mucous membrane. The artery supplies the labial glands, the mucous membrane, and muscles of the lower lip and anastomoses with the artery on the opposite side.

The submental artery is a branch of the facial artery that arises after it leaves the submandibular gland. It passes forward over the mylohyoid muscle, just below the body of the mandible, and beneath the digastric muscle. It supplies the surrounding muscles, part of the platysma muscle, and the skin of the submental region.

14 Oral Floor and Upper Neck Regions

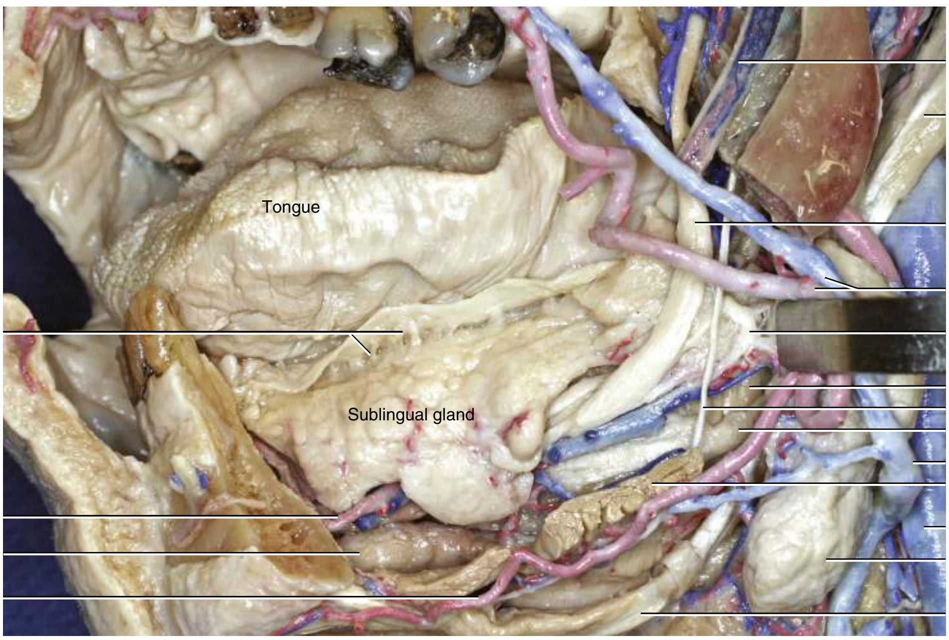


Fig. 14.1 Lateral view of the oral floor. Part of the mandible has been removed to show the submandibular ganglion

The submandibular ganglion is a parasympathetic ganglion situated on the floor of the mouth, on the superficial surface of the hyoglossus muscle. It lies between the lingual nerve and the deep part of the submandibular gland and is suspended by two roots from the lingual nerve. The submandibular ganglion is responsible for the innervation of the submandibular and sublingual glands. Preganglionic parasympathetic fibers originate from the superior salivatory nucleus in the brain stem. These fibers travel with the nervus intermedius of the facial nerve into the internal acoustic meatus and exit the skull through the petrotympanic fissure as the chorda tympani nerve. The chorda tympani nerve then joins the lingual nerve.

The inferior alveolar nerve gives off the mylohyoid branch before entering the mandibular canal. The mylohyoid branch passes inferiorly and anteriorly in the mylohyoid groove beneath the mylohyoid line. It supplies the mylohyoid muscle and the anterior belly of the digastric muscle. It also gives a few sensory filaments to supply the skin of the mentum.

The lingual nerve passes toward the floor of the mouth from the infratemporal fossa. It supplies the mucosa covering the anterior two-thirds of the dorsum of the tongue, the ventral surface of the tongue, the floor of the mouth, and the lingual gingivae of the mandibular teeth. The posterior one-third of the tongue is innervated by the glossopharyngeal nerve.

The mylohyoid muscle arises from the mylohyoid line on the medial surface of the body of the mandible. Its fibers interdigitate with those from the contralateral side to form a medial raphe. This raphe is attached to the mandible above and the hyoid bone below. The muscle raises the floor of the mouth during the initial stages of swallowing. It also helps to depress the mandible when the hyoid bone is fixed and aids in the elevation of the hyoid bone.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_14

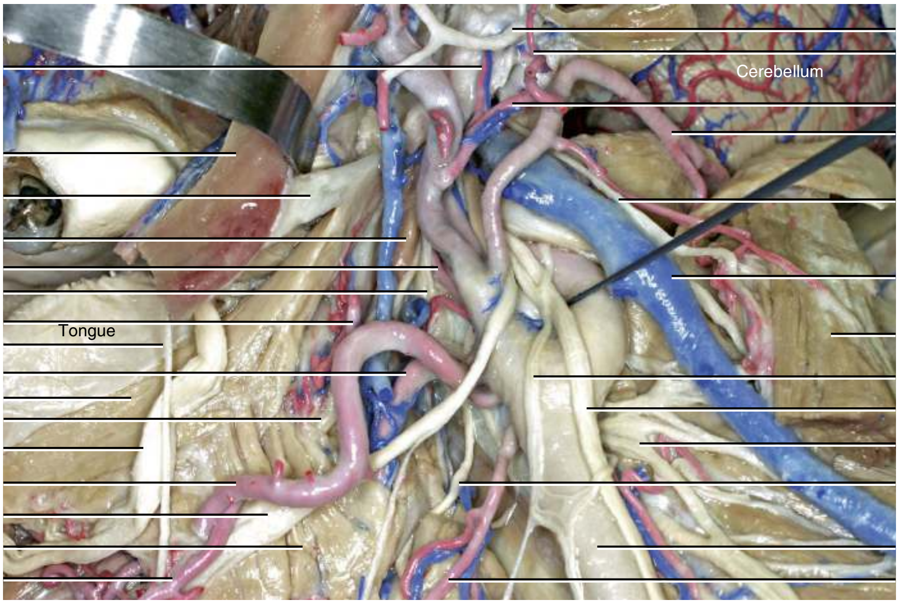


Fig. 14.2 Inferolateral view of the upper neck region. The branches of the external carotid artery are shown

The common carotid artery divides at the upper border of the thyroid cartilage, which is usually level with the upper boundary of the fourth cervical vertebra. At its origin, the external carotid artery is anteromedial to the internal carotid artery. The external carotid artery ascends anterior to the internal carotid artery through the parotid gland, deep to the retromandibular vein. Before its terminal bifurcation into the maxillary and the superficial temporal arteries, it gives rise to six branches: the ascending pharyngeal, superior thyroid, lingual, facial, occipital, and posterior auricular arteries.

