Blue Boxes for Unit II Exam

Neck

- **Cervical Pain** (1046)
  - Neck pain has several causes, including inflamed lymph nodes, muscle strain, and protruding IV discs
    - Enlarged cervical lymph nodes may indicate a malignant tumor in the head
      - The primary cancer may be in the thorax or abdomen bc the neck connects the head to the trunk
  - Most chronic cervical pain is caused by bony abnormalities (eg cervical osteoarthritis) or by trauma
  - Usually affected by movement of the head and neck, and it may be exaggerated during coughing or sneezing
- **Fracture of the hyoid** (1048)
  - Fracture of the hyoid (or of the styloid processes of the temporal bone), occurs in people who are manually strangled by compression of the throat
    - Results in depression of the body of the bone onto the thyroid cartilage
    - Inability to elevate the hyoid and move it anteriorly beneath the tongue makes swallowing and maintenance of the separation of the alimentary canal and respiratory tracts difficult
      - May result in *aspiration pneumonia*
- **Paralysis of the platysma** (1049)
  - Results from injury to the cervical branch of the facial nerve
    - Causes the skin to fall away from the neck in slack folds
  - During surgical dissections of the neck, extra care is necessary to preserve the cervical branch of the facial nerve
  - When suturing wounds of the neck, surgeons carefully suture the skin and the edges of the platysma
    - If not, the skin would will be distracted (pulled in different directions) by the contracting platysma muscle fibers
      - A broad ugly scar may develop
- **Spread of infections in the neck** (1053)
  - Investing layer of deep cervical fascia helps prevent the spread of abscesses caused by tissue destruction
    - If an infection occurs *between the investing layer of deep cervical fascia and the muscular part of the pretracheal fascia surrounding the infrahyoid muscles*
      - The infection usually will not spread beyond the superior edge of the manubrium
    - If an infection occurs *between the investing fascia and the visceral part of the pretracheal fascia*
      - It can spread into the thoracic cavity anterior to the pericardium
    - Pus from an abscess *posterior to the prevertebral layer of deep cervical fascia* may extend laterally in the neck and form a swelling posterior to the SCM
      - It may perforate the prevertebral layer of deep cervical fascia and enter the retropharyngeal space, producing a bulge in the pharynx = *retropharyngeal abscess*
        - May cause dysphagia and difficulty speaking (dysarthria)
    - Infections *in the head* may also spread
      - Inferiorly posterior to the esophagus and enter the posterior mediastinum
      - Or anterior to the trachea and enter the anterior mediastinum
    - Infections *in the retropharyngeal space* may also extend inferiorly into the superior mediastinum
- **Congenital torticollis** (1055)
  - Torticollis is a contraction of the cervical muscles that produces twisting of the neck and slanting of the head
  - Most common type = ***wry neck***
    - Results from a *fibrous tissue tumor* that develops in the SCM before or shortly after birth
    - This lesion, causes the head to tilt toward, and the face to turn away from, the affected side
  - When it occurs prenatally, the position of the infant's head usually necessitates a breech delivery
  - ***Muscular torticollis*** = the SCM is injured when an infant's head is pulled too much during a difficult birth, tearing its fibers
    - A hematoma occurs that may develop into a fibrotic mass that entraps a branch of the spinal accessory nerve (CN XI) and thus denervates part of the SCM
    - The stiffness and twisting of the neck results from fibrosis and shortening of the SCM
  - Surgical release of the SCM from its inferior attachments to the manubrium and clavicle inferior to the level of CN XI may be necessary to enable the person to hold and rotate the head normally
- **Spasmodic torticollis** (1055-1056)
  - Also known as ***cervical dystonia*** = abnormal tonicity of the cervical muscles
    - Usually begins in adulthood

        - May involve any bilateral combination of lateral neck muscles, especially the SCM and trapezius
        - Characteristics –
            - Sustained turning, tilting, flexing, or extending of the neck
            - Shifting the head laterally or anteriorly can occur involuntarily
            - Shoulder is usually elevated and displaced anteriorly on the side to which the chin turns
- **Subclavian vein puncture** (1060)
    - R or L subclavian vein is often the point of entry to the venous system for *central line placement*, such as a Swan-Ganz catheter
        - Central lines are inserted to administer parenteral (venous nutritional) fluids and medications and to measure central venous pressure
        - In the infraclavicular subclavian vein approach
            - The administrator places the thumb of one hand on the middle part of the clavicle and the index finger on the jugular notch
            - Needle punctures the skin inferior to the thumb (middle of the clavicle) and is advanced medially toward the tip of the index finger (jugular notch) until the tip enters the right venous angle, posterior to the sternoclavicular joint
                - Here the internal jugular and subclavian veins merge to form the brachiocephalic vein
        - If the needle is not inserted carefully, it may puncture the pleura and lung, resulting in pneumothorax
        - If the needle is inserted too far posteriorly, it may enter the subclavian artery
        - When it has been inserted correctly, a soft, flexible catheter is inserted into the subclavian vein, using the needle as a guide
- **Right cardiac catheterization** (1060)
    - Used to take measurements of pressures in the right chambers of the heart
    - Puncture of the IJV can be used to introduce a catheter through the R brachiocephalic vein into the SVC and the R side of the heart
        - May be necessary to use the EJV in some patients
            - This is not ideal bc its angle of junction with the subclavian vein makes passage of the catheter difficult
- **Prominence of the EJV** (1060)
    - EJV may serve as an "internal barometer"
        - When venous pressure is in the normal range, the EJV is usually visible above the clavicle for a shor distance
        - When venous pressure rises (eg as in heart failure), the vein is prominent throughout its course along the side of the neck
        - Routine observation of the EJVs during physical exam may give diagnostic signs of…
            - Heart failure, SVC obstruction, enlarged supraclavicular lymph nodes, increased intrathoracic pressure
- **Severance of the EJV** (1060-1061)
    - If the EJV is severed along the posterior border of the SCM where it pierces the roof of the lateral cervical region (eg by a knife slash), its lumen is held open by the tough investing layer of deep cervical fascia, and the negative intrathoracic pressure will suck air into the vein
        - This produces a churning noise in the thorax and cyanosis
        - A *venous air embolism* produced in this way will fill the R side of the heart with froth, which nearly stops the blood flow through it, resulting is dyspnea
        - Application of firm pressure to the severed jugular vein until it can be sutured will stop the bleeding and entry of air
- **Lesions of the spinal accessory nerve (CN XI)** (1061)
    - Uncommon, but it may be damaged by
        - Penetrating trauma, such as a stab or bullet wound
        - Surgical procedures in the lateral cervical region
        - Tumors at the cranial base or cancerous cervical lymph nodes
        - Fractures of the jugular foramen where CN XI leaves the cranium
    - Although contraction of one SCM turns the head to one side, a unilateral lesion of CN XI usually does not produce an abnormal position of the head
        - People with CN XI damage usually have weakness in turning the head to the opposite side against resistance
        - Lesions of CN XI produce weakness and atrophy of the trapezius, impairing neck movements
            - *Unilateral paralysis of the trapezius* is evident by the patient's inability to elevate and retract the shoulder and by difficulty in elevating the upper limb superior to the horizontal level
            - The normal prominence in the neck produced by the trapezius is also reduced

    - *Drooping of the shoulder* is an obvious sign of CN XI injury
  - During extensive surgical dissections in the lateral cervical region – for ex during removal of cancerous lymph nodes – the surgeon isolates CN XI to preserve it
  - An awareness of the superficial location of CN XI during superficial procedures in the lateral cervical region is important bc it is the most commonly iatrogenic nerve injury
- **Severance of the phrenic nerve, phrenic nerve block, and phrenic nerve crush** (1064)
  - *Severance of a phrenic nerve* results in paralysis of the corresponding half of the diaphragm
  - *Phrenic nerve block* produces a short period of paralysis of the diaphragm on one side (eg for a lung operation)
    - Anesthetic is injected around the nerve where it lies on the anterior surface of the middle third of the anterior scalene
  - *Surgical phrenic nerve crush* (eg compressing the nerve injuriously with forceps) produces a longer period of paralysis
    - Can sometimes last for weeks after surgical repair of a diaphragmatic hernia
    - If an accessory phrenic nerve is present, it must also be crushed to produce complete paralysis of the hemidiaphragm
- **Nerve blocks in the lateral cervical region** (1064)
  - For regional anesthesia before neck surgery, a *cervical plexus block* inhibits nerve impulse conduction
    - Anesthesia is injected at several points along the posterior border of the SCM
      - Mainly at the junction of its superior and middle thirds, the nerve point of the neck
    - Bc the phrenic nerve supplying half the diaphragm is usually paralyzed by a cervical nerve block, this procedure is not performed on persons with pulmonary or cardiac disease
  - For anesthesia of the upper limb, the anesthetic agent in a *supraclavicular brachial plexus block* is injected around the supraclavicular part of the brachial plexus
    - Main injection site is superior to the midpoint of the clavicle
- **Injury to the suprascapular nerve** (1065)
  - Vulnerable to injury in fractures of the middle 1/3 of the clavicle
  - Injury results in loss of lateral rotation of the humerus at the glenohumeral joint
    - Relax limb rotates medially into the *waiter's tip position*
  - Ability to initiate abduction of the limb is also affected
- **Ligation of the external carotid artery** (1071)
  - Sometimes necessary to control bleeding from one of its relatively inaccessible branches
  - Decreases blood flow through the artery and its branches, but does not eliminate it
    - Blood flows in a retrograde (backward) direction into the artery from the external carotid artery on the other side through communications between its branches (eg those in the face and scalp) and across the midline
  - When the external carotid or subclavian arteries are ligated, the descending branch of the occipital artery provides the main collateral circulation, anastomosing with the vertebral and deep cervical arteries
- **Surgical dissection of the carotid triangle** (1071)
  - Carotid triangle provides an important surgical approach to the carotid system of arteries
    - Also provides access to the IJV, the vagus and hypoglossal nerves, and the cervical sympathetic trunk
      - Damage or compression of the vagus and/or recurrent laryngeal nerves during surgical dissection of the carotid triangle may produce an alteration in the voice bc these nerves supply laryngeal muscles
- **Carotid occlusion and endarterectomy** (1071)
  - Atherosclerotic thickening of the intima (innermost coat) of the internal carotid artery may obstruct blood flow
    - Symptoms depend on the degree of obstruction and the amount of collateral blood flow to the brain and structures in the orbit from other arteries
      - Partial occlusion of the internal carotid may cause *transient ischemic attack* (TIA), a sudden focal loss of neurological function (eg dizziness and disorientation) that disappears within 24 hr
      - Arterial occlusion may also cause a *minor stroke*, a loss of neurological function such as weakness or sensory loss on one side of the body that exceeds 24 hr but disappears within 3 weeks
    - Obstruction of blood flow can be observed in a *Doppler color study*
      - A Doppler is a diagnostic instrument that emits an ultrasonic beam and detects its reflection from moving fluid (blood) in a manner that distinguishes the fluid from static surrounding tissue
      - Provides information about its pressure, velocity, and turbulence
    - ***Carotid occlusion***, causing stenosis in otherwise healthy persons can be relieved by opening the artery at its origin and stripping off the atherosclerotic plaque with the intima
      - This procedure is called ***carotid endarterectomy***

- After the operation, drugs that inhibit clot formation are administered until the endothelium has regrown
- Bc of the relations of the internal carotid artery, there is risk of CN injury during the procedure involving one or more of…
    - CN IX, CN X (or superior laryngeal branch), CN XI, or CN XII

