SEVENTH EDITION

Scott-Brown's Otorhinolaryngology, Head and Neck Surgery

VOLUME 2

Edited by

Michael Gleeson

George G Browning, Martin J Burton, Ray Clarke, John Hibbert, Nicholas S Jones, Valerie J Lund, Linda M Luxon, John C Watkinson

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How to use this book

This new edition of *Scott-Brown's Otorhinolaryngology, Head and Neck Surgery* incorporates some special features to aid the readers' understanding and navigation of the text. These are described below.

SEARCH STRATEGY

The majority of the chapters feature a search strategy indicating the key words used by the author when conducting their literature review in order to prepare the chapter, so that the reader can repeat and develop the search.

EVIDENCE SCORING

For the major sections in each chapter, the authors have used a hierarchical system to indicate the level of evidence supporting their statements. This is shown in the text in the form [***], with the number of stars indicating the level of evidence. The key to this system is shown in the table below.

Level	Category of evidence
****	Systematic reviews, meta-analyses of randomized controlled trials and randomized controlled trials
***	Non-randomised studies
**	Observational or non-experimental studies
*	Expert opinion

Where no level is shown, the quality of supporting evidence, if any exists, is of low grade only (for example, case reports, clinical experience etc.). For more information on evidence scoring, please refer to Chapter 304, Evidence-based medicine; and 305 Critical appraisal skills.

CLINICAL RECOMMENDATIONS

The authors have indicated the basis on which they have made clinical recommendations by grading them according to the level of the supporting evidence. This is shown in the text in the form [Grade A], with the grade indicating the level of evidence supporting the recommendation. The key to this system is shown in the table below.

Grade	Nature of supporting evidence
A	Recommendation based on evidence from meta-analyses of randomized controlled trails
B	Recommendation based on evidence from high quality case-controlled or cohort studies
C	Recommendation based on evidence from low quality case-controlled or cohort studies
D	Recommendation based on evidence from clinical series or expert opinion

Recommendations are graded where the author is satisfied that the literature supports such a grading; otherwise a grading may not be given.

REFERENCE ANNOTATION

The reference lists are annotated with an asterisk, where appropriate, to guide readers to key primary papers and major review articles. We hope that this feature will render the lists of references more useful to the reader and will encourage self-directed learning among both trainees and practicing physicians.

Contents

Please note: The table of contents for all three volumes can be found on the *Scott-Brown* website at: www.scottbrownENT.com.

The list of contributors, preface and list of abbreviations are included in the prelims for Volume 1.

The index for all three volumes is included in Volume 3.

PART 13

THE NOSE AND PARANASAL SINUSES

EDITED BY VALERIE J LUND

104

Anatomy of the nose and paranasal sinuses

H STAMMBERGER AND VALERIE J LUND

SEARCH STRATEGY

The data in this chapter are supported by a literature search using the key words endoscopic anatomy, paranasal sinuses, nasal cavity and external nose.

DEVELOPMENT OF NOSE AND PARANASAL SINUSES

The external nose and nasal cavity

The nose develops from a number of mesenchymal processes around the primitive mouth (**Figure 104.1**).[1,2] The nasal cavity is first recognizable in the 5.6 mm (crown–rump distance) embryo in the fourth intrauterine week as the **olfactory** or **nasal placode**, a thickening of the ectoderm above the stomatodaeum.[3] This placode sinks to form the **olfactory pit** lying between the proliferating mesoderm of the medial and lateral nasal folds of the frontonasal process. This deepens to form the **nasal sac** by the fifth week (**Figure 104.2**).

In the 12.5 mm embryo, the maxillary process of the first branchial arch grows anteriorly and medially to fuse anteriorly with the medial nasal folds and the frontonasal process which closes the nasal pits off to form widely separated primitive, nasal cavities (**Figure 104.3**). The primitive nasal cavity and mouth are separated initially by a bucconasal membrane. This gradually thins as the nasal sacs extend posteriorly and eventually breaks down at the 14–15 mm stage to form the primitive choanae. These are more anteriorly placed than the definitive choana due to continuous posterior growth of the palate.[4] The floor anterior to the choana forms from mesenchymal extensions of the medial nasal folds to produce the premaxilla and ultimately the upper lip and medial crus of the lower lateral cartilages.