The ascending pharyngeal artery is the first and smallest branch of the external carotid artery. It is a long, thin vessel deeply seated in the neck, beneath the other branches of the external carotid artery, and under the stylopharyngeus muscle. It arises from the posterior surface of the external carotid artery. The artery ascends between the internal carotid artery and the side of the pharynx to the undersurface of the base of the skull, lying on the longus capitis muscle.

The superior thyroid artery is the second branch of the external carotid artery. It arises at the level of the greater horn of the hyoid bone and supplies the thyroid gland, the sternocleidomastoid muscle, and the larynx.

The lingual artery arises from the external carotid artery just above the superior thyroid artery and passes beneath the hyoglossus muscle to enter the tongue. Its branches include the infrahyoid artery, the sublingual artery, and the deep lingual arteries, with the deep lingual artery being its terminal branch.

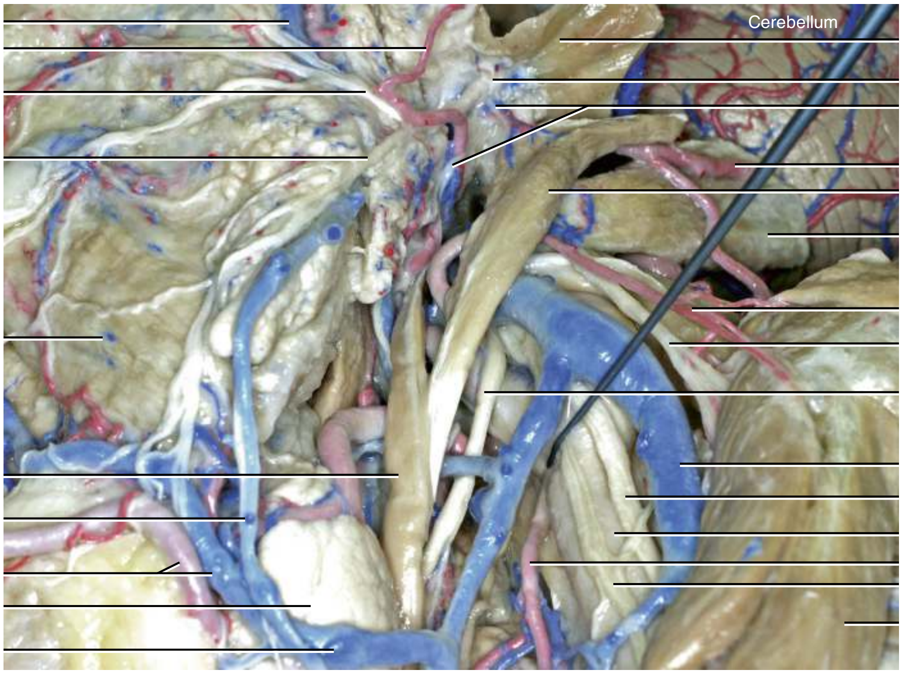


Fig. 14.3 Inferolateral view of the lower facial and upper neck region. The posterior belly of the digastric muscle is shown detached from the digastric groove

The ansa cervicalis is a loop of nerves that is part of the cervical plexus. The upper root of the ansa cervicalis is derived from the ventral ramus of the first cervical nerve (C1) and then connects to the hypoglossal nerve, forming a branch that descends as the superior root of the ansa cervicalis. This superior root descends along the carotid sheath, which covers the carotid artery, and is joined by the lower root of the ansa cervicalis, which arises from the cervical plexus (C2 and C3), forming the ansa cervicalis. Branches from the ansa cervicalis innervate most of the infrahyoid muscles, including the sternothyroid, sternohyoid, and omohyoid muscles.

The facial artery arises from the external carotid artery immediately above the greater horn of the hyoid bone. It ascends behind the submandibular gland, passing deep to the stylohyoid muscle and the posterior belly of the digastric muscle. Above the stylohyoid muscle, it turns downward and forward between the lateral surface of the submandibular gland and the medial pterygoid muscle to reach the lower border of the mandible.

The vagus nerve exits the skull through the jugular foramen. It passes into the carotid sheath between the internal carotid artery and the internal jugular vein. The nerve descends from the head through the neck and chest and into the abdomen, contributing to the innervation of the viscera.

