REVIEW OF CLINICAL EMBRYOLOGY OF HEAD AND NECK

OUTLINE - EMBRYOLOGY UNDERLYING CLINICAL CONDITIONS

I. EARLY DEVELOPMENT OF FACE: CLEFT LIP, CLEFT PALATE, OBSTRUCTED NASOLACRIMAL DUCT

II. BRANCHIAL ARCHES - STRUCTURES FORMED AND ANOMALIES: BRANCHIAL CYSTS AND FISTULI

III. THYROID DEVELOPMENT - ECTOPIC THYROID, THYROGLOSSAL DUCT CYSTS
I. EARLY DEVELOPMENT - FEW STRUCTURES IN THE HEAD ARE DERIVED FROM SOMITES

Many structures in the body are derived from somites; however, only two groups of muscles in the head are derived from somites.

1) Preotic myotomes (somitomeres) form extrinsic muscles of eye:
   III - Oculomotor, IV - Trochlear, VI - Abducens.

2) Occipital myotomes form muscles of tongue
   - XII - Hypoglossal N.

Note: this is GSE innervation
MANY STRUCTURES ARE FROM BRANCHIAL ARCHES

1. BRANCHIAL ARCHES-
Structures which develop in foregut (pharynx) and are similar to gills of fish

- Gill = Branchial

- Gills of fish are composed of cartilage and have muscles, nerves, arteries

~4 weeks → ~11 weeks
EARLY DEVELOPMENT: HEAD END ENLARGES

HEAD END OF TRILAMINAR EMBRYO

FRONTONASAL PROCESS = Central swelling

NEURAL CREST CELLS

Trilaminar embryo folds and head end enlarges

Neural crest cells invade head and neck lateral to rostral part of foregut to develop branchial arches
DEVELOPMENT OF FACE

First arch develops Maxillary and Mandibular process; Maxillary processes (bilateral) form part of upper lip and palate

Frontonasal Process - formed by mesenchyme below brain

Maxillary and Mandibular processes surround developing mouth (Stomodeum)

Nasal Placodes (thickenings) form in Frontonasal process at site of external nares (nostrils)
DEVELOPMENT OF UPPER LIP

Medial & Lateral Nasal Processes–form at margins of nasal placodes

Medial nasal processes and Maxillary Processes –fuse at philtrum to form upper lip

Medial nasal processes fuse
Terminology: process = prominence
PHILTRUM OF LIP = central region of upper lip

Philtron - Greek to love, to kiss
CLEFT LIP (cheiloschisis) = Failure of fusion of Medial Nasal Process and Maxillary process - 1/1000 Births, can be unilateral or bilateral - At philtrum of lip

CLEFT LIP CAN OCCUR IN COMBINATION WITH CLEFT PALATE
ANATOMY OF BONY PALATE

INCISIVE FORAMEN
- connects oral cavity and nasal cavity;
contains Nasopalatine nerve (branch of V2), Sphenopalatine artery

view of bones of hard palate from inside mouth looking superiorly
a. Primary Palate – Anterior to Incisive Foramen formed by union Medial Nasal Processes

b. Secondary Palate – Posterior to Incisive Foramen formed by fusion of Maxillary process of each side
MALFORMATIONS: CLEFT PALATE

1) Anterior Cleft Palate
- Not fuse Medial Nasal Process and Maxillary Process (Primary and Secondary Palate)

1:1000 Births
INCISIVE FORAMEN

2) Posterior Cleft Palate
- Maxillary Processes from each side (Secondary Palate)

1:2500 births

Note: Ant. Cleft Palate is same as Cleft Lip
SUMMARY OF CLEFT LIP, CLEFT PALATE

1) CLEFT LIP AND ANTERIOR CLEFT PALATE (PRIMARY PALATE)– failure of fusion of Medial Nasal Process and Maxillary process
   1:1000 births

2) POSTERIOR CLEFT PALATE (SECONDARY PALATE)– failure of fusion of Maxillary process of each side
   1:2500 births