The maxillary process also grows ventrally from the dorsal end of the mandibular process (first visceral arch) to join the lateral nasal fold around the nasomaxillary groove. Ectoderm in this region eventually canalizes to form the nasolacrimal duct. The lateral nasal folds also form the nasal bones, upper lateral cartilages and lateral crus of the lower lateral cartilages.

The palate and nasal septum

The primitive palate begins to form anteriorly with fusion of the maxillary and frontonasal processes by the 13.5 mm embryo stage. A midline ridge develops from the posterior edge of the frontonasal process in the roof of the oral cavity and extends posteriorly to the opening of Rathke's pouch (**Figure 104.4**). This becomes the nasal septum which is continuous anteriorly with the partition between

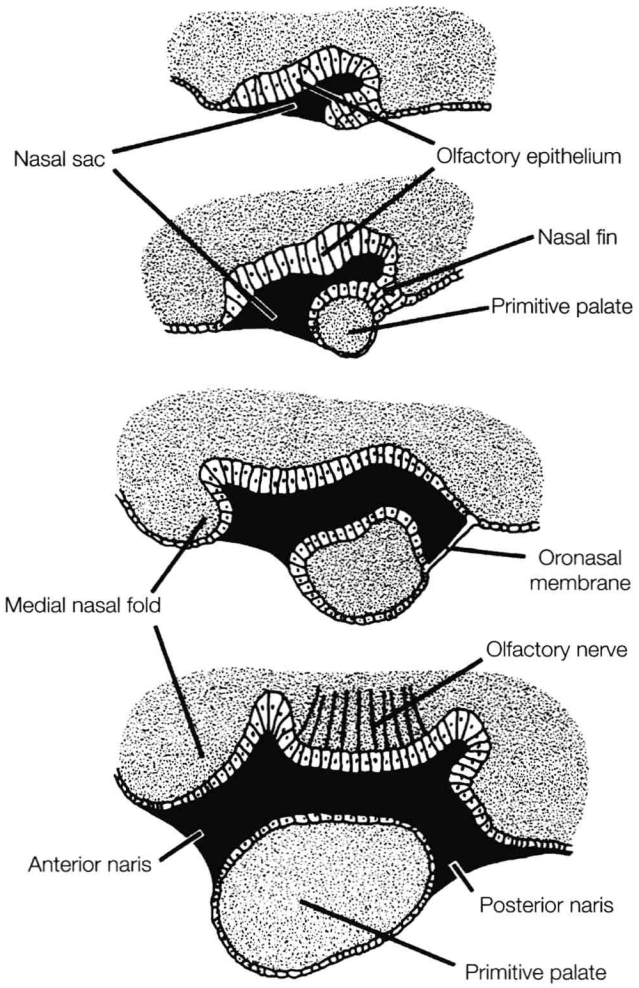

Figure 104.1 Development of the nasal sac, nasal cavity and primitive palate. After Hamilton and Mossman[1].

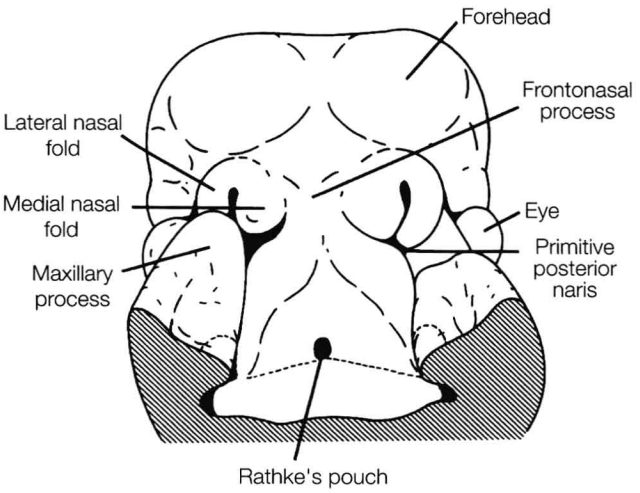

Figure 104.2 The roof of the stomatodaeum of a 12 mm human embryo illustrating the development of the primitive palate and posterior nares by approximation of the maxillary processes to the lateral and medial nasal folds. The previous site of attachment of the buccopharyngeal membrane is represented by a dotted line and part of the left maxillary process has been removed. After Hamilton and Mossman[1].