Posterior Neck and Occipital Regions

15

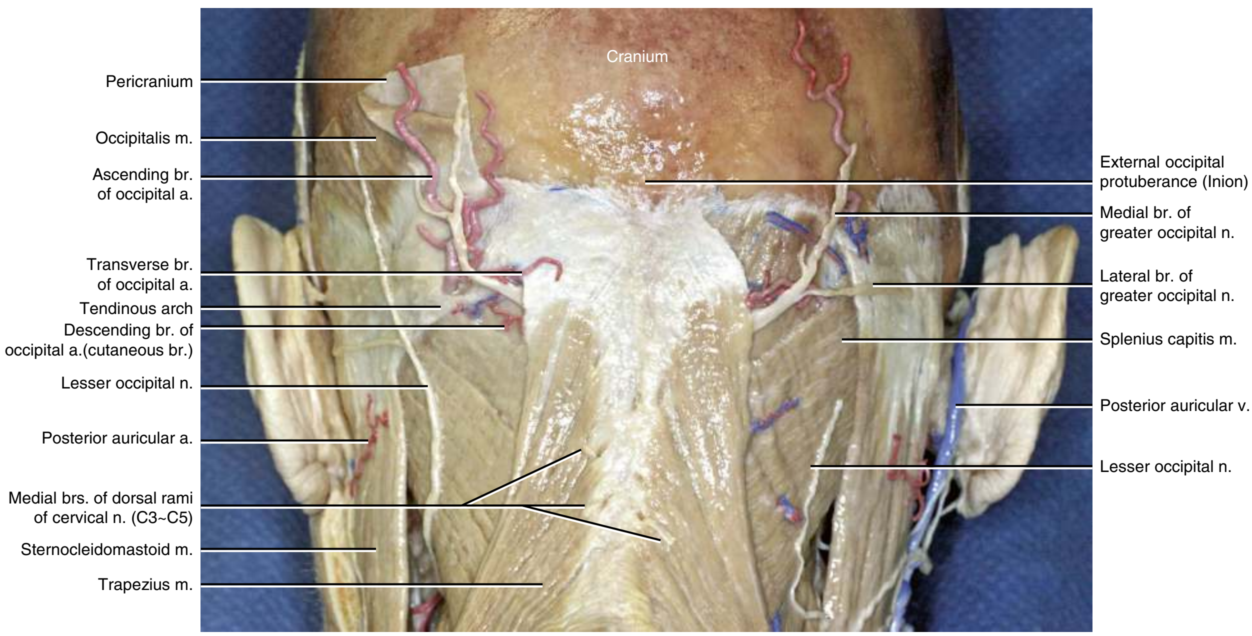


Fig. 15.1 The posterior neck region. The skin and the galea aponeurotica have been removed to leave the occipitalis muscle on the left side

The occipitalis muscle has two muscle bellies separated in the midline by the aponeurosis. Each occipital belly arises from the lateral two-thirds of the highest nuchal line of the occipital bone and the mastoid process of the temporal bone. It extends forward to become continuous with the galea aponeurotica. It is a part of the occipitofrontalis muscle along with the frontalis muscle. The posterior auricular branch of the facial nerve innervates the muscle. Its function is to move the scalp back.

The greater occipital nerve and occipital artery reach the subcutaneous tissues by piercing the attachment between the trapezius muscle and the sternocleidomastoid muscle below the superior nuchal line. The occipital artery crosses deeply to the greater occipital nerve approximately 4 cm lateral to the external occipital protuberance (inion). After it pierces the deep fascia, it gives rise to three major cutaneous branches: descending, transverse, and ascending. The greater occipital nerve branches into medial and lateral branches around the superior nuchal line. It supplies the skin over the occipital part of the scalp up to the vertex of the skull.

The lesser occipital nerve has a variable origin, either from the second or the second and third cervical ventral rami. The lesser occipital nerve lies approximately 7 cm lateral to the external occipital protuberance. This nerve supplies the skin over the lateral scalp and the cranial surface of the upper part of the auricle.

The medial branches of the dorsal rami of the third, fourth, and fifth cervical nerves pierce the trapezius muscle at its paraspinal position to supply the skin of the back of the neck.

The trapezius muscle covers the back of the neck and upper back. It extends from the medial half of the superior nuchal line, the external occipital protuberance, and the spinous processes of the cervical and thoracic vertebrae. It converges on the shoulder to attach to the spine of the scapula, the acromion, and the lateral third of the clavicle.

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_15

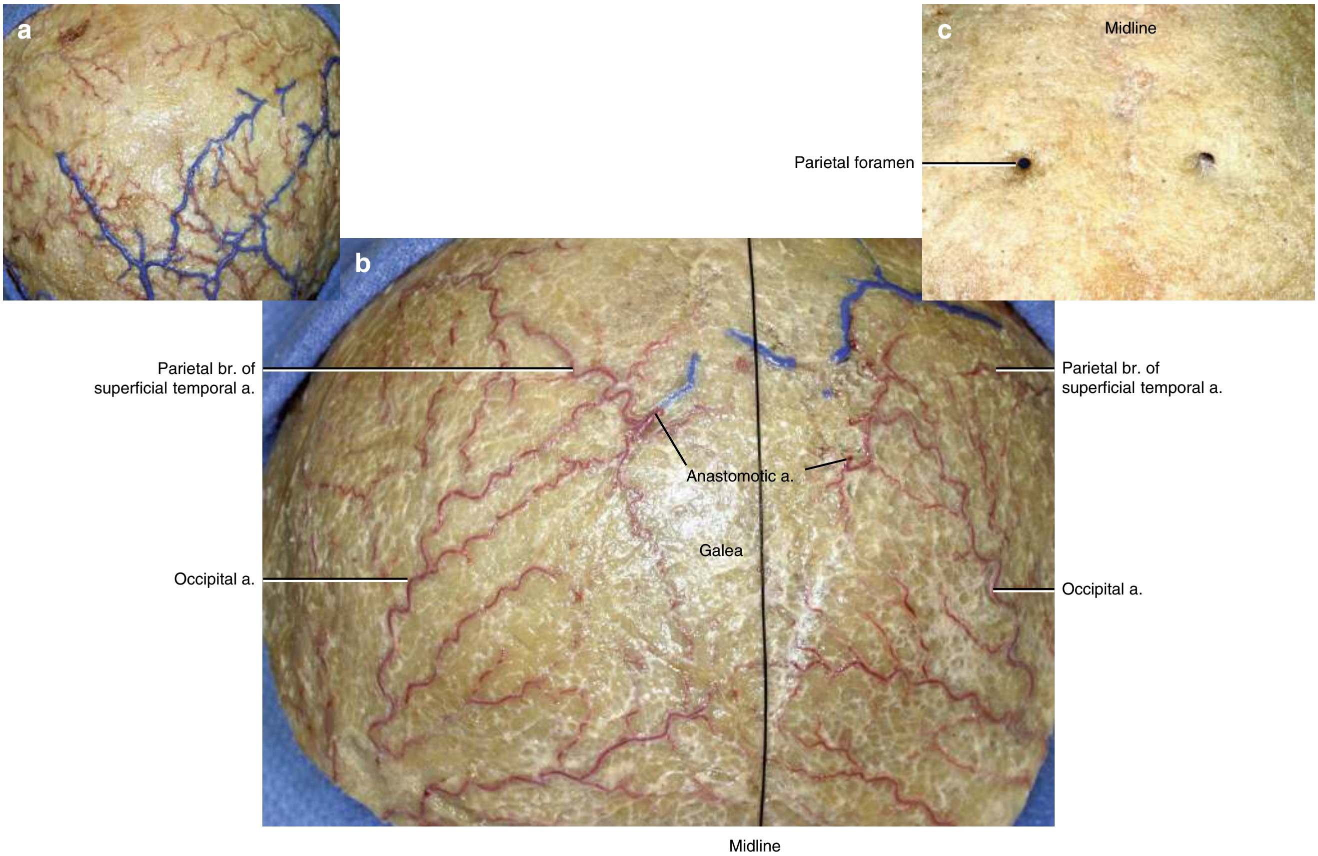


Fig. 15.2 (**a**–**c**) Superior view of the scalp. (**a**) The skin has been removed to show the galea aponeurotica. (**b**) The scalp, without the pericranium, has been turned inside out. (**c**) Superior view of the skull

The branches from the superficial temporal, posterior auricular, occipital, supraorbital, and supratrochlear arteries freely anastomose in the scalp.