INCISIVE FORAMEN is landmark
ANATOMY OF LACRIMAL APPARATUS

**LACRIMAL GLAND** - LOCATED IN SUPEROLATERAL ORBIT - OPENS BY DUCTS (~12) THROUGH CONJUNCTIVA TO SUPERIOR FORNIX - TEARS CONSTANTLY PRODUCED

LACRIMAL GLAND IS INNERVATED BY VII- FACIAL NERVE (PARASYMPATHETICS)
TEARS FLOW ACROSS EYE TO LACRIMAL PUNCTA ON MEDIAL END OF EYELIDS (eyelids meet at MEDIAL CANTHUS);

- TEARS THEN PASS THROUGH LACRIMAL CANALICULI TO LACRIMAL SAC;

- SAC CONNECTS TO NASOLACRIMAL DUCT WHICH DRAINS TO INFERIOR MEATUS OF NASAL CAVITY

LACRIMAL GLAND IS INNERVATED BY VII - FACIAL NERVE
**OBSTRUCTED NASOLACRIMAL DUCT**

- extends from Medial Canthus of eye to Inferior Meatus of nasal cavity

- Develops as a fold between maxillary process and frontonasal process - then forms a solid cord that becomes canalized.

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**Obstructed Duct** - *failure of duct to canalize*; tears drain over lower eyelid to face; opened surgically for tears to drain to nasal cavity
II. BRANCHIAL ARCH DERIVATIVES - EACH ARCH HAS A NERVE, MUSCLES AND CARTILAGES

I. MANDIBULAR ARCH - TRIGEMINAL NERVE (V) has Maxillary and Mandibular Processes

II. HYOID ARCH - FACIAL NERVE (VII)

III. THIRD ARCH - GLOSSO-PHARYNGEAL NERVE (IX)

IV. FOURTH ARCH - VAGUS NERVE (X)

VI. SIXTH ARCH - ACCESSORY NERVE (XI)
**TERMINOLOGY: ARCHES, GROOVES, POUCHES, MEMBRANES**

**VIEW OF EXTERIOR OF EMBRYO**

1. **Branchial Arches** = LUMPS

2. **Branchial Grooves (CLEFTS)**
   - ectodermal clefts between adjacent arches

**VIEW OF EMBRYO BISECTED IN SAGITTAL PLANE**

3. **Branchial Pouch**
   - endodermal outpocketing from rostral foregut
   - between adjacent arches
BRANCHIAL APPARATUS - 4 elements

1. **Branchial Arch = LUMP**
   - covered by:
     - Ectoderm - externally
     - Endoderm - lined internally
   - (Mesenchyme-core); arch form skeletal elements, muscles, arteries;
   - Each nerve innervates structures derived from its associated arch

2. **Branchial Groove (Cleft)**
   - ectodermal cleft between adjacent arches

3. **Branchial Pouch**
   - endodermal outpocketing between adjacent arches
   - (from rostral foregut)

4. **Branchial Membrane**
   - site of contact of Groove (ectoderm)
## Structures Derived from Branchial Arches

<table>
<thead>
<tr>
<th>Arch/Nerve</th>
<th>Skeletal</th>
<th>Ligaments</th>
<th>Muscles</th>
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</thead>
</table>
| First (V)  | 1) Malleus  
             2) Incus | 1) Ant. ligament of malleus  
             2) Sphenomandibular ligament | 1) Muscles of Mastication  
             2) Tensor tympani  
             3) Tensor palati  
             4) Mylohyoid  
             5) Ant. belly of Digastric |
| Second (VII) | 1) Stapes  
              2) Styloid process  
              3) Hyoid bone - lesser horn, upper half of body | Stylohyoid ligament | 1) Muscles of Facial Expression  
              2) Stapedius  
              3) Stylohyoid  
              4) Post. belly of Digastric |
| Third (IX) | Hyoid bone - greater horn, lower half of body | — | Stylopharyngeus |
| Fourth (X) | Cartilages of Larynx | — | 1) All muscles of Larynx  
              2) All muscles of Pharynx (except Stylopharyngeus)  
              3) All muscles of Soft Palate (except Tensor palati) |
| Sixth (XI) | — | — | 1) Sternocleidomastoid  
              2) Trapezius |
SKELETAL DERIVATIVES OF BRANCHIAL ARCHES