- **Carotid pulse** (1071)
    - The "neck pulse" is easily felt by palpating the common carotid artery in the side of the neck
        - Here it lies in a groove between the trachea and the infrahyoid muscles
    - It is usually easily palpated just deep to the anterior border of the SCM at the level of the superior border of the thyroid cartilage
    - Routinely checked during *cardiopulmonary resuscitation* (CPR)
    - Absence of a carotid pulse indicates cardiac arrest
- **Carotid sinus hypersensitivity** (1071)
    - Carotid sinus hypersensitivity = exceptional responsiveness of the carotid sinuses in various types of vascular disease
        - External pressure on the carotid artery may cause slowing of the heart rate, a fall in blood pressure, and cardiac ischemia resulting in fainting (syncope)
            - In all forms of syncope, symptoms result from a sudden and critical decrease in cerebral perfusion
        - This method of checking the pulse is not recommended for people with cardiac or vascular disease
            - Alternate sites, such as the radial artery at the wrist, should be used to check their pulse
- **Role of the carotid bodies** (1072)
    - Carotid bodies are in an ideal position to monitor the O_2 content of the blood before it reaches the brain
        - A decrease in PO_2 occurs at high altitudes or in pulmonary disease
            - It activates the aortic and carotid chemoreceptors, increasing alveolar ventilation
        - Carotid bodies also respond to increased CO_2 tension or free hydrogen ions in the blood
    - The glossopharyngeal nerve (CN IX), perhaps with involvement of the vagus nerve) conducts the information centrally
        - Results in reflexive stimulation of the respiratory centers of the brain that increase the depth and rate of breathing
        - Pulse rate and blood pressure also increase
        - Increased ventilation and circulation leads to more O_2 taken in and $[CO_2]$ is reduced accordingly
- **Internal jugular pulse** (1072)
    - Although pulsations are most commonly associated with arteries, pulsations of the IJV can provide information about heart activity corresponding to ECG recordings and right atrial pressure
        - IJV pulse is not palpable like arterial pulses
            - But the vein's pulsations are transmitted through the surrounding tissue and may be observed beneath the SCM superior to the medial end of the clavicle
            - Bc there are no valves in the brachiocephalic vein or the SVC, a wave of contraction passes up these vessels to the inferior bulb of the IJV
            - Pulsations are especially visible when the person's head is inferior to the lower limbs (*Trendelenburg position*)
        - IJV pulse increases considerably in conditions such as mitral valve disease, which increases pressure in the pulmonary circulation and the R side of the heart
            - Right IJV runs a straighter, more direct course to the RA than the left, so it is examined
- **Internal jugular vein puncture** (1072-1073)
    - Needle and catheter may be inserted into the IJV for diagnostic or therapeutic purposes
        - Right IJV is preferred bc it is usually larger and straighter
        - During the procedure
            - Clinician palpates the common carotid artery
            - Inserts the needle into the IJV just lateral to it at a 30° angle, aiming at the apex of the triangle between the sternal and clavicular heads of the SCM, the lesser supraclavicular fossa
            - Needle is then directed inferolaterally toward the ipsilateral nipple
- **Cervicothoracic ganglion block** (1083)
    - Anesthetic injected around the large cervicothoracic ganglion blocks transmission of stimuli through the cervical and superior thoracic ganglia
        - May relieve vascular spasms involving the brain and upper limb
        - Also useful when deciding if a surgical resection of the ganglion would be beneficial to a person with excess vasoconstriction in the ipsilateral limb

- **Lesion of the cervical sympathetic trunk** (1083)
    - Results in a sympathetic disturbance = ***Horner syndrome***, characterized by –
        - **Miosis** – contraction of the pupil, resulting from paralysis of the dilator pupillae muscle
        - **Ptosis** – drooping of the superior eyelid, resulting from paralysis of the smooth (tarsal) muscle intermingling with striated muscle of the levator palpebrae superioris
        - **Enophthalmos** – sinking in of the eye, possibly caused by paralysis of the smooth (orbitalis) muscle in the floor of the orbit
        - **Anhydrosis** – vasodilation and absence of sweating on the face and neck, caused by lack of sympathetic (vasoconstrictive) nerve supply to the blood vessels and sweat glands
- **Thyroid ima artery** (1084)
    - In approx 10% of people a small, unpaired thyroid ima artery arises from the brachiocephalic trunk
        - It may arise from the arch of the aorta or from the right common carotid, subclavian, or internal thoracic arteries
    - This small artery ascends on the anterior surface of the trachea, which it supplies, and continues to the isthmus of the thyroid gland, where it divides and supplies it
        - Possible presence of this artery must be considered when performing procedures in the midline of the neck inferior to the isthmus bc it is a potential source of bleeding
- **Thyroglossal duct cysts** (1084)
    - Development of the thyroid gland begins in the floor of the embryonic pharynx at the side indicated by a small pit in the dorsum of the postnatal tongue = ***foramen cecum***
    - During development the gland descends from the tongue into the neck, passing anterior to the hyoid and thyroid cartilages to reach its final position anterolateral to the superior part of the trachea
    - During this descent it is attached to the foramen cecum by the ***thyroglossal duct***
        - Duct normally disappears but remnants of epithelium may remain and form a ***thyroglossal duct cyst*** at any point along the path of its descent
            - Cyst is usually near or within the body of the hyoid and forms a swelling in the anterior part of the neck
- **Ectopic thyroid gland** (1084-1085)
    - Uncommonly, the thyroid gland fails to descend from its embryonic region in the tongue
        - Results in a ***lingual thyroid gland***
    - Incomplete descent results in the gland being located ***high in the neck***, at or just inferior to the hyoid
    - Usually, an ectopic thyroid gland in the medial plane of the neck is the only thyroid tissue present
        - Occasionally, thyroid glandular tissue is associated with a thyroglossal duct cyst
            - So, it is important to differentiate between an ectopic thyroid gland and a thyroglossal cyst when excising a cyst
            - Failure to do so may result in a total thyroidectomy, leaving the person permanently dependent on thyroid medication
- **Accessory thyroid glandular tissue** (1085)
    - Portions of the thyroglossal duct may persist to form thyroid tissue
        - Accessory thyroid glandular tissue may appear anywhere along the embryonic course of the thyroglossal duct (eg in the thymus inferior to the thyroid gland or in the thorax)
        - Accessory thyroid tissue may develop in the neck lateral to the thyroid cartilage – it usually lies on the thyrohyoid muscle
    - Although the accessory tissue may be functional, it is often of insufficient size to maintain normal function if the thyroid gland is removed
- **Pyramidal lobe of the thyroid gland** (1085)
    - Approx 50% of thyroid glands have a pyramidal lobe
        - Lobe varies in size
        - Extends superiorly from the isthmus of the thyroid gland, usually to the left of the median plane
        - The isthmus may be incomplete
    - A band of connective tissue, often containing accessory thyroid tissue, may continue from the apex of the pyramidal lobe to the hyoid
    - Pyramidal lobe and band develop from remnants of the epithelium and connective tissue of the thyroglossal duct
- **Enlargement of the thyroid gland** (1085-1086)
    - A non-neoplastic and non-inflammatory enlargement of the thyroid gland, other than the variable enlargement that may occur during menstruation and pregnance, is called a ***goiter***

        - Results from lack of iodine
            - Common in certain parts of the world where the soil and water are deficient in iodine
        - Causes a swelling in the neck that may compress the trachea, esophagus, and recurrent laryngeal nerves
        - May enlarge anteriorly, posteriorly, inferiorly, or laterally
            - Cannot move superiorly bc of the superior attachments of the sternothyroid and sternohyoid muscles
            - Substernal extension of a goiter is also common
- **Thyroidectomy** (1086)
    - Excision of a malignant tumor of the thyroid gland or other surgical procedure sometimes necessitates removal of the gland = ***thyroidectomy***
    - In the surgical treatment of hyperthyroidism, the posterior part of each lobe of the enlarged thyroid is usually preserved = ***near-total thyroidectomy***
        - To protect the recurrent and superior laryngeal nerves and to spare the parathyroid glands
    - Post-operative hemorrhage after thyroid gland surgery may compress the trachea, making breathing difficult
        - Blood collects within the fibrous capsule of the gland
- **Injury to the recurrent laryngeal nerves** (1086-1087)
    - Risk of injury to the recurrent laryngeal nerves is ever present during neck surgery
        - Near the inferior pole of the thyroid gland, the R recurrent laryngeal nerve is intimately related to the inferior thryroid artery and its branches
            - Nerve may cross anterior or posterior to branches of the artery, or it may pass between them
            - Bc of this close relationship, the inferior thyroid artery is ligated some distance lateral to the thyroid gland, where it is not close to the nerve
        - The danger of injuring the L recurrent laryngeal nerve during surgery is not as great bc it has a more vertical ascent from the superior mediastinum
            - But the artery and nerve are also closely associated near the inferior pole of the thyroid
    - Hoarseness is the usual sign of unilateral recurrent nerve injury
        - Temporary aphonia or disturbance of phonation (voice production) and laryngeal spasm may occur
            - These normally result from bruising the recurrent laryngeal nerve during surgery or from the pressure of accumulated blood and serious exudates after the operation
- **Inadvertent removal of the parathyroid glands** (1088)
    - The variable position of the parathyroid glands, especially the inferior ones, puts them in danger of being damaged or removed during surgical procedures in the neck
        - The superior parathyroid glands may be as far superior as the thyroid cartilage
        - The inferior ones may be as far inferior as the superior mediastinum
        - Aberrant sites of these glands are of concern when searching for abnormal parathyroid glands, as may be necessary in treating *parathyroid adenoma* – an ordinarily benign tumor of epithelial tissue associated with hyperparathyroidism
    - Atrophy or inadvertent surgical removal of all the parathyroid glands results in ***tetany*** = a severe neurological syndrome characterized by muscle twitches and cramps
        - Generalized spasms are caused by decreased serum calcium levels
            - Bc laryngeal and respiratory muscles are involved, failure to respond immediately with the appropriate therapy can result in death
    - To safeguard these glands during thyroidectomy, surgeons usually preserve the posterior part of the lobes of the thyroid gland
        - In cases when it is necessary to remove all of the thyroid gland (eg bc of malignant disease), the parathyroid glands are carefully isolated with their blood vessels intact before removal of the thyroid
            - Parathyroid tissue may also be transplanted, usually to the arm so it will not be damaged by subsequent surgery or radiation therapy
- **Fractures of the laryngeal skeleton** (1091)
    - May result from blows received in sports such as kick boxing and hockey, or from compression by a shoulder strap during a car accident
        - Bc this is a frequent injury, hockey goalies and baseball catchers wear protective guards hanging from their mask to cover their larynges
    - Produce submucous hemorrhate and edema, respiratory obstruction, hoarseness, and sometimes a temporary inability to speak
- **Laryngoscopy** (1095)
    - Procedure used to examine the interior of the larynx