Figure 15.2b shows the meningeal branch (anastomotic artery) of the occipital artery on both sides, which passes through the parietal foramen. The well-developed anastomotic artery is found in approximately 50% of specimens, and it enhances the vascular network of the galea and scalp. The vascular connections in the galea and scalp contribute to the rich vascularity of the galeal and scalp flaps on the head.

The parietal foramen is found in more than 60% of skulls. It may be unilateral, bilateral, or duplicated on one or both sides. The vertical distance from the inion to the level of the parietal foramen is approximately 8 cm, and the distance from the midline to the foramen is within 10 mm (Fig. 15.2c).

The superficial temporal artery that supplies the galea does not cross the midline nor does it anastomose with the contralateral superficial temporal artery on the galeal layer. The veins on the galea generally course superficially over the arteries except in the vertex region. The arteries in the vertex region course superficially over the veins and anastomose with the contralateral arteries in the subcutaneous layer (Fig. 15.2a).

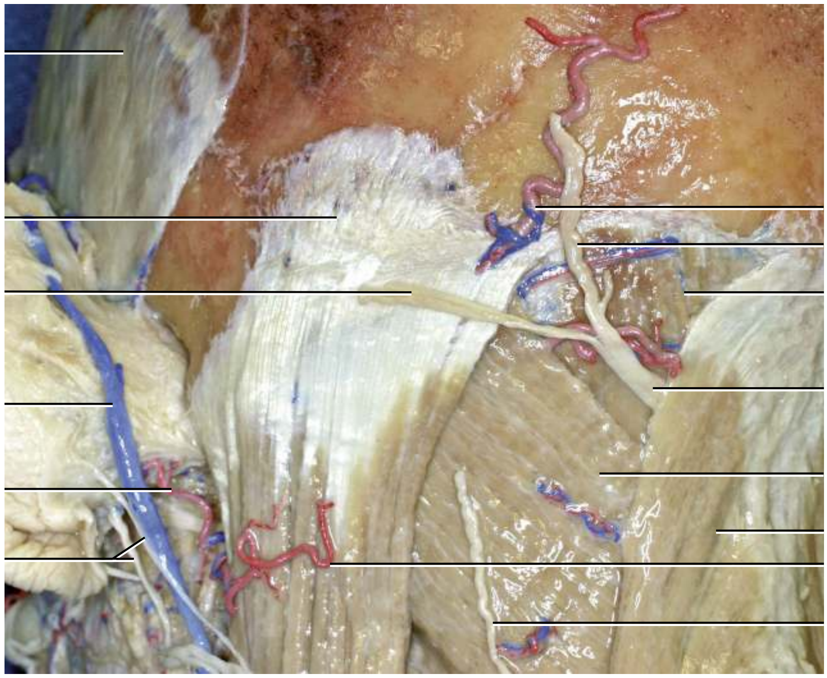


Fig. 15.3 The posterior neck region. The galea aponeurotica and occipitalis muscle have been removed

The sternocleidomastoid muscle descends obliquely across the side of the neck from the lateral half of the superior nuchal line and mastoid process to the upper part of the sternum and the adjacent part of the clavicle. The accessory nerve innervates the sternocleidomastoid muscle. The function of this muscle is to rotate the head to the opposite side or obliquely rotate the head. When both sides act together, the neck flexes, and the head is drawn forward. The sternocleidomastoid branches of the occipital artery supply the superior part of the muscle. The spinal part of the accessory nerve supplies the sternocleidomastoid muscle. It passes through or deep to the muscle to emerge into the posterior triangle on the way to the trapezius muscle.

The sternocleidomastoid muscle divides the side of the neck into an anterior and posterior triangle. The anterior triangle is formed by the inferior border of the mandible extending from the midline to the mastoid process superiorly, the midline of the neck anteriorly, and the anterior border of the sternocleidomastoid posteriorly. The posterior triangle is bounded by the posterior border of the sternocleidomastoid anteriorly, the middle third of the clavicle inferiorly, and the anterior border of the trapezius posteriorly.