I. MANDIBULAR ARCH - forms
   a) BONES OF MIDDLE EAR (malleus, incus, also ant. lig. of malleus);
   b) STRUCTURES ASSOCIATED WITH MANDIBLE
      sphenomandibular lig., (Meckel's cartilage, framework of mandible)

II. HYOID ARCH -
   a) ONE BONE OF MIDDLE EAR (stapes);
   b) STYLOID PROCESS and stylohyoid lig.
   c) part of HYOID BONE (upper half of body of hyoid bone)

III. THIRD ARCH - REST OF HYOID BONE - lower half of body of hyoid

IV. FOURTH ARCH - cartilages of larynx

note: FIRST ARCH SYNDROME (TREACHER COLLINS) - genetic disorder; Neural crest cells do not migrate into Arch 1:
- mandibular hypoplasia
- conductive hearing loss
- facial malformation

TREACHER COLLINS SYNDROME
1. Branchial Groove (Pharyngeal Cleft)
- ectodermal cleft between adjacent arches
2. Branchial Pouch
- endodermal outpocketing from rostral foregut
- between adjacent arches
3. Branchial Membrane
- site of contact of Groove (ectoderm) Pouch (endoderm)
BRANCHIAL POUCH DERIVATIVES

A. Pouch 1 - forms Tubotympanic recess - Auditory Tube, Tympanic cavity

B. Pouch 2 - lining (crypts) of Palatine Tonsils

C. Pouch 3 - Inferior Parathyroid Glands & Thymus

D. Pouch 4 - Superior Parathyroid Glands & C-Cells (Calcitonin)

Note: Pouch 3 derivatives migrate caudal to pouch 4
OUTER AND MIDDLE EAR DEVELOP FROM FIRST BRANCHIAL, CLEFT, MEMBRANE AND POUCH: SIMILAR TO ADULT ANATOMY

First Membrane — Tympanic Membrane

External Auditory Meatus - derived from first branchial cleft - ectoderm

First Pouch - Auditory Tube

TYMPANIC MEMBRANE = first branchial membrane

First Cleft - Ext. Aud. Meatus

Middle Ear and Auditory Tube - extends from Nasopharynx to middle ear; derived from first branchial pouch - endoderm
BRANCHIAL 'CLEFT' CYSTS - PERSISTENT CERVICAL SINUS

NORMALLY - OTHER GROOVES (CLEFTS) OBLITERATED

Branchial Sinus = Blind pouch from Pharynx

Branchial cleft cysts - persist anywhere along path between pouch and cleft

Confusion: Clinically can be called Branchial cleft cysts and refer to embryological pouches or clefts
BRANCHIAL CLEFT CYSTS, FISTULI

Branchial Fistula = Channel, often connecting Pharynx to skin of neck; usually passes **Anterior to Sternocleidomastoid Muscle**
BRANCHIAL CLEFT 'CYSTS' (FISTULAE) - often have tracts that extend from site of embryological origin

<table>
<thead>
<tr>
<th>POUCH</th>
<th>FORMS</th>
<th>CLINICAL</th>
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<tbody>
<tr>
<td>First</td>
<td>1) Auditory tube 2) Tympanic cavity</td>
<td>First Branchial 'Cleft' cyst - tract linked to external auditory meatus</td>
</tr>
<tr>
<td>Second</td>
<td>Lining (crypts) of palatine tonsils</td>
<td>Second Branchial 'Cleft' cyst - tract linked to tonsillar fossa (palatine tonsils) - <strong>MOST COMMON CYST</strong></td>
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<tr>
<td>Third</td>
<td>1) Inferior parathyroid gland 2) Thymus</td>
<td>Third Branchial 'Cleft' cyst - tract at thyrohyoid membrane or piriform recess</td>
</tr>
<tr>
<td>Fourth</td>
<td>1) Superior parathyroid gland 2) C-cells of Thyroid</td>
<td>rare</td>
</tr>
</tbody>
</table>
BRANCHIAL 'CLEFT' CYSTS (FISTULAE)