        - *Indirect laryngoscopy* = visual examination using a laryngeal mirror
            - Anterior part of the tongue is gently pulled from the oral cavity to minimize the extent to which the posterior part of the tongue covers the epiglottis and laryngeal inlet
            - Bc the rima vestibuli is larger than the rima glottidis during normal respiration, the vestibular folds and vocal folds are visible during a laryngoscopic exam
        - *Direct laryngoscopy* = using a laryngoscope, a tubular endoscopic instrument
            - It is a tube of flexible fiber optic endoscope equipped with electrical lighting for examining or operating on the interior of the larynx through the open mouth
            - Vestibular folds normally appear pink, whereas the vocal folds are usually pearly white
- **Valsalva maneuver** (1095)
    - Forced expiratory effort against a closed airway, such as a cough, sneeze, or strain during bowel movement or weight lifting
        - The sphincteric actions of the vestibular and vocal folds are important during this maneuver
            - Vestibular and vocal folds abduct widely as the lungs inflate during deep inspiration
    - In the maneuver, both the vestibular and vocal folds are tightly adducted at the end of deep inspiration
        - The anterolateral abdominal muscles then contract strongly to increase the intrathoracic and intra-abdominal pressures
        - The relaxed diaphragm passively transmits the increased abdominopelvic pressure to the thoracic cavity
    - Bc high intrathoracic pressure impedes venous return to the RA, researchers use the Valsalva maneuver to study cardiovascular effects of raised peripheral venous pressure and decreased cardiac filling and cardiac output
- **Aspiration of foreign bodies and the Heimlich maneuver** (1095-1096)
    - A foreign object, such as a piece of steak, may accidentally aspirate through the laryngeal inlet into the vestibule of the larynx, where it becomes trapped superior to the vestibular folds
        - When it enters the vestibule of the larynx, the laryngeal muscles go into spasm, tensing the vocal folds
        - The rima glottidis closes and no air enters the trachea
            - The resulting blockage may completely seal off the larynx (laryngeal obstruction) and choke the person, leaving the individual speechless bc the larynx is blocked
        - Asphyxiation occurs and the person will die in approximately 5 min from lack of oxygen if the obstruction is not removed
    - A person who is choking will cough in an attempt to dislodge the object
        - The vestibular folds are part of the protective mechanism that closes the larynx
            - The mucosa of the vestibule is sensitive to foreign objects such as food
            - When an object passes through the laryngeal inlet and contacts the vestibular epithelium, violent coughing occurs
            - Emergency therapy must be given to open the airway
                - The procedure used depends on the condition of the person, the facilities available, and the experience of the person giving first aid
                - ***Heimlich maneuver*** – bc the lungs still contain air, sudden compression of the abdomen causes the diaphragm to elevate and compress the lungs, expelling air from the trachea into the larynx
                    - Usually dislodges the food or other material from the larynx
                    - *How to do it* – person giving first aid uses subdiaphragmatic abdominal thrusts to expel the foreign object from the larynx
                        - The closed fist, with the base of the palm facing inward, is placed on the victim's abdomen between the umbilicus and the xiphoid process
                        - The fist is grasped by the other hand and forcefully thrust inward and superiorly, forcing the diaphragm superiorly
                            - This action forces air from the lungs and creates an artificial cough that usually expels the foreign object
                        - Several abdominal thrusts may be necessary to remove the obstruction
                - In extreme cases, physicians insert a large-bore needle through the cricothyroid ligament (***needle cricothyrotomy*** or ***coniotomy***) to permit fast entry of air
                - Later, a ***surgical crithyrotomy*** may be performed which involves an incision through the skin and cricothyroid ligament and insertion of a small ***tracheastomy tube*** into the trachea
- **Injury to the laryngeal nerves** (1098-1099)

- Bc the ***inferior laryngeal nerve***, the continuation of the recurrent laryngeal nerve, innervates the muscles moving the vocal fold, paralysis of the vocal fold results when the nerve (or its parent nerve) is injured
  - The voice is poor initially bc the paralyzed vocal fold cannot adduct to meet the normal vocal fold
    - Within weeks, the contralateral fold crosses the midline when its muscles act to compensate
  - When bilateral paralysis of the vocal fold occurs, the voice is almost absent bc the vocal folds are motionless in a position that is slightly narrower than the usually neutral respiratory position
    - They cannot be adducted for phonation, nor can they be abducted for increased respiration
    - Results in ***stridor*** (high pitched, noisy respiration) often accompanied by anxiety similar to that accompanying an asthmatic episode
  - In progressive lesions of the recurrent laryngeal nerve, abduction of the vocal ligaments is lost before adduction
  - Conversely, during recovery adduction returns before abduction
  - Hoarseness is the common symptom of serious disorders of the larynx, such as carcinoma of the vocal folds
- Paralysis of the ***superior laryngeal nerve*** causes anesthesia of the superior laryngeal mucosa
  - As a result, the protective mechanism designed to keep foreign bodies out of the larynx is inactive, and foreign bodies can easily enter the larynx
- Injury to the ***external branch of the superior laryngeal nerve*** results in a voice that is monotonous in character bc the paralyzed cricothyroid muscle supplied by it is unable to vary the length and tension of the vocal fold
  - Such an injury may be unnoticed in individuals who don't usually employ a wide range of tone in their speech, but it may be critical to singers or public speakers
  - To avoid injury to the external branch of the superior laryngeal nerve (eg during thyroidectomy), the superior thyroid artery is ligated and sectioned more superior to the gland, where it is not as closely related to the nerve
    - Bc an enlarged thyroid gland (goiter) itself may cause impaired innervations of the larynx by compressing the laryngeal nerves, the vocal folds are examined by laryngoscopy before an operation in this area
      - In this way, damage to the larynx or its nerves resulting from a surgical mishap may be distinguished from a pre-existing injury resulting from nerve compression

- **Superior laryngeal nerve block** (1099)
  - Often administered with endotracheal intubation in the conscious patient
  - Used for peroral endoscopy, transesophageal echocardiography, and laryngeal and esophageal instrumentation
  - How –
    - Needle is inserted midway between the thyroid cartilage and the hyoid, 1-5 cm anterior to the greater horn of the hyoid
    - Needle passes through the thyrohyoid membrane, and the anesthetic agent bathes the internal laryngeal nerve, the larger terminal branch of the superior laryngeal nerve
  - Anesthesia of the laryngeal mucosa occurs superior to the vocal folds and includes the superior surface of these folds
- **Cancer of the larynx** (1099)
  - Incidence is high in individuals who smoke cigarettes or chew tobacco
  - Most people present with persistent hoarseness, often associated with *otalgia* (earache) and dysphagia
  - Enlarged pretracheal or paratracheal lymph nodes may indicate the presence of laryngeal cancer
  - *Laryngectomy* (removal of the larynx) may be performed in severe cases
    - Vocal rehabilitation can be accomplished by the use of an electrolarynx, a tracheoesophageal prosthesis, or esophageal speech (regurgitation of ingested air)
- **Age changes in the larynx** (1099)
  - Grows steadily until approx 3 years of age, after which time little growth occurs until approx 12 years of age
  - Before puberty, no major laryngeal sex differences exist
    - Owing to the presence of testosterone at puberty in males, the walls of the larynx strengthen and the laryngeal cavity enlarges
      - All of the laryngeal cartilages enlarge, and the laryngeal prominence becomes conspicuous in most males
      - Anteroposterior diameter of the rima glottidis almost doubles its prepubescent measurement
        - The vocal folds lengthening and thickening proportionately and abruptly
      - This growth accounts for the voice changes that occur
        - The pitch typically becomes an octave lower
      - The pitch of the voice of *eunuchs*, males whose testes have not developed (agonadal males), does not become lower without administration of male hormones
    - There is only a slight increase in the size of the larynx of most girls

- The thyroid, cricoids, and most of the artyneoid cartilages often ossify as age advances, commencing at approx 25 years of age in the thyroid cartilage
- By 65 years of age, the cartilages are frequently visible in radiographs

- **Tracheostomy** (1100-1101)
  - Transverse incision through the skin of the neck and anterior wall of the trachea to establish an airway in patients with upper airway obstruction or respiratory failure
  - How –
    - Infrahyoid muscles are retracted laterally, and the isthmus of the thyroid gland is either divided or retracted superiorly
    - An opening is made in the trachea between the 1st and 2nd tracheal rings or through the 2nd through 4th rings
    - A tracheostomy tube is then inserted into the trachea and secured
  - To avoid complications, the following anatomical relationships are important –
    - The *inferior thyroid veins* arise from a venous plexus on the thyroid gland and descend anterior to the trachea
    - A small *thyroid ima artery* is present in approx 10% of people, it ascends from the brachiocephalic trunk or the arch of the aorta to the isthmus of the thyroid gland
    - The *left brachiocephalic vein*, jugular venous arch, and pleurae may be encountered, particularly in infants and children
    - The *thymus* covers the inferior part of the trachea in infants and children
    - The trachea is small, mobile, and soft in infants, making it easy to cut through its posterior wall and damage the esophagus
- **Foreign bodies in the laryngopharynx** (1109-1110)
  - When food passes through the laryngopharynx during swallowing, some of it enters the piriform fossae
    - Foreign bodies (eg a chicken bone or fishbone) entering the pharynx may lodge in this recess
      - If the object is sharp, it may pierce the mucous membrane and injure the internal laryngeal nerve
      - The superior laryngeal nerve and its internal laryngeal branch are also vulnerable to injury during removal of the object if the instrument used to remove the foreign body accidentally pierces the mucous membrane
        - Injury to these nerves may result in anesthesia of the laryngeal mucous membrane as far inferiorly as the vocal folds
    - Young children swallow a variety of objects, most of which reach the stomach and pass through the alimentary canal without difficulty
      - In some cases, the foreign body stops at the inferior end of the laryngopharynx, its narrowest part
        - A medical image such as a radiograph or a CT scan will reveal the presence of a radiopaque foreign body
        - Foreign bodies in the pharynx are removed under direct vision through a pharyngoscope
- **Sinus tract from the piriform recess** (1110)
  - Although uncommon, a sinus tract may pass from the piriform fossa to the thyroid gland, becoming a potential site for recurring thyroiditis (inflammation of the thyroid gland)
    - This sinus tract apparently develops from a remnant of the thyroglossal duct that adheres to the developing laryngopharynx
    - Removal of this sinus tract essentially involves a partial thyroidectomy bc the piriform fossa lies deep to the superior pole of the gland
- **Tonsillectomy** (1110)
  - Removal of the tonsils is performed by dissecting the palatine tonsil from the tonsillar bed or by a guillotine or snare operation
    - Each procedure involves removal of the tonsil and the fascial sheet covering the tonsillar bed
    - Bc of the rich blood supply of the tonsil, bleeding commonly arises from the large *external palatine vein*, or less commonly from the *tonsillar artery* or other arterial twigs
    - The glossopharyngeal nerve (CN IX) accompanies the tonsillar artery on the lateral wall of the pharynx
      - Bc this wall is thin, the nerve is vulnerable to injury
    - The internal carotid artery is especially vulnerable when it is tortuous and lies directly lateral to the tonsil
- **Adenoiditis** (1110)
  - Inflammation of the pharyngeal tonsils (adenoids)
    - Can obstruct the passage of air from the nasal cavities through the choanae into the nasopharynx, making mouth breathing necessary