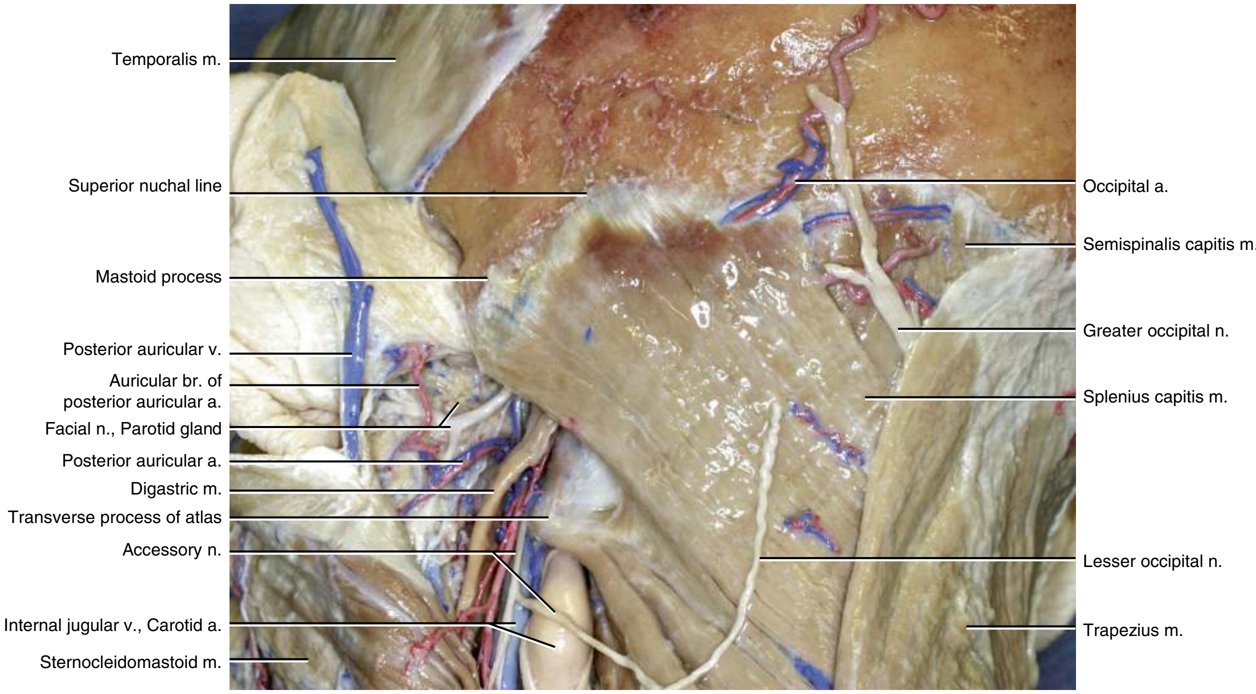


Fig. 15.4 The posterior neck region. The sternocleidomastoid muscle has been reflected inferiorly

The posterior auricular artery is a small artery that arises from the external carotid artery above the digastric and stylohyoid muscles. It ascends over the digastric muscle between the auricular cartilage and the mastoid process, pierces the deep fascia at the level of the external acoustic meatus, and divides into the auricular and occipital branches. The auricular branch ascends deep to the posterior auricular muscle and anastomoses with the superficial temporal artery. The auricular branch has small branches that pierce the auricular cartilage to reach the external surface.

The splenius capitis, situated deep to and partially covered by the trapezius and sternocleidomastoid muscles, extends from the mastoid process and the occipital bone just below the lateral third of the superior nuchal line to the spinous processes of the lower cervical and upper thoracic vertebrae.

The accessory nerve descends obliquely to innervate the trapezius muscle. It passes over the internal jugular vein in approximately 70% of cases. The nerve crosses the internal jugular vein around the level of the posterior belly of the digastric muscle. As it descends, the nerve pierces the sternocleidomastoid muscle, providing motor branches. It then continues its descent until it reaches the trapezius muscle, where it provides motor innervation to all parts of the muscle.

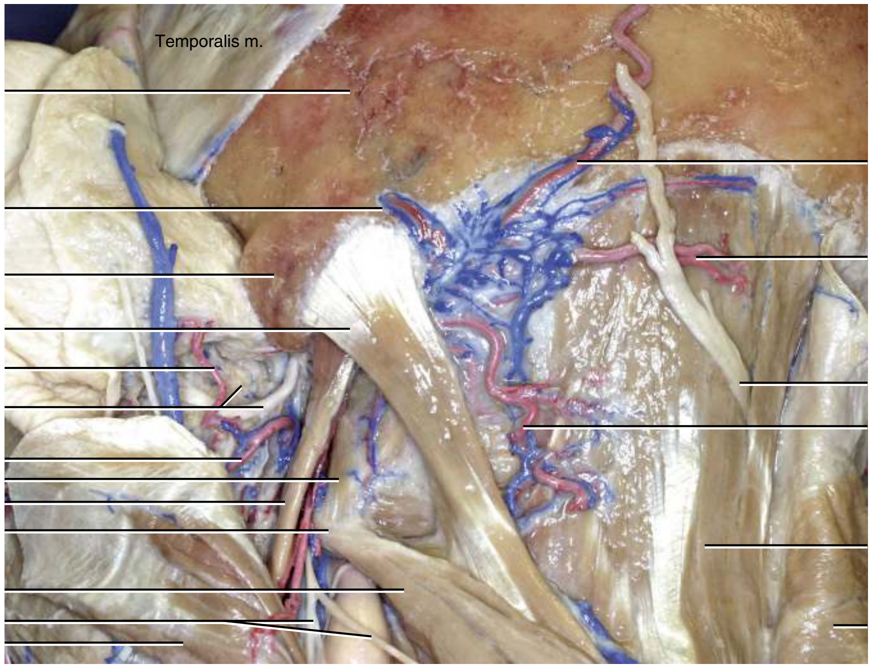


Fig. 15.5 The posterior neck region. The splenius capitis and trapezius muscles have been reflected medially

The mastoid foramen is located on the posterior border of the temporal bone. It transmits a mastoid emissary vein, which connects to the sigmoid sinus, and a small meningeal branch of the occipital artery, the posterior meningeal artery, which supplies the dura mater.

The semispinalis capitis muscle, situated deep to the splenius capitis and trapezius muscles, arises from the medial part of the area between the superior and inferior nuchal lines of the occipital bone and attaches inferiorly to the upper thoracic and lower cervical vertebrae. The longissimus capitis muscle, situated deep to the splenius capitis and sternocleidomastoid muscles, arises from the posterior edge of the mastoid process and attaches to the transverse processes of the lower cervical and upper thoracic vertebrae.

The greater occipital nerve ascends obliquely between the inferior oblique and the semispinalis capitis muscle. It pierces the semispinalis capitis and the trapezius muscle near their attachments to the occipital bone. As it passes through these muscles, the greater occipital nerve gives off branches that contribute to the innervation of the semispinalis capitis muscle. It then ascends with the occipital artery to supply sensory innervation to the scalp as far forward as the vertex.