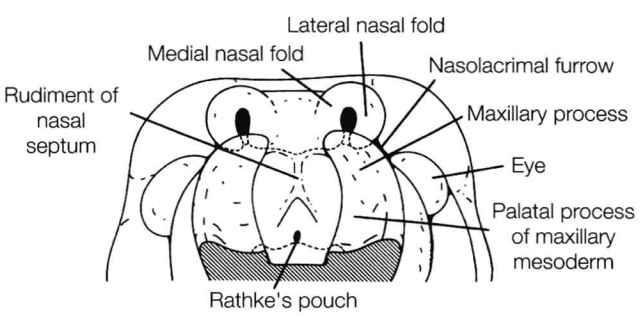

Figure 104.3 The roof of the stomatodaeum of a 12.5 mm embryo. After Hamilton and Mossman[1].

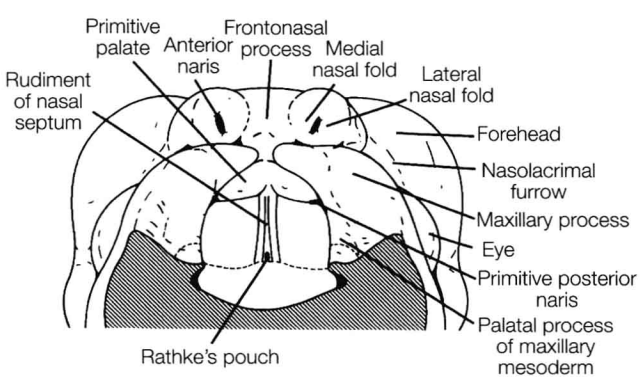

Figure 104.4 The roof of the stomatodaeum of a 13.5 mm embryo. After Hamilton and Mossman[1].

the primitive nasal cavities. As the nasal cavities enlarge, the palatal processes, derived from the lateral maxillary mesoderm, grow medially towards each other and the septum. Initially, they lie lateral to the tongue, but as this moves ventrally with further growth, the palatal processes swing medially and fuse horizontally (**Figures 104.5** and **104.6**). The fusion begins along the posterior margin of the primitive palate and is complete except for a midline dehiscence at the future site of the incisive canal. Fusion continues between the palatal processes and the septum from anterior to posterior, separating the nasal and oral cavities and most posteriorly the nasopharynx and oral cavity as the palatal processes complete the soft palate and uvula.

On either side of the anterior septum, in relation to the paraseptal Jacobson's cartilage, an invagination of ectoderm forms the vomeronasal organ, which largely disappears in man, leaving only a blind tubular pouch, 2–6 mm long.[5] Longitudinal strips of cartilage 7–15 mm in length may be identified in the embryo, lying adjacent to the vomeronasal organ on either side of the septal cartilage. These may occasionally remain as discrete entities in the adult but more usually involute, leaving only a small cartilaginous bulge. The primitive septum is initially made entirely of cartilage. The superior