        - Infection from the enlarged pharyngeal tonsils may spread to the tubal tonsils, causing swelling and closure of the pharyngotympanic tubes
        - Infection spreading from the nasopharynx to the middle ear causes *otitis media* (middle ear infection)
            - May produce temporary or permanent hearing loss
    - Sometimes the palatine and pharyngeal tonsils are removed during the same operation (tonsillectomy and adenoidectomy)
- **Branchial fistula** (1110-1111)
    - An abnormal canal that opens internally into the tonsillar cleft and externally on the side of the neck
        - This uncommon cervical canal results from persistence of remnants of the 2nd pharyngeal pouch and 2nd pharyngeal groove
        - Fistula ascends from its cervical opening, usually along the anterior border of the SCM in the inferior 1/3 of the neck, through the subcutaneous tissue, platysma, and fascia of the neck to enter the carotid sheath
            - Then passes between the internal and external carotid arteries on its way to its opening in the tonsillar cleft
            - Course can be demonstrated radiographically
- **Branchial sinuses and cysts** (1111)
    - When the embryonic cervical sinus fails to disappear, it may retain its connection with the lateral surface of the neck by a *branchial sinus*, a narrow canal
        - The opening of the sinus may be anywhere along the anterior border of the SCM
    - If the remnant of the cervical sinus is not connected with the surface, it may form a *branchial cyst* (*lateral cervical cyst*), usually located just inferior to the angle of the mandible
    - Although these cysts may be present in infants and children , they may not enlarge and become visible until early adulthood
    - Sinus and cyst are usually excised
- **Esophageal injuries** (1112)
    - The rarest kinds of penetrating neck trauma, but they cause most complications following a surgical procedure or other treatment
    - Most occur in conjunction with an airway injury bc the airway lies anterior to the esophagus and provides some protection to it
    - Esophageal injuries are often occult (hidden), which makes the injury difficult to detect, especially when it is isolated
        - Unrecognized esophageal perforation causes death in nearly all patients who do not have surgery and in approx 50% of those who do
- **Tracheoesophageal fistula** (1112-1113)
    - Most common congenital anomaly of the esophagus
        - Usually, it is combined with some form of esophageal atresia
        - In the most common type (approx 90% of cases), the superior part of the esophagus ends in a blind pouch and the inferior part communicates with the trachea
            - The pouch fills with mucus, which the infant aspirates
        - In some cases, the superior esophagus communicates with the trachea and the inferior esophagus joins the stomach
        - Sometimes the inferior esophagus does not join the stomach, producing TEF with esophageal atresia
    - TEF results from abnormalities in partitioning the esophagus and trachea by the tracheoesophageal septum
- **Esophageal cancer** (1113)
    - Mos common presenting complaint of esophageal cancer is dysphagia, which is not usually recognized until the lumen is reduced by 30-50%
    - *Esophagoscopy* is a common diagnostic tool for observing these cancers
    - Painful swallowing in some patients suggests the extension of the tumor to periesophageal tissues
    - Enlargement of the inferior deep cervical lymph nodes also suggests esophageal cancer
    - Compression of the recurrent laryngeal nerves by an esophageal tumor produces hoarseness
- **Zones of penetrating neck trauma** (1113)
    - 3 zones are common clinical guides to the seriousness of neck trauma – give physicians an understanding of the structures that are at risk with penetrating neck injuries –
        - ***Zone I*** – includes the root of the neck and extends from the clavicles and the manubrium to the level of the inferior border of the cricoid cartilage
            - Structures at risk – cervical pleurae, apices of lungs, thyroid and parathyroid glands, trachea, esophagus, common carotid arteries, jugular veins, cervical region of the vertebral column
        - ***Zone II*** – extends from the cricoid cartilage to the level of the angles of the mandible
            - Structures at risk – superior poles of the thyroid gland, thyroid and cricoid cartilages, larynx, laryngopharynx, carotid arteries, jugular veins, esophagus, cervical region of the vertebral column

        - ***Zone III*** – occurs at the angels of the mandibles superiorly
            - Structures at risk – salivary glands, oral and nasal cavities, oropharynx, nasopharynx
    - Injuries in zones I and III obstruct the airway and have the greatest risk for *morbidity* (complications following surgical procedures and other treatments) and *mortality* (a fatal outcome)
        - Bc the injured structures are difficult to visualize and repair and vascular damage is difficult to control
    - Injuries in zone II are most common
        - Morbidity and mortality are lower bc physicians can control vascular damage by direct pressure and surgeons can visualize and treat injured structures more easily
- **Radical neck dissections** (1115)
    - Performed when cancer invades the lymphatics
    - During the procedure
        - Deep cervical lymph nodes and tissues around them are removed as completely as possible
        - Major arteries, brachial plexus, CN X and phrenic nerve are preserved
        - Most cutaneous branches of the cervical plexus are removed
    - Aim of the dissection is to remove all tissue that bears lymph nodes in one piece
        - The deep cervical lymph nodes, particularly those located along the transverse cervical artery, may be involved in the spread of cancer from the thorax and abdomen
            - Their enlargement may give the first clue to cancer in these regions, so they are often referred to as the *cervical sentinel lymph nodes*

Head

- **Head injuries** (886)
    - Major cause of death and disability
    - Complications of head injuries include hemorrhage, infection, and injury to the brain and cranial nerves
    - Most common symptom = disturbance in the level of consciousness (LOC)
    - Almost 10% of all deaths in the US are caused by head injuries
        - Approx half of traumatic deaths involve the brain
    - Occur mostly in young people between the ages of 15 and 24
    - Major cause of brain injury varies, but car and motorcycle accidents are prominent
    - Men are affected 3 or 4 times as often as women
- **Headaches and facial pain** (886)
    - Few complains are more common that headaches and facial pain
    - They are usually benign and frequently associated with tension, fatigue, or mild fever
        - However, headaches may indicate a serious intracranial problem such as a brain tumor, subarachnoid hemorrhage, or meningitis
    - ***Neuralgias*** are characterized by severe throbbing or stabbing pain in the course of a nerve caused by a demyelinating lesion
        - Common cause of facial pain
        - Term *facial neuralgia* describes diffuse painful sensations
        - Localized aches have specific names, such as *earache* (otalgia) and *toothache* (odontalgia)
    - A sound knowledge of the anatomy of the head helps in understanding the causes of headaches and facial pain
- **Injury to the superciliary arches** (891)
    - The superciliary arches are relatively sharp bony ridges
        - So, a blow to them (eg during boxing) may lacerate the skin and cause bleeding
        - Bruising of the skin around the orbit causes tissue fluid and blood to accumulate in the surrounding connective tissue, which gravitates into the superior (upper) eyelid and around the eye = “black eye”
- **Malar flush** (891)
    - Zygomatic bone was once called the malar bone, so the term *malar flush* exists
    - Describes redness of the skin covering the zygomatic prominence (malar eminence)
        - Associated with a rise in temperature in various fevers occurring with certain diseases such as tuberculosis, and systemic lupus erhtematosus disease (SLE)
- **Fractures of the maxillae and associated bones** (891)
    - Dr. Leon-Clement Le Fort classified 3 common variants of fractures of the maxillae
        - ***Le Fort I fracture*** – wide variety of horizontal fractures of the maxillae
            - Passing superior to the maxillary alveolar process (ie to the roots of the teeth)

        - Crossing the bony nasal septum and possibly the pterygoid plates of the sphenoid
    - ***Le Fort II fracture*** – passes from the posterolateral parts of the maxillary sinuses (cavities in the maxillae) superomedially through the infraorbital foramina, lacrimals, or ethmoids to the bridge of the nose
        - As a result, the entire central part of the face, including the hard palate and alveolar processes, is separated from the rest of the cranium
    - ***Le Fort III fracture*** – horizontal fracture that passes through the superior orbital fissures and the ethmoid and nasal bones and extends laterally through the greater wings of the sphenoid and the frontozygomaic sutures
        - Concurrent fracturing of the zygomatic arches causes the maxillae and zygomatic bones to separate from the rest of the cranium
- **Fractures of the mandible** (891-892)
    - Usually involves 2 fractures, which frequently occur on opposite sides of the mandible
        - So, if one fracture is observed, a search should be made for another
            - Ex. a hard blow to the jaw often fractures the nck of the mandible and its body in the region of the opposite canine tooth
        - *Fractures of the coronoid process* are uncommon and usually single
        - *Fractures of the neck of the mandible* are often transverse and may be associated with dislocation of the TMJ on the same side
        - *Fractures of the angle of the mandible* are usually oblique and may involve the bony socket or alveolus of the 3rd molar tooth
        - *Fractures of the body of the mandible* frequently pass through the socket of a canine tooth
- **Resorption of alveolar bone** (892)
    - Extraction of teeth causes the alveolar bone to resorb in the affected region(s)
        - Following complete loss or extraction of maxillary teeth, the sockets begin to fill in with bone and the alveolar process begins to resorb
        - Similarly, extraction of mandibular teeth causes the bone to resorb
            - Gradually, the mental foramen lies near the superior border of the body of the mandible
            - In some cases, the mental foramina disappear, exposing the mental nerves to injury
                - Pressure from a dental prosthesis (eg a denture resting on an exposed mental nerve) may produce pain during eating
        - Loss of all the teeth results in a decrease in the vertical facial dimension and *mandibular prognathism* (overclosure)
            - Deep creases in the facial skin also appear that pass posteriorly from the corners of the mouth
- **Fractures of the calvaria** (893)
    - The convexity of the calvaria distributes and thereby usually minimizes the effect of a blow to the head
    - Hard blows in thin areas of the calvaria are likely to produce ***depressed fractures*** in which a bone fragment is depressed inward, compressing and/or injuring the brain
    - ***Linear calvarial fractures***, the most frequent type, usually occur at the point of impact
        - Fracture lines often radiate away from it in 2 or more directions
    - In ***communited fractures***, the bone is broken into several pieces
    - If the area of the calvaria is thick at the site of impact, the bone may bend inward without fracturing
        - However, a fracture may occur some distance from the site of direct trauma where the calvaria is thinner
    - In a ***contrecoup (counterblow) fracture***, no fracture occurs at the point of impact, but one occurs on the opposite side of the cranium
- **Fracture of the pterion** (893-894)
    - Can be life-threatening bc it overlies the anterior branches of the middle meningeal vessels, which lie in grooves on the internal aspect of the lateral wall of the calvaria
    - The pterion is 2 fingers' breath superior to the zygomatic arch and a thumb's breadth posterior to the frontal process of the zygomatic bone
    - A hard blow to the side of the head may fracture the thin bones forming the pterion (frontal, parietal, greater wing of the sphenoid, and temporal bones)
        - Produces a rupture of the anterior branch of the middle meningeal artery crossing the pterion
        - The resulting *hematoma* exerts pressure on the underlying cerebral cortex
            - An untreated middle meningeal artery hemorrhage may cause death in a few hours
- **Development of the cranium** (902-903)
    - The bones of the calvaria and some parts of the cranial base develop by *intramembrane ossification*