First Branchial 'Cleft' Cyst - external auditory meatus/auditory tube

Second Branchial 'Cleft' Cyst - tract to palatine tonsils

Most Common

Third Branchial 'Cleft' Cyst - tract to piriform recess, Thyrohyoid membrane

Note: Opening anterior to sternocleidomastoid muscle
1st Branchial Cleft Cyst - opens on face or near ear
Type 1 - tract to external auditory meatus
Type 2 - tract to auditory tube

BRANCHIAL 'CLEFT' CYSTS

OPENING
1st Branchial Cleft Cyst - opens on face or near ear
Type 1 - tract to external auditory meatus
Type 2 - tract to auditory tube
2nd Branchial Cleft Cyst-
MOST COMMON - opens on neck ANTERIOR TO STERNOCLEIDO-MASTOID MUSCLE - tract to PALATINE TONSIL

OPENING - clinical sign - mucous secretion; can increase when have respiratory infection.
2nd Branchial Cleft Cyst - MOST COMMON - opens on neck ANTERIOR TO STERNOCLEIDOMASTOID MUSCLE - TRACT TO PALATINE TONSIL

3rd Branchial Cleft Cyst - more inferior on neck; also ANTERIOR TO STERNOCLEIDOMASTOID MUSCLE - tract opens to piriform recess or thyrohyoid membrane
BRANCHIAL 'CLEF'T CYSTS

- can also become apparent in adult
- lateral neck mass
- slow growing
- anterior to Sterno-cleidomastoid muscle
DEVELOPMENT OF ORAL CAVITY

- Stomodeum formed by Ectoderm; forms Oral Cavity & Nasal Cavity
- Contacts Endoderm at Oropharyngeal Membrane
- Pharynx – rostral foregut - formed by Endoderm
PALATOGLOSSAL ARCH = SITE OF OROPHARYNGEAL MEMBRANE = BOUNDARY, BETWEEN ORAL CAVITY AND PHARYNX

SAY AAHH!
ANATOMY OF TONGUE - HAS ORAL AND PHARYNGEAL PARTS

ORAL PART OF TONGUE
= ant. 2/3
SENSORY INNERVATION
1) TASTE - VII Facial N.
2) TOUCH - V Trigeminal N.

PHARYNGEAL PART OF TONGUE
= post. 1/3
SENSORY INNERVATION
TASTE AND TOUCH - most CN IX
CN X (small part anterior to epiglottis)

FORAMEN CECUM - pit in midline of sulcus terminalis

SULCUS TERMINALIS - marks boundary

ALL MUSCLES OF TONGUE - XII HYPOGLOSSAL N.
DEVELOPMENT OF THYROID

1) Thyroid start as Median endodermal thickening on floor of pharynx at future junction of ant 2/3 & post 1/3 of tongue (marked by foramen cecum)

2) Elongates to form Thyroid Diverticulum; descends ant. to hyoid bone & larynx

3) Thyroglossal duct connects Diverticulum to Foramen cecum
NORMAL ANATOMY OF THYROID GLAND

A. THYROID GLAND

Two Lateral Lobes - below & on sides cricoid cartilage

Isthmus- links lateral lobes below cricoid cartilage

Pyramidal Lobe - 50% of people; attached to hyoid by fibrous strand; no clinical problems
Thyroglossal Duct Remnants - can have thyroid tissue or form Thyroglossal Duct cysts anywhere along path Symptom - Midline neck mass, anterior to hyoid bone, larynx
Thyroglossal Duct Cyst - Midline of Neck
Thyroglossal Duct Cyst - Anterior to Hyoid Bone
PARATHYROID GLANDS

- 4 small bodies (2 on each side) located posterior to or within Thyroid gland

Location variable due to migration after embryological origin from Branchial Pouches 3 and 4;
Inferior parathyroid glands from 3, Superior parathyroid gland from 4

Abnormal location - Normally no symptoms
Clinical consequence Surgical removal of thyroid - calcium imbalance
GOOD LUCK!