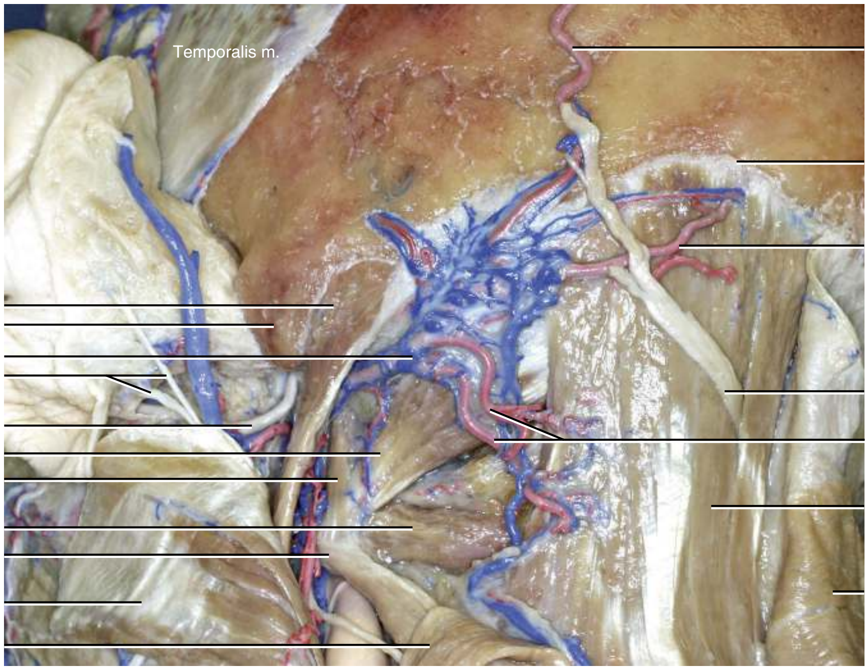


Fig. 15.6 The posterior neck region. The longissimus capitis muscle has been reflected inferiorly

The occipital artery arises from the posterior surface of the external carotid artery opposite the facial artery and ascends posteriorly. On its way to the mastoid process, it crosses the internal carotid artery, internal jugular vein, and hypoglossal and spinal accessory nerves. It passes beneath the lower portion of the parotid gland, and then courses horizontally backward through the occipital groove of the temporal bone, covered by all the muscles attached to the mastoid process: the sternocleidomastoid, splenius capitis, longissimus capitis, and the posterior belly of the digastric muscles. It lies superficial to the superior oblique and semispinalis capitis muscles. The artery reaches the subcutaneous tissue by piercing the attachments between the trapezius muscle and the sternocleidomastoid muscle near the superior nuchal line.

The descending branch of the occipital artery, its largest branch, descends on the back of the neck and divides into superficial and deep portions. The superficial part passes beneath the splenius, giving off branches that pierce this muscle to supply the trapezius muscle. The deep part descends beneath the semispinalis capitis muscle and anastomoses with branches of the vertebral artery.

The suboccipital muscles in the next layer are a group of muscles situated deep to the splenius, semispinalis, and longissimus capitis in the suboccipital area. This group includes the superior oblique, which extends from the area lateral to the semispinalis capitis between the superior and inferior nuchal lines to the transverse process of the atlas; the inferior oblique, which extends from the spinous process and lamina of the axis to the transverse process of the atlas; the rectus capitis posterior major, which extends from and below the lateral part of the inferior nuchal line to the spine of the axis; and the rectus capitis posterior minor, which is situated medial to and is partially covered by the rectus capitis posterior major and extends from the tubercle on the posterior arch of the atlas to the medial part of the inferior nuchal line.

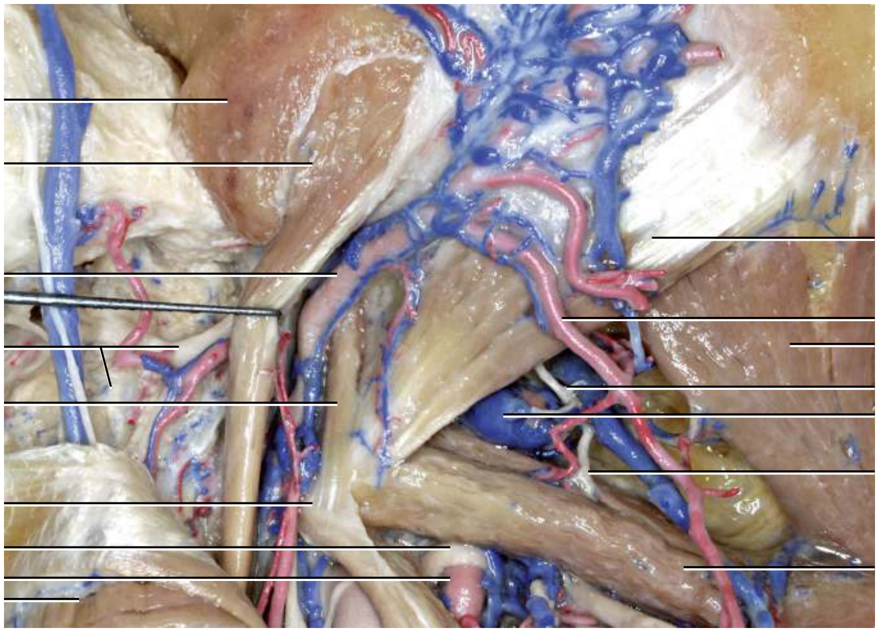


Fig. 15.8 The posterior neck region. The innervation to the muscles from the dorsal ramus of C1 is shown

The suboccipital triangle is a region bounded above and medially by the rectus capitis posterior major, above and laterally by the superior oblique, and below and laterally by the inferior oblique. The posterior atlanto-occipital membrane and the posterior arch of the atlas form the floor of the triangle. The structures within the triangle include the terminal extradural segment of the vertebral artery and the dorsal ramus of the first cervical nerve.

The C2 nerve emerges between the posterior arch of the atlas and the lamina of the axis, where the spinal ganglion is located extradurally, medial to the inferior facet of C1 and the vertebral artery. The nerve divides into a large dorsal and a smaller ventral ramus. After passing below and supplying the inferior oblique muscle, the dorsal ramus divides into a large medial and a small lateral branch. The medial branch forms the greater occipital nerve. The lateral branch sends filaments that innervate the splenius, longissimus, and semispinalis capitis muscles and is often joined by a corresponding branch from the C3 nerve.

The C2 ventral ramus passes between the vertebral arches and transverse processes of the atlas and axis and behind the vertebral artery. Two branches of the C2 and C3 ventral rami, the lesser occipital and great auricular nerves, curve around the posterior border of the sternocleidomastoid and ascend along the sternocleidomastoid muscle to supply the skin behind the ear.