- Most parts of the cranial base develop by *endochondrial ossification*

- At birth, the bones of the calvaria are smooth and unilaminar – no diploë is present
  - The frontal and parietal eminences are especially prominent
  - The cranium of a newborn infant is disproportionately large compared to other parts of the skeleton
    - The facial aspect is small compared to the calvaria, which forms approx 1/8 of the cranium
      - In the adult, the facial skeleton forms 1/3 of the cranium
    - The large size of the calvaria in infants results from precocious growth and development of the brain and eyes
    - The rudimentary development of the face makes the orbits appear relatively large
      - The smallness of the face results from the rudimentary development of the maxillae, mandible, and paranasal sinuses (air-filled bone cavities), the absence of erupted teeth, and the small size of the nasal cavities
- ***Sutures*** –
  - The halves of the frontal bone in the newborn are separated by the ***frontal suture***
  - The frontal and parietal bones are separated by the ***coronal suture***
  - The maxillae and mandibles are separated by the ***intermaxillary suture*** and ***mandibular symphsis*** (secondary cartilaginous joint), respectively
- There are no mastoid and styloid processes at birth
  - So, the facial nerves are close to the surface when they emerge from the stylomastoid foramina
    - As a result, the facial nerves may be injured by forceps during a difficult delivery or later by an incision posterior to the auricle of the external ear (as for the surgical treatment of mastoiditis or middle ear problems)
  - The mastoid processes form gradually during the 1st year as the SCM muscles complete their development and pull on the petromastoid parts of the temporal bones
- The bones of the calvaria of a newborn infant are separated by membranous intervals – largest occur between the angles (corners) of the flat bones
  - ***Fontanelles*** –
    - **Important facts** –
      - Palpation of the fontanelles during infancy, especially the anterior and posterior ones, enables physicians to determine the:
        - Progress of growth of the frontal and parietal bones
        - Degree of hydration of an infant (a depressed fontanelle indicates dehydration)
        - Level of intracranial pressure (a bulging fontanelle indicates increased pressure on the brain)
    - **Anterior fontanelle** – largest one, diamond or star shaped
      - Bounded by the halves of the frontal bone anteriorly and the parietal bones posteriorly
      - So it is located at the junction of the sagittal, coronal, and frontal sutures, the future site of the **bregma**
      - By 18 months, the surrounding bones have fused and it is no longer clinically palpable
      - Union of the halves of the frontal bone begins in the 2nd year
        - In most cases, the frontal suture is obliterated by the 8th year
        - In approx 8% of people a remnant of it, the **metopic suture**, persists
        - Much less frequently, the entire suture remains, and this must not be interpreted as a fracture in a radiograph or other medical image
    - **Posterior fontanelle** – triangular
      - Bounded by the parietal bones anteriorly and the occipital bone posteriorly
      - Located at the junction of the lambdoid and sagittal sutures, the future site of the **lambda**
      - Begins to close during the first few months after birth, and by the end of the 1st year, it is small and no longer clinically palpable
    - **Sphenoidal and mastoid fontanelles**
      - Overlain by the temporalis muscle
      - Fuse during infancy and are less important clinically than the midline fontanelles
      - The halves of the mandible fuse in the 2nd year
      - The 2 maxillae and nasal bones usually do not fuse

- The softness of the cranial bones in infants and their loose connections at the sutures and fontanelles enable the shape of the calvaria to change (mold) during birth
  - During passage through the birth canal, the halves of the frontal bone become flat, the occipital bone is drawn out, and one parietal bone slightly overrides the other
  - Within a few days after birth, the shape of the calvaria returns to normal
  - The resilience of the cranial bones of infants allows them to resist forces that would produce fractures in adults
  - The fibrous sutures of the calvaria also permit the cranium to enlarge during infancy and childhood
    - The increase in size of the calvaria is greatest during the first 2 years, the period of most rapid brain development
    - The calvaria normally increases in capacity for 15-16 years
    - After this, the calvaria usually increases slightly in size for 3-4 years as a result of bone thickening

- **Age changes in the face** (903-904)
  - The mandible is the most dynamic of our bones
    - Its size and shape and the number of teeth it normally bears undergo considerable change with age
    - In the newborn, the mandible consists of 2 halves united in the median by a cartilaginous joint, the *mandibular symphysis*
      - Union between the halves of the mandible is effected by means of fibrocartilage
      - This union begins during the 1st year and the halves are fused by the end of the 2nd year
    - The body of the mandible in newborn infants is a mere shell lacking an alveolar process, each half enclosing five deciduous (primary) teeth
      - These teeth usually begin to erupt in infants at approx 6 months of age
      - The body of the mandible elongates, particularly posterior to the mental foramen, to accommodate this development and later 8 permanent (secondary) teeth, which begin to erupt during the 6th year of life
        - Eruption of the permanent teeth is not complete until early adulthood
      - Rapid growth of the face during infancy and early childhood coincides with the eruption of deciduous teeth
      - Vertical growth of the upper face results mainly from dentoalveolar development
        - These changes are more marked after the permanent teeth erupt
    - Concurrent enlargement of the frontal and facial regions is associated with the increase in the size of the *paranasal sinuses*, the air-filled extensions of the nasal cavities in certain cranial bones
      - Most paranasal sinuses are rudimentary or absent at birth
      - Growth of the paranasal sinuses is important in altering the shape of the face and in adding resonance to the voice
- **Obliteration of the cranial sutures** (904)
  - Usually begins between the ages of 30 and 40 on the internal surfaces
  - About 10 years later on the external surface
  - Usually begins at the bregma and continues sequentially in the sagittal, coronal, and lambdoid sutures
- **Age changes in the cranium** (904)
  - As people age, the cranial bones normally become progressively thinner and lighter, and the diploë gradually become filled with a gray gelatinous material
  - In these individuals, the bone marrow has lost its blood cells and fat, giving it a gelatinous appearance
- **Craniosynostosis and cranial malformations** (904-905)
  - Premature closure of the cranial sutures (***primary craniosynostosis***) results in several cranial malformations
    - Incidence is approx 1/2000 births
    - Cause is unknown, but genetic factors appear to be important
      - Prevailing hypothesis is that abnormal development of the cranial base creates exaggerated forces on the dura mater that disrupt normal cranial sutural development
      - These malformations are more common in males than in females and are often associated with other skeletal anomalies
  - The type of malformed cranium that forms depends on which sutures close prematurely
    - ***Premature closure of the sagittal suture*** – anterior fontanelle is small or absent
      - Results in a long, narrow, wedge-shaped cranium = **scaphocephaly**
    - ***Premature closure of the coronal or the lambdoid suture*** on one side only
      - Cranium is twisted and asymmetrical = **plagiocephaly**
    - ***Premature closure of the coronal suture***

        - Results in a high, tower-like cranium = **oxycephaly** or **turricephaly**
        - Usually occurs in females
    - Premature closure of the sutures usually does not affect brain development
- **Scalp wounds** (906)
    - The epicranial aponeurosis is clinically important
        - Bc of its strength, *superficial scalp wounds* do not gape and the margins of the wound are held together
            - Furthermore, deep sutures are not necessary when suturing superficial wounds bc the aponeurosis does not allow wide separation of the skin
        - *Deep scalp wounds* gape widely when the aponeurosis is lacerated in the coronal plane bc of the pull of the frontal and occipital bellies of the occipitofrontalis muscle in opposite directions
- **Scalp infections** (906)
    - The loose connective tissue layer (layer 4) of the scalp is the *danger area of the scalp* bc pus or blood spreads easily in it
        - Infection in this layer can also pass into the cranial cavity through *emissary veins*, which pass through the parietal foramina into the calvaria and reach intracranial sutures such as the meninges
    - An infection cannot pass into the neck bc the occipital bellies of the occipitofrontalis muscle attach to the occipital bone and mastoid parts of the temporal bones
    - Also can't spread laterally beyond the zygomatic arches bc the epicranial aponeurosis is continuous with the temporal fascia that attaches to these arches
    - An infection or fluid (eg pus or blood) can enter the eyelids and the root of the nose bc the frontalis inserts into the skin and subcutaneous tissue and does not attach to the bone
        - Consequently, "black eye" can result from an injury to the scalp and/or the forehead
        - *Ecchymosis*, or purple patches, develop as a result of extravasation of blood into the subcutaneous tissue and skin of the eyelids and surrounding tissues
- **Sebaceous cysts** (906)
    - The ducts of sebaceous cysts associated with hair follicles in the scalp may become obstructed, resulting in the retention of secretions and the formation of ***sebaceous cysts*** (wens)
        - Bc they are in the skin, they move with the scalp
- **Cephalhematoma** (906)
    - Sometimes after a difficult birth, bleeding occurs between the baby's pericranium and calvaria, usually over one parietal bone
        - Blood becomes trapped in this area, causing a ***cephalhematoma***
            - Benign condition that frequently results from birth trauma that ruptures multiple, minute periosteal arteries that nourish the bones of the calvaria
- **Bone flaps** (908)
    - Bc the adult pericranium has poor osteogenic (bone-forming) properties, little regeneration occurs after bone loss (eg when pieces of bone are removed during repair of a comminuted cranial fracture)
        - *Surgically produced bone flaps* are put back into place and wired to other parts of the calvaria
- **Blunt trauma to the head** (911-912)
    - A blow to the head can detach the periosteal layer of dura mater from the calvaria without fracturing the cranial bones
        - In the cranial base the 2 dural layers are firmly attached and difficult to separate from the bones
            - So, a fracture of the cranial base usually tears the dura and results in leakage of CSF
        - The innermost part of the dura, the *dural border cell layer*, is composed of flattened fibroblasts that are separated by large extracellular spaces
            - This layer constitutes a plane of structural weakness at the dura-arachnoid junction
- **Tentorial herniation** (912)
    - The ***tentorial notch*** is the opening in the cerebellar tentorium for the brainstem
        - It is slightly larger than is necessary to accommodate the midbrain
            - So, *space-occupying lesion*, such as tumors in the supratentorial compartment, produce increased intracranial pressure and may cause part of the adjacent temporal lobe of the brain to herniated through the tentorial notch
                - During *tentorial herniation*, the temporal lobe may be lacerated by the tough cerebellar tentorium and the occulomotor nerve (CN III) may be stretched, compressed, or both
                    - *Oculomotor lesion* may produce paralysis of the extrinsic eye muscles
- **Bulging of the sellar diaphragm** (912)
    - *Pituitary tumors* may extend superiorly through the aperture in the sellar diaphragm or cause it to bulge

        - These tumors often expand the sellar diaphragm, producing disturbances in endocrine function early or late (ie before or after enlargement of the diaphragm)
        - Superior extension of a tumor may cause visual symptoms owing to pressure on the optic chiasm, the place where the optic nerve fibers cross
- **Occlusion of cerebral veins and dural venous sinuses** (915)
    - May result from thrombi (clots), thrombophlebitis (venous inflammation), or tumors (eg meningiomas)
        - The dural sinuses most frequently thrombosed are the transverse, cavernous, and superior sagittal sinuses
    - The facial veins make clinically important connections with the cavernous sinuses through the superior opthalamic veins
        - *Cavernous sinus thrombosis* usually results from infections in the orbit, nasal sinuses, and superior part of the face (the danger triangle)
        - In people with *thrombophlebitis of the facial vein*, pieces of an infected thrombus may extend into the cavernous sinus, producing *thrombophlebitis of the cavernous sinus*
            - The infection usually involves only one sinus initially but may spread to the opposite side through the intercavernous sinuses
            - Thrombophlebitis of the cavernous sinus may affect the abducent nerve as it traverses the sinus
                - May also affect the nerves embedded within the lateral wall of the sinus
            - Septic thrombosis of the cavernous sinus often results in the development of *acute meningitis*
- **Metastasis of tumor cells to the dural sinuses** (915)
    - The basilar and occipital sinuses communicate through the foramen magnum with the internal vertebral venous plexuses
        - These venous channels are valveless
            - So, compression of the thorax, abdomen, or pelvis, as occurs during heavy coughing and straining, may force venous blood from these regions into the internal vertebral venous system
                - From there it can pass into the dural venous sinuses
        - As a result, pus in abscesses and tumor cells in these regions may spread to the vertebrae and brain
- **Fractures of the cranial base** (915)
    - In fractures of the cranial base, the internal carotid artery may be torn, producing an *arteriovenous fistula* within the sinus
        - Arterial blood rushes into the cavernous sinus, enlarging it and forcing retrograde blood flow into its venous tributaries, especially the ophthalmic veins
            - As a result, the eyeball protrudes (*exophthalmos*) and the conjunctiva becomes engorged (*chemosis*)
                - The protruding eyeball pulsates in synchrony with the radial pulse, a phenomenon known as *pulsating exophthalmos*
        - Bc CN III, CN IV, CN V_1, CN V_2, and CN VI lie in or close to the lateral wall of the cavernous sinus, these nerves may also be affected when the sinus is injured
- **Dural origin of headaches** (917)
    - The dura is sensitive to pain, especially where it is related to the dural venous sinuses and meningeal arteries
        - Consequently, pulling on arteries at the cranial base or veins near the vertex where they pierce the dural causes pain
            - Distension of the scalp or meningeal vessels (or both) is believed to be one cause of headache
                - Many headaches appear to be dural in origin, such as the headache occurring after a lumbar spinal puncture for removal of CSF
                    - These headaches are thought to result from stimulation of sensory nerve endings in the dura
                    - When CSF is removed, the brain sags slightly, pulling on the dura
                    - This may also cause a headache
                    - For this reason, patients are asked to keep their heads down after a lumbar puncture to minimize the pull on the dura, reducing the chances of getting a headache
- **Leptomeningitis** (919)
    - An inflammation of the leptomeninges resulting from pathogenic microorganisms
        - The infection and inflammation are usually confined to the subarachnoid space and the arachnoid-pia mater
            - The bacteria may enter the subarachnoid space through the blood (*septicemia*, or "blood poisoning") or spread from an infection of the heart, lungs, or other viscera
            - Microorganisms may also enter the subarachnoid space from a compound cranial fracture or a fracture of the nasal sinuses
    - *Acute purulent meningitis* can result from infection with almost any pathogenic bacteria (eg *meningococcal meningitis*)
- **Head injuries and intracranial hemorrhage** (919)