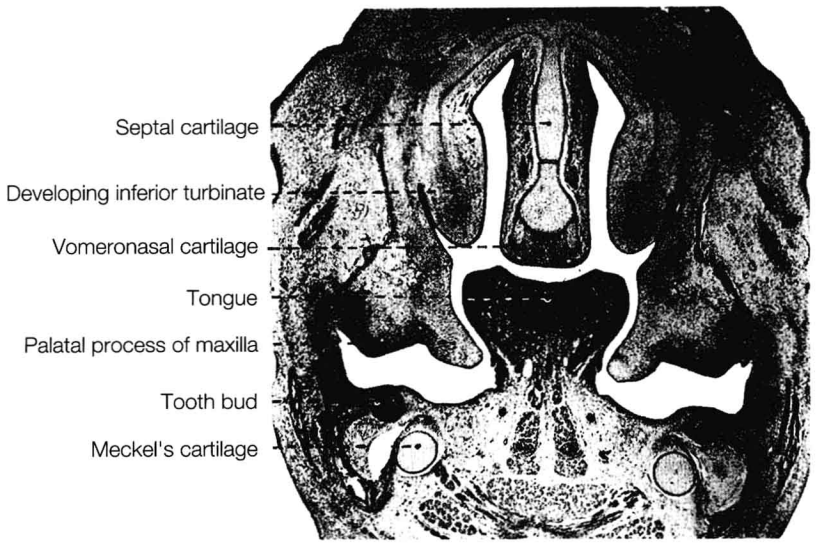

Figure 104.5 Section through the developing palate of a 20 mm human foetus. After Hamilton and Mossman[1].

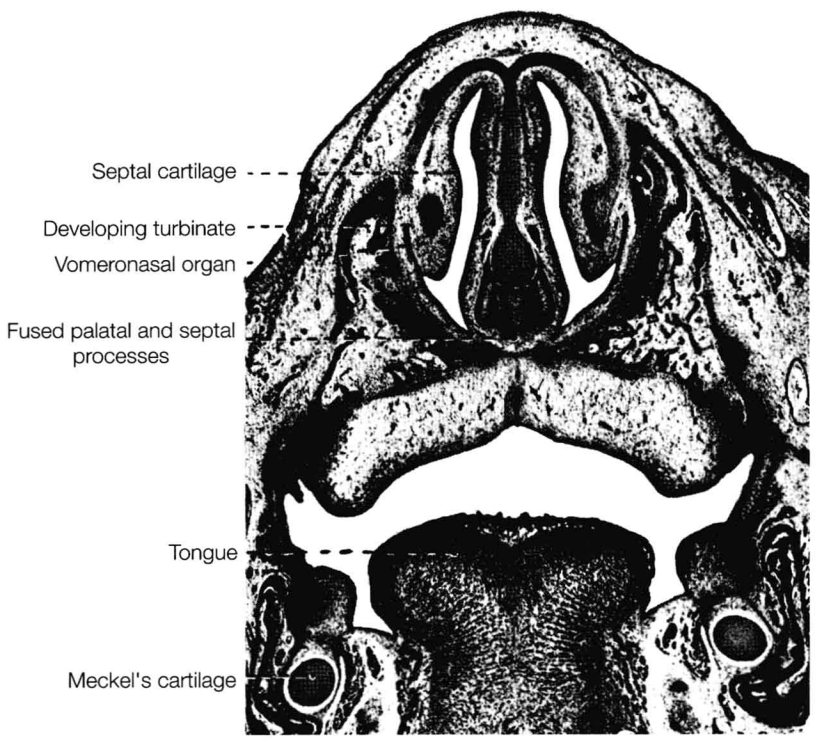

Figure 104.6 Section through the developing palate of a 48 mm human foetus. After Hamilton and Mossman[1].

part ossifies to form the perpendicular plate of the ethmoid (from crista galli downwards[6,7]) and the vomer in the posteroinferior portion, leaving an anteroinferior quadrilateral cartilaginous plate. Two ossification centres appear for the vomer at the eighth foetal week on either side of the cartilage, uniting to form a deep bony groove in which the cartilage sits. As growth continues, part of the cartilage absorbs as the two bony lamellae fuse. By puberty, the lamellae are almost completely united with everted alae and an anterior groove as indications of the vomer's bilaminar origin. The nasal bones arise during the tenth and eleventh weeks.

The paranasal bones and sinuses

THE MAXILLA

The maxilla arises during the sixth and seventh weeks from five ossification centres. In the fourth foetal month these fuse to form the alveolar, palatine, zygomatic and frontal processes and the floor of the orbit. A further centre appears in the medial floor of the pyriform aperture, forming the premaxilla in which the upper incisor teeth develop. The premaxilla forms the anterior nasal spine and fuses with the vomeronasal cartilages laterally and septal cartilage superiorly.