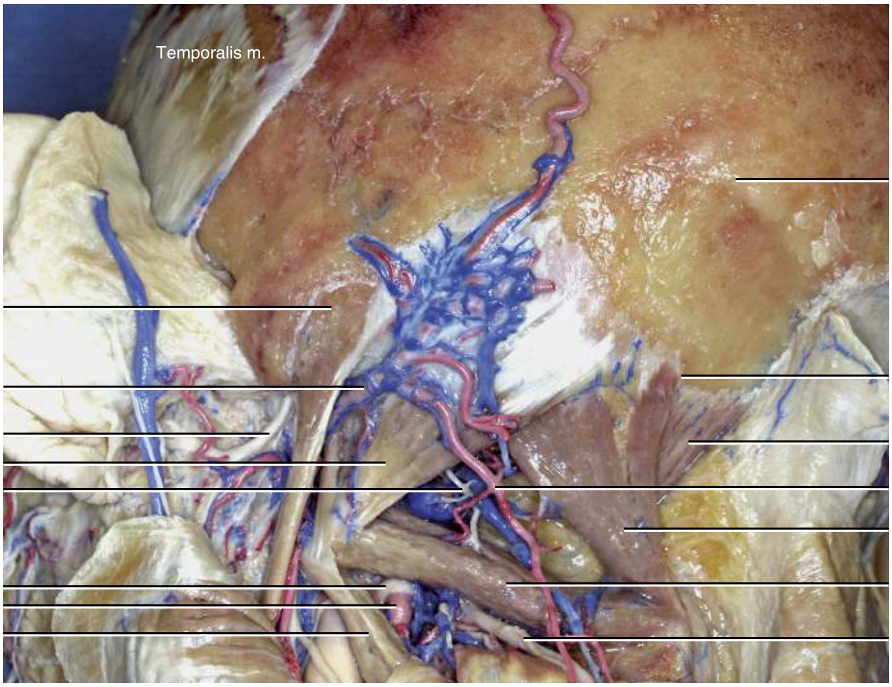


Fig. 15.7 The posterior neck region. The semispinalis capitis muscle has been reflected inferiorly to expose the suboccipital triangle

The C1, C2, and C3 nerves divide into dorsal and ventral rami. Each dorsal ramus, except the first, divides into medial and lateral branches that supply the skin and muscles of the posterior region of the neck. The C1 dorsal ramus, also called the suboccipital nerve, leaves the vertebral canal between the occipital bone and the atlas. It passes between the posterior arch of the atlas and the vertebral artery to reach the suboccipital triangle. It sends branches to the rectus capitis posterior major, rectus capitis posterior minor, superior oblique, inferior oblique, and semispinalis capitis muscles. Occasionally, it has a cutaneous branch accompanying the occipital artery to the scalp. The C1 ventral ramus passes between the posterior arch of the atlas and the vertebral artery, and then passes forward, lateral to the lateral mass of the atlas and medial to the vertebral artery, to supply the rectus capitis lateralis muscle.

16 Lateral Neck Region

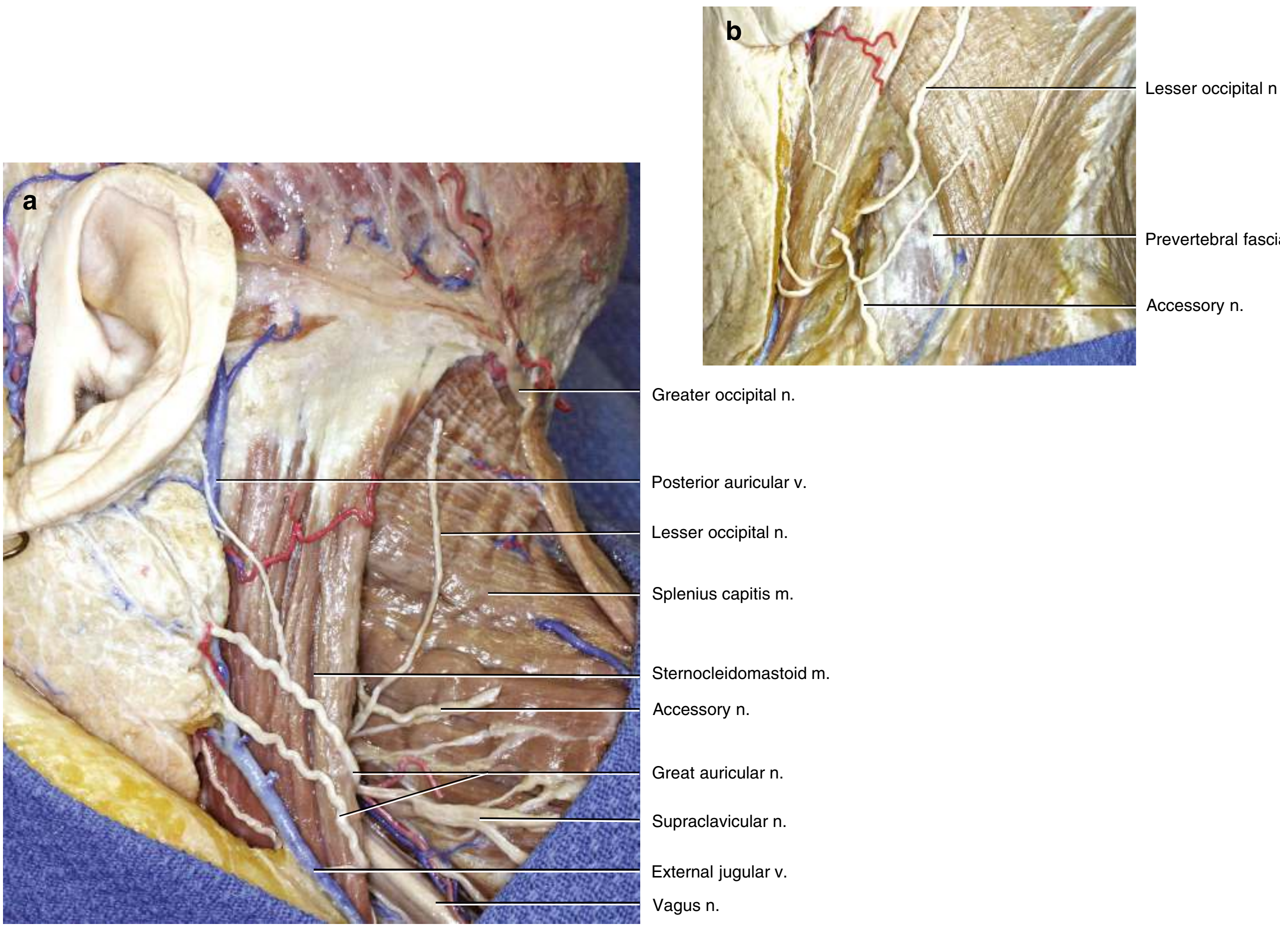


Fig. 16.1 (**a**) The lateral neck region. (**b**) Posterolateral view of the posterior triangle