- ***Extradural*** or ***epidural hemorrhage*** is arterial in origin
  - Blood from torn branches of a middle meningeal artery collects between the external periosteal layer of the dura and the calvaria, usually following a hard blow to the head
    - Forms an *extradural* or *epidural hematoma*
  - Typically, a brief *concussion* (loss of consciousness) occurs, followed by a lucid interval of some hours
  - Later, drowsiness and coma (profound unconsciousness) occur
    - Compression of the brain occurs as the blood mass increases, necessitating evacuation of the blood and occlusion of the bleeding vessels
- A ***dural border hematoma*** is classically called a ***subdural hematoma***
  - This term is a misnomer bc there is no naturally occurring spac at the dura-arachnoid junction
  - Hematomas at this junction are usually caused by extravasated blood that splits open the dural border cell layer
    - This blood does not collect within a pre-existing space, but rather creates a space at the dura-arachnoid junction
  - Usually follows a blow to the head that jerks the brain inside the cranium and injures it
    - The precipitating trauma may be trivial or forgotten
  - Typically venous in origin and commonly results from tearing a superior cerebral vein as it enters the superior sagittal sinus
- ***Subarachnoid hemorrhage*** is an extravasation (escape) of blood, usually arterial, into the subarachnoid space
  - Most result from *rupture of a saccular aneurysm* (sac-like dilation on the side of an artery), such as an aneurysm of the internal carotid artery
  - Some are associated with head trauma involving cranial fractures and cerebral lacerations
  - Bleeding into the subarachnoid space results in meningeal irritation, a severe headache, stiff neck, and often loss of consciousness

- **Cerebral injuries** (921, 923)
  - ***Cerebral concussion*** is an abrupt, brief loss of consciousness immediately after a head injury
    - Consciousness may be lost for only 8-10 sec, as occurs in a knockdown during boxing
    - With a more severe injury, such as that resulting from a car accident, consciousness may be lost for hours and even days
    - If a person recovers consciousness within 6 hr, the long-term outcome is excellent
      - If the coma lasts longer than 6 hr, brain tissue injury usually occurs
    - Professional boxers are especially at risk for *chronic traumatic encephalopathy*, or *punchdrunk syndrome*
      - A brain injury characterized by weakness in the lower limbs, unsteady gait, slowness of muscular movements, tremors of the hands, hesitancy of speech, and slow cerebration (use of one's brain)
      - The injuries result from acceleration and deceleration of the head that shears or stretches axons (*diffuse axonal injury*)
      - The sudden stopping of the moving head results in the brain hitting the suddenly stationary cranium
  - ***Cerebral contusion*** results from brain trauma in which the pia is stripped from the injured surface of the brain and may be torn, allowing blood to enter the subarachnoid space
    - The bruising results either from the sudden impact of the still-moving brain against the suddenly stationary cranium or from the suddenly moving cranium against the still-stationary brain
    - May result in an extended loss of consciousness, but if there is no diffuse axonal injury, brain swelling, or secondary hemorrhage, recovery from a contusion can be excellent
  - ***Cerebral lacerations*** are often associated with depressed cranial fractures or gunshot wounds
    - Result in rupture of blood vessels and bleeding into the brain and subarachnoid space
      - Causes increased intracranial pressure and cerebral compression
        - **Cerebral compression** may be produced by:
          - Intracranial collections of blood
          - Obstruction of CSF circulation or absorption
          - Intracranial tumors or abscesses
          - Brain swelling caused by *brain edema*, an increase in brain volume resulting from an increase in water and sodium content

- **Cisternal puncture** (925)
  - May be used to obtain CSF from the posterior cerebellomedullary cistern for diagnostic or therapeutic purposes
  - How –

        - The needle is carefully inserted through the posterior atlanto-occipital membrane into the cistern
    - The subarachnoid space or the ventricular system may also be entered for measuring or monitoring CSF pressure, injecting antibiotics, or administering contrast media for medical imaging
    - The cerebellomedullary cistern is the site of choice in infants and young children
        - The lumbar cistern is used most frequently in adults
- **Hydrocephalus** (925)
    - Overproduction of CSF, obstruction of CSF flow, or interference with CSF absorption results in excess fluid in the cerebral ventricles and enlargement of the head, a condition called ***obstructive hydrocephalus***
        - The excess CSF dilates the ventricles, thins the cerebral cortex, and separates the bones of the calvaria in infants
            - Although an obstruction can occur any place, the blockage usually occurs in the cerebral aqueduct or an interventricular foramen
                - *Aqueductal stenosis* may be caused by a nearby tumor in the midbrain or by cellular debris following intraventricular hemorrhage or bacterial and fungal infections of the CNS
            - Blockage of CSF circulation results in dilation of the ventricles to the point of obstruction and in pressure on the cerebral hemispheres
                - Squeezes the brain between the ventricular fluid and the calvarial bones
                - In infants, the internal pressure results in expansion of the brain and calvaria bc the sutures and fontanelles are still open
                    - It is possible to produce an artificial drainage system to bypass the blockage and allow CSF to escape, thereby lessening damage to the brain
    - In ***communicating hydrocephalus***, the flow of CSF through the ventricles and into the subarachnoid space is not impaired
        - However, movement of CSF from this space into the venous system is partly or completely blocked
        - The blockage may be caused by the congenital absence of arachnoid granulations, or the granulations may be blocked by RBC as the result of a subarachnoid hemorrhage
- **Leakage of CSF** (925-926)
    - Fractures in the floor of the middle cranial fossa may result in CSF leakage from the external acoustic meatus (***CSF otorrhea***) if the meninges superior to the middle ear are torn and the tympanic membrane is ruptured
    - Fractures in the floor of the anterior cranial fossa may involve the cribriform plate of the ehtmoid, resulting in CSF leakage through the nose (***CSF rhinorrhea***)
    - CSF can be distinguished from mucus by testing its glucose level – the glucose level of the CSF reflects that of blood
    - CSF otorrhea and rhinorrhea may be the primary indications of a cranial base fracture and increase the risk of meningitis bc an infection could spread to the meninges from the ear or nose
- **Anastomoses of cerebral arteries and cerebral embolism** (930)
    - Branches of the 3 cerebral arteries anastomose with each other on the surface of the brain
        - However, if a cerebral artery is obstructed by a ***cerebral embolism*** (eg a blood clot), these microscopic anastomoses are not capable of providing enough blood for the area of cerebral cortex concerned
        - Consequently, *cerebral ischemia* and *infarction* occur and an area of necrosis results
            - Large cerebral emboli occluding major cerebral vessels may cause severe neurological problems and death
- **Variations of the cerebral arterial circle** (930)
    - Variations in the size of the vessels forming the cerebral arterial circle is common
        - The ***posterior communicating arteries*** are absent in some people
        - In others there may be 2 ***anterior communicating arteries***
        - In approx 1/3 people, one ***posterior cerebral artery*** is a major branch of the ***internal carotid artery***
        - One of the ***anterior cerebral arteries*** is often small in the proximal part of its course
            - The ***anterior communicating artery*** is larger than usual in these individuals
- **Strokes** (930-931)
    - An ***ischemic stroke*** denotes the sudden development of focal neurological deficits that are usually resulted to *impaired cerebral blood flow*
        - Generally caused by an embolism in a major cerebral artery
            - Most common neurological disorders affecting adults in the US
            - More often disabling than fatal
            - Cardinal feature of a stroke is the sudden onset of neurological symptoms
        - The cerebral arterial circle is an important means of collateral circulation in the event of gradual obstruction of one of the major arteries forming the circle

- Sudden occlusion, even if only partial, results in neurological deficits
- In elderly person, the anastomoses of the arterial circle are often inadequate when a large artery (eg the internal carotid) is occluded, even if the occlusion is gradual

- The most common causes of strokes are ***spontaneous cerebrovascular accidents***, such as cerebral thromobosis, cerebral hemorrhage, cerebral embolism, and subarachnoid hemorrhage
- ***Hemorrhagic stroke*** follows the rupture of an artery or a *saccular aneurysm*, a sac-like dilation on a weak part of the arterial wall
  - The most common type of saccular aneurysm is a *berry aneurysm*, occurring in the vessels of or near the cerebral arterial circle and the medium arteries at the base of the brain
  - Aneurysms also occur at the bifurcation of the basilar artery into the posterior cerebral arteries
  - In time, especially in people with hypertension, the weak part of the wall of the aneurysm expands and may rupture
    - Allows blood to enter the subarachnoid space
  - Sudden rupture of an aneurysm usually produces a severe, almost unbearable headache and a stiff neck
    - Symptoms result from gross bleeding into the subarachnoid space

- **Brain infarction** (931)
  - An *atherosclerotic plaque* at a bend of an artery (eg at the bifurcation of a common carotid artery) results in progressive narrowing (stenosis) of the artery, producing increasingly severe neurological deficits
    - An *embolus* separates from the plaque and is carried in the blood until it lodges in an artery, usually an intracranial branch that is too small to allow its passage
      - This event usually results in ***acute cortical infarction***, a sudden insufficiency of arterial blood to the brain (eg of the left parietal lobes)
        - An interruption of blood supply for 30 sec alters a person's brain metabolism
        - After 1-2 min, neural function may be lost
        - After 5 min, lack of oxygen (anoxia) can result in cerebral infarction
          - Quickly restoring oxygen to the blood supply may reverse the brain damage
- **Transient ischemic attacks** (931)
  - Refer to neurological symptoms resulting from *ischemia*
    - Most last only a few minutes, but some persist for up to an hour
    - With major ***carotid*** or ***vertebrobasilar stenosis***, the TIA tends to last longer and causes distal closure of intracranial vessels
  - The symptoms of TIA may be ambiguous –
    - Staggering, dizziness, light-headedness, fainting, and paresthesias
  - People with TIAs are at increased risk for myocardial infarction and ischemic stroke
- **Facial lacerations and incisions** (933)
  - Bc the face has no distinct deep fascia and the subcutaneous tissue between the cutaneous attachments of the facial muscle is loose, ***facial lacerations*** tend to gape (part widely)
    - Consequently, the skin must be carefully sutured to prevent scarring
    - The looseness of the subcutaneous tissue also enables fluid and blood to accumulate in the loose connective tissue following bruising of the face
    - Similarly, facial inflammation causes considerable swelling (eg a bee sting on the bridge of the nose may close both eyes)
  - As a person ages, the skin loses its resiliency (elasticity)
    - As a result, ridges and wrinkles occur in the skin perpendicular to the direction of the facial muscle fibers
    - Skin incisions along these cleavage or wrinkle lines (Langer lines) heal with minimal scarring
- **Flaring of the nostrils** (938)
  - The actions of the nasalis muscles have generally been held as insignificant
    - However, observant clinicians study their action bc of their diagnostic value
      - For ex. true *nasal breathers* can flare their nostrils distinctly
      - Habitual *mouth breathing*, caused by chronic nasal obstruction, for ex, diminishes and sometimes eliminates the ability to flare the nostrils
        - Children who are chronic mouth breathers often develop dental malocclusion (improper bite) bc the alignment of the teeth is maintained to a large degree by normal periods of occlusion and labial closure

        - Antisnoring devices have been developed that attach to the nose to flare the nostrils and maintain a more patent air passageway
- **Paralysis of facial muscles** (938-939)
    - Injury to the facial nerve (CN VII) or its branches produces paralysis of some or all facial muscles on the affected side = ***Bell palsy***
        - The affected area sags and facial expression is distorted, making it appear passive or sad
        - The loss of tonus of the orbicularis oculi causes the inferior eyelid to evert (fall away from the surface of the eyeball)
            - As a result, lacrimal fluid is not spread over the cornea, preventing adequate lubrication, hydration, and flushing of the surface of the cornea
                - This makes it vulnerable to ulceration and a resulting corneal scar can impair vision
        - If the injury weakens or paralyzes the buccinators and orbicularis oris, food will accumulate in the oral vestibule during chewing, usually requiring continual removal with a finger
        - When the sphincters or dilators of the mouth are affected, displacement of the mouth (drooping of its corner) is produced by contraction of unopposed contralateral facial muscles and gravity
            - Results in food and saliva dribbling out of the side of the mouth, a sad look when the face is relaxed, and a markedly contorted smile
        - Weakened lip muscles affect speech as a result of an impaired ability to produce labial sounds
    - Affected people cannot whistle or blow a wind instrument
    - They frequently dab their eyes and mouth with a handkerchief to wipe the fluid (tears and saliva), which runs from the drooping lid and mouth
        - The fluid and constant wiping may result in localized skin irritation
- **Infraorbital Nerve Block** (943-944)
    - For treating wounds of the upper lip and cheek, or for repairing the maxillary incisor teeth
    - Local anesthesia of the inferior part of the face is achieved by infiltration of the infraorbital nerve with an anesthetic agent
        - Injection is made in region of the infraorbital foramen, by elevating the upper lip and passing the neecle through the junction of the oral mucosa and gingival at the superior aspect of the oral vestibule
            - To determine where the infraorbital nerve emerges – pressure is exerted on the maxilla in the region of the infraorbital foramen
                - Too much pressure causes a lot of pain
            - Aspiration of the syringe during injection prevents inadvertent injection of anesthetic fluid into the infraorbital vessels that leave the infraorbital foramen with the nerve
            - Bc the orbit is located just superior to the injection site, a careless injection could result in passage of anesthesia into the orbit, causing temporary paralysis of the extraocular muscles
- **Mental and incisive nerve blocks** (944)
    - Used to anesthetize one side of the skin and mucous membrane of the lower lip and the skin of the chin
        - Ex to suture a severe laceration of the lip
    - Injection of an anesthetic agent into the mental foramen blocks the mental nerve that supplies the skin and mucous membrane of the lower lip from the mental foramen to the midline, including the skin of the chin
- **Buccal nerve block** (944)
    - To anesthetize the skin and mucous membrane of the cheek
        - Ex to suture a knife wound
    - Anesthetic injection can be made into the mucosa covering the *retromolar fossa*, located posterior to the 3rd mandibular molar between the anterior border of the ramus and the temporal crest
- **Trigeminal neuralgia** (944)
    - Also known as ***tic douloureux***
    - Sensory disorder of the sensory root of CN V that occurs most often in the middle-aged and elderly
    - Characterized by sudden attacks of excruciating, lightening-like jabs of facial pain
        - A *paroxysm* (sudden sharp pain) can last for 15 min or more
            - May be so intense that the person winches = *tic*/twitch
        - In some cases, the pain may be so severe that psychological changes can occur that lead to depression and even suicide attempts
    - CN V_2 is most frequently involved, then CN V_3, then CN V_1
    - Paroxysms are often set off by touching the face, brushing the teeth, shaving, drinking, or chewing
        - Often initiated by touching an especially sensitive *trigger zone*, frequently located around the tip of the nose or cheek

- Cause is unknown
  - Some investigators believe that most affected people have an anomalous blood vessel that compresses the nerve
    - Often when the aberrant artery is moved away from the sensory root of CN V the symptoms disappear
  - Other scientists believe the condition is caused by a pathological process affecting neurons in the trigeminal ganglion
  - Others believe that neurons in the nucleus of the spinal tract may be involved
- Treatment – medical or surgical treatment, or both, may be used to alleviate the pain
  - In CN V_2 cases, attempts have been made to block the infraorbital nerve at the infraorbital foramen by using alcohol
    - Usually relives pain temporarily
  - Simplest surgical procedure = avulsion or cutting of the branches of the nerve at the infraorbital foramen
  - Other treatments have used radiofrequency selective ablation of parts of the trigeminal ganglion by a needle electrode passing through the cheek and the foramen ovale
  - In some cases, it is necessary to section the sensory root for relief of pain
    - Rhizotomy between the ganglion and the brainstem may be necessary to prevent regeneration of the sensory root – try to cut only sensory fibers of involved CN V division
  - Tractotomy (sectioning of the spinal tract of CN V) may be achieve the same result
    - The sensation of pain, temperature, and simple (light) touch is lost over the area of skin and mucous membrane supplied by the affected component of CN V
    - This may annoy the patient, who may not recognize the presence of food on the lip and cheek or feel it within the mouth on the side of the nerve section, but this is usually preferable to excruciating pain

- **Lesions of the trigeminal nerve** (944)
  - Lesions of the entire trigeminal nerve cause widespread anesthesia involving the:
    - Corresponding anterior half of the scalp
    - Face, except for an area around the angle of the mandible, the cornea, and the conjunctiva
    - Mucous membrane of the nose, mouth, and anterior part of the tongue
  - Paralysis of muscles of mastication also occurs
- **Herpes zoster infection of the trigeminal ganglion** (944)
  - Herpes zoster virus infection may produce a lesion in the cranial ganglia
    - Involvement of the trigeminal ganglion occurs in approx 20% of cases
    - Characterized by an eruption of groups of vesicles following the course of the affected nerve (eg *opthalamic herpes zoster*)
    - Any division of CN V may be involved, but the opthalamic division is most commonly infected
      - Usually the cornea is involved, often resulting in painful *corneal ulceration* and subsequent *scarring of the cornea*
- **Testing the sensory function of CN V** (945)
  - Tested by asking the person to close his/her eyes and respond when types of touch are felt
    - Ex – a dry piece of gauze is gently stroken across the skin of one side of the face and then the corresponding position on the other side
    - Test is then repeated until the skin of the forehead (CN V_1), cheek (CN V_2), and lower jaw (CN V_3) have been tested
      - Person is asked if one side feels the same as or different from the other side
    - Testing may then be repeated using warm or cold instruments and then gentle touch of a sharp pin, again alternating sides
- **Injuries to the facial nerve** (945, 947)
  - Causes paralysis of the facial muscles (***Bell palsy***), with or without loss of taste on the anterior 2/3 of the tongue or altered secretion of the lacrimal and salivary glands
    - *Lesions near the origin of CN VII from the pons of the brain or proximal to the origin of the greater petrosal nerve (in the region of the geniculate ganglion)* = loss of motor, gustatory (taste), and autonomic functions
    - *Lesions distal to the geniculate ganglion, but proximal to the origin of the chorda tympani nerve* = same dysfunction, except that lacrimal secretion is not affected
    - *Lesions near the stylomastoid foramen* = loss of motor function only = facial paralysis
  - Has many causes
    - Most common non-traumatic cause = inflammation of the facial nerve near the stylomastoid foramen, probably as a result of a viral infection
      - Produces edema and compression of the nerve in the facial canal
    - Fracture of the temporal bone can also be a cause = facial paralysis is evident soon after injury

- If the nerve is completely sectioned, the chances of complete or even partial recovery are remote
- Muscular movement usually improves when the nerve damage is associated with blunt head trauma, but it may not be complete
- It may be idiopathic, occurring without a known cause
  - But, it often follows exposure to cold, as occurs when riding in a car or sleeping with a window open
- May be a complication of surgery
  - So ID of the facial nerve is essential during surgery (eg parotidectomy)
  - It is most distinct as it emerges from the stylomastoid foramen
  - Electrical stimulation may be used for confirmation
  - May be associated with dental manipulation, vaccination, pregnancy, HIV infection, Lyme disease, and infections of the middle ear (otitis media)

- Bc the branches are superficial, they are subject to injury by stab and gunshot wounds, cuts, and injury at birth:
  - A *lesion of the zygomatic branch* of CN VII causes paralysis, including loss of tonus of the orbicularis oculi in the inferior eyelid
  - *Paralysis of the buccal branch* of CN VII causes paralysis of the buccinators and superior portion of the orbicularis oris and upper lip muscles
  - *Paralysis of the marginal mandibular branch* of CN VII may occur when an incision is made along the inferior border of the mandible
    - Injury of this branch (eg during a surgical approach to the submandibular gland) causes paralysis of the inferior portion of the orbicularis oris and lower lip muscles

- **Compression of the facial artery** (950)
  - Can be occluded by pressure against the mandible where the vessel crosses it
    - Bc of the numerous anastomoses between the branches of the facial artery and other arteries of the face, compression of the facial artery on one side does not stop all bleeding from a lacerated facial artery or one of its branches
    - In lacerations of the lip, pressure must be applied on both sides of the cut to stop bleeding
  - In general, facial wounds bleed freely and heal quickly
- **Pulses of the arteries of the face** (951)
  - Pulses of the superficial temporal and facial arteries can be used for taking the pulse
    - For ex – anesthesiologists at the head of the operating table often take the *temporal pulse* anterior to the auricle where the superficial temporal artery crosses the zygomatic process
  - Can feel the facial pulse when clenching your teeth – it crosses the inferior border of the mandible immediately anterior to the masseter muscle
- **Stenosis of the internal carotid artery** (951)
  - At the medial angle of the eye, an anastomosis occurs between the facial artery, a branch of the external carotid artery, and the cutaneous branches of the internal carotid artery
  - With advanced age, the internal carotid artery may become narrow (stenotic) owing to atherosclerotic thickening of the intima of the arteries
    - Bc of the arterial anastomosis, intracranial structures such as the brain can receive blood from the connection of the facial artery to the dorsal nasal branch of the ophthalmic artery
- **Scalp lacerations** (951)
  - Most common type of head injury requiring surgical care
  - Bleed profusely bc the arteries entering the periphery of the scalp bleed from both ends owing to abundant anastomoses
  - Arteries do not retract when lacerated bc they are help open by the dense connective tissue in layer 2 of the scalp
    - Spasms of the occipitofrontalis can increase gaping of scalp wounds
    - Bleeding from scalp lacerations can be fatal if not controlled (eg by sutures)
- **Scalp injuries** (951)
  - Bc the scalp arteries arising at the sides of the head are well protected by dense connective tissue and anastomose freely, a *partially detached scalp* may be replaced with a reasonable chance of healing as long as one of the vessels supplying the scalp remains intact
  - During an ***attached craniotomy*** (surgical removal of a segment of the calvaria with a soft tissue scalp flat to expose the cranial cavity) the incisions are usually made convex upward, and the superficial temporal artery is included in the tissue flap
    - The *scalp proper*, the first 3 layers of the scalp, is often regarded clinically as a single layer bc they remain together when a scalp flap is made during a craniotomy when part of the scalp is torn off (eg during industrial accidents)