The ventral rami of the second, third, and fourth cervical spinal nerves supply the cutaneous branches: the lesser occipital nerve (C2), the great auricular nerve (C2, 3), the transverse cervical nerve (C2, 3), and the supraclavicular nerve (C3, 4), via the cervical plexus. The cervical plexus consists of two types of branches: cutaneous and muscular. The muscular branches include the ansa cervicalis, the phrenic nerve, and segmental branches. The cutaneous branches emerge at the posterior border of the sternocleidomastoid muscle.

The lesser occipital nerve curves around the accessory nerve, ascends along the posterior border of the sternocleidomastoid, and pierces the deep fascia near the skull to supply the skin over the lateral scalp and posterior surface of the auricle. The great auricular and transverse cervical nerves enter

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4_16

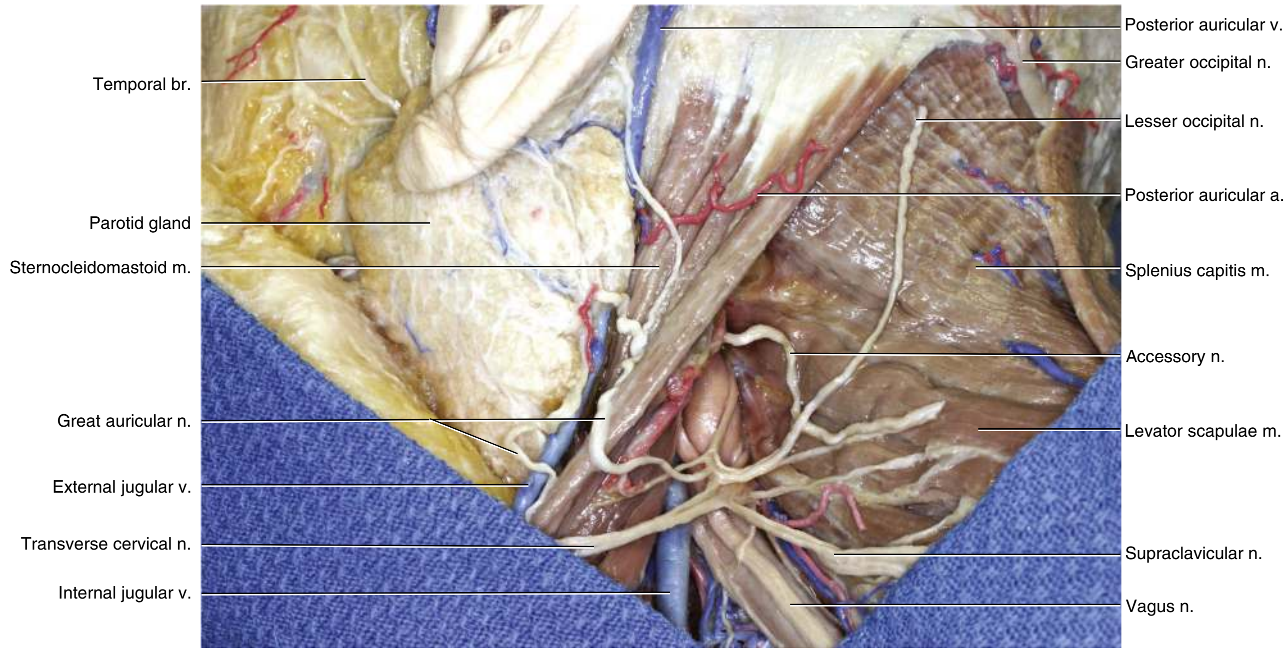


Fig. 16.2 The lateral neck region. The distal part of the sternocleidomastoid muscle has been retracted anteriorly to expose the cervical plexus

the posterior triangle, turning sharply around the posterior border of the sternocleidomastoid muscle. The transverse cervical nerve supplies the skin on the anterolateral parts of the neck. The supraclavicular nerve emerges from beneath the sternocleidomastoid, passing across and down the posterior triangle toward the clavicle, supplying the skin over the upper chest, including the pectoralis major and deltoid regions, and the upper and posterior parts of the shoulder.

The prevertebral fascia is prolonged downward and laterally behind the carotid vessels and in front of the scalene muscles. It forms a sheath for the brachial plexus and subclavian vessels in the posterior triangle of the neck.

The great auricular nerve emerges around the midpoint of the posterior border of the sternocleidomastoid muscle. It passes forward and upward across the muscle to reach the angle of the mandible on and beneath the parotid fascia. It supplies the skin overlying the mastoid process, the lower part of the auricle, and the angle of the mandible. It may connect with branches of the facial nerve within the parotid gland. The posterior auricular nerve, which arises from the main trunk of the facial nerve, communicates with the great auricular nerve. The great auricular and sural nerves are the most commonly used for nerve grafting. However, harvesting the great auricular nerve inevitably results in a sensory deficit of the earlobe, a complication that can be significant and difficult to ignore for some patients.

The accessory nerve also emerges from the sternocleidomastoid muscle into the posterior triangle. The accessory nerve is usually found slightly above the great auricular point, where the great auricular nerve emerges from the sternocleidomastoid muscle. It descends obliquely across the levator scapulae muscle to enter the trapezius.

The external jugular vein lies on the lateral surface of the sternocleidomastoid muscle. It is formed by the confluence of the posterior branch of the retromandibular vein and the posterior auricular vein. It drains into the subclavian or the internal jugular vein.

Index

N. Yoshioka et al., *Atlas of the Facial Nerve and Related Structures*, https://doi.org/10.1007/978-981-96-3620-4