        - Nerves and vessels of the scalp enter inferiorly and ascend through layer 2 of the skin
            - So, surgical pedicle scalp flaps are made so that they remain attached inferiorly to preserve the nerves and vessels, thereby promoting good healing
            - The arteries of the scalp supply little blood to the calvaria, which is supplied by the middle meningeal arteries
                - So, loss of the scalp does not produce necrosis of the calvarial bones
- **Thrombophlebitis of the facial vein** (952)
    - Facial vein makes clinically important connections with the cavernous sinus (a venous sinus of the dura mater) through the superior ophthalmic vein, and with the pterygoid plexus (a network of small veins within the infratemporal fossa), through the inferior ophthalmic vein and the deep facial vein
        - Bc of these connections, an infection of the face may spread to the cavernous sinus and pterygoid venous plexus
    - Blood from the medial angle of the eye, nose, and lips usually drains inferiorly through the facial vein, especially when a person is erect
        - Bc the facial vein has no valves, blood may pass through it in the opposite direction
            - So, venous blood from the face may enter the cavernous sinus
    - In individuals with *thrombophlebitis of the facial vein*, inflammation of the facial vein with secondary thrombus (clot) formation, pieces of an infection clot may extend into the intracranial venous system and produce *thrombophlebitis of the cavernous sinus*
        - Infection of the facial vein spreading to the dural venous sinuses may result from lacerations of the nose or be initiated by squeezing pustules (pimples) on the side of the nose and upper lip
            - So, the triangular area from the upper lip to the bridge of the nose is considered the *danger triangle of the face*
- **Squamous cell carcinoma of the lip** (952)
    - Usually involves the lower lip
    - Common causes -
        - Overexposure to sunshine over many years is a common factor
        - Chronic irritation from pipe smoking
    - Cancer cells from the central part of the lower lip, the floor of the mouth, and the apex of the tongue spread to the submental lymph nodes
        - Cells from the lateral parts of the lower lip drain to the submandibular lymph nodes
- **Parotidectomy** (955)
    - About 80% of salivary gland tumors occur in the parotid glands
        - Most of these tumors are benign
        - But most salivary gland cancer begins in the parotid
    - Surgical excision of the parotid gland (parotidectomy) is often performed as part of the treatment
        - Bc the parotid plexus of CN VII is embedded in the parotid, the plexus and its branches are in jeopardy during surgery
            - Must ID, dissect, isolate, and preserve the facial nerve during this surgery
            - A superficial portion of the gland (often called a “lobe”) is removed, and then the parotid plexus can be retracted to enable dissection of the deep portion of the gland
    - The parotid gland makes a substantial contribution to eh posterolateral contour of the face, the extent of its contribution being especially evident after it has been surgically removed
- **Infection of the parotid gland** (955)
    - May become infected by infectious agents that pass through the bloodstream, as occurs in mumps, an acute communicable viral disease
    - Infection of the gland causes inflammation (***parotiditis***) and swelling of the gland
        - Severe pain occurs bc the carotid sheath limits swelling
        - Often the pain is worse during chewing bc the enlarged gland is wrapped around the posterior border of the ramus of the mandible and is compressed against the mastoid process of the temporal bone when the mouth is opened
        - Mumps virus may also cause *inflammation of the parotid duct*, producing *redness of the parotid papilla* (the small projection at the opening of the duct into the superior oral vestibule)
            - Bc the pain produced by mumps may be confused with a toothache, redness of the papilla is often an early sign that the disease involves the gland and not a tooth
    - ***Parotid gland disease*** often causes pain in the auricle, external acoustic meatus, temporal region, and TMJ
        - Bc the auriculotemporal nerve, from which the parotid gland and sheath receive sensory fibers, also supplies sensory fibers to the skin over the temporal fossa and auricle

- **Abscess in the parotid gland** (955)
  - A bacterial infection localized in the parotid gland usually produces an abscess
  - Infection can result from extremely poor dental hygiene and spread to the gland through the parotid ducts
  - Physicians and dentists must determine whether a swelling of the cheek results from infection of the parotid gland or form an abscess of dental origin
- **Sialography of the parotid duct** (955)
  - A radiopaque fluid can be injected into the duct system of the parotid gland through a cannula inserted through the orifice of the parotid duct in the mucous membrane of the cheek
    - This technique (***sialography***) is followed by radiography of the gland
      - Demonstrates part of the parotid duct system that may be displaced or dilated by disease
- **Blockage of the parotid duct** (955)
  - May be blocked by a calcified deposit, called a ***sialolith*** or ***calculus***
    - Resulting pain in the parotid gland is made worse by eating
    - Sucking a lemon slice is painful bc of the buildup of saliva in the proximal part of the blocked duct
- **Accessory parotid gland** (955)
  - Sometimes an accessory parotid gland lies on the masseter muscle between the parotid duct and the zygomatic arch
    - Several ducts open from this accessory gland into the parotid duct
- **Periorbital ecchymosis** (958)
  - The skin of the eyelid is the thinnest of the body and is delicate and sensitive
  - Bc of the loose nature of the subcutaneous tissue within the eyelids, even a relatively slight injury or inflammation may result in an accumulation of fluid, causing the eyelids to swell
    - Blows to the periorbital region usually produce soft tissue damage bc the tissues are crushed against the strong and relatively sharp margin
      - Significant swelling and hemorrhage into the eyelids and extravasation of blood into the periorbital skin may occur = ***ecchymosis***
        - This type of injury is common in boxers
- **Fractures of the orbit** (958)
  - Orbital margin is strong to protect the orbital content
    - However, when the blows are powerful enough and the impact is directly on the bony rim, the resulting fractures usually occur at the sutures between the bones forming the orbital margin
      - Bc of the thinness of the medial and inferior walls of the orbit, a blow to the eye may fracture the orbital walls while the margin remains intact
    - Indirect traumatic injury that displaces the orbital walls is called a “blowout” fracture
      - Fractures of the medial wall may involve the ethmoidal and sphenoidal sinuses
      - Fractures of the inferior wall may involve the maxillary sinus
    - Although the superior wall is stronger than the medial and inferior walls, it is thin enough to be translucent and may be readily penetrated
      - A sharp object may pass through it and enter the frontal lobe of the brain
  - Orbital fractures often result in intraorbital bleeding, which exerts pressure on the eyeball, causing ***exophthalmos*** (protrusion of the eyeball)
    - Any trauma to the eye may affect adjacent structures, for ex.
      - Bleeding into the maxillary sinus, displacement of maxillary teeth, and fracture of nasal bones resulting in hemorrhage, airway obstruction, and infection that could spread to the cavernous sinus through the ophthalmic vein
- **Orbital tumors** (961)
  - Bc of the closeness of the optic nerve to the sphenoidal and posterior ethmoidal sinuses, a malignant tumor in these sinuses may erode the thin bony walls of the orbit and compress the optic nerve and orbital contents
    - Tumors in the orbit produce ***exopthalmos***
    - The easiest entrance to the orbital cavity for a tumor in the middle cranial fossa is through the superior orbital fissure
    - Tumors in the temporal or infratemporal fossa gain access to this cavity through the inferior orbital fissure
  - Although the lateral wall of the orbit is nearly as long as the medial wall bc it extends laterally and anteriorly, it does not reach as far anteriorly as the medial wall does, which occupies essentially a sagittal plane
    - Thus nearly 2.5 cm of the eyeball is exposed when the pupil is turned medially as far as possible
      - This is why the lateral side affords a good approach for operations on the eyeball

- **Injury to the nerves supplying the eyelids** (963)
    - Bc it supplies the levator palpabrae superioris, a lesion of the **oculomotor nerve** causes paralysis of the muscle, and the superior eyelid droops (***ptosis***)
    - Damage to the **facial nerve** involves paralysis of the obicularis oculi, preventing the eyelids from closing fully
        - Normal rapid protective blinking of the eye is also lost
        - The loss of tonus of the muscle in the inferior eyelid causes the lid to fall away (evert) from the surface of the eyeball, leading to drying of the cornea
            - This leaves the eyeball unprotected from dust and small particles
            - Thus irritation of the unprotected eyeball results in excessive but inefficient lacrimation
    - Excessive lacrimal fluid also forms when the lacrimal drainage apparatus is obstructed, thereby preventing the fluid from reaching the inferior part of the eyeball
        - People often dab their eyes constantly to wipe the tears, resulting in further irritation
- **Inflammation of the palpebral glands** (963)
    - Any of the glands in the eyelid may become inflamed and swollen from infection or obstruction of their ducts
        - If the ducts of the ***ciliary glands*** are obstructed, a painful red suppurative (pus-producing) swelling, a *sty* (*hordeolum*), develops on the eyelid
            - *Cysts of the sebaceous glands* of the eyelid, called *chalazia*, may also form
        - Obstruction of a ***tarsal gland*** produces inflammation, a *tarsal chalazion*, that protrudes toward the eyeball and rubs against it as the eyelids blink
        - *Chalazion* are often more painful than sties
- **Hyperemia of the conjunctiva** (963)
    - The conjunctiva is colorless, except when its vessels are dilated and congested = "***bloodshot eyes***"
        - Hyperemia of the conjunctiva is caused by local irritation (eg from dust, chlorine, or smoke)
        - An inflamed conjunctiva, ***conjunctivitis*** ("pinkeye"), is a common contagious infection of the eye
- **Subconjunctival hemorrhages** (963)
    - Common and manifested by bright or dark red patches deep to and within the bulbar conjunctiva
    - May result from injury or inflammation
        - A blow to the eye, excessively hard blowing of the nose, and paroxysms of coughing or violent sneezing can causes hemorrhages resulting from rupture of small subconjunctival capillaries
- **Pupillary light reflex** (964, 966)
    - Tested using a penlight during a neurological exam
    - Involves CN II (afferent limb) and CN III (efferent limb)
    - Is the rapid constriction of the pupil in response to light
        - When light enters one eye, both pupils constrict bc each retina sends fibers into the optic tracts of both sides
            - The sphincter pupillae muscle is innervated by parasympathetic fibers
                - So, interruption of these fibers causes dilation of the pupil bc of the unopposed action of the sympathetically innervated dilator pupillae muscle
    - The first sign of *compression of the oculomotor nerve* is ipsilateral slowness of the pupillary response to light
- **Uveitis** (966)
    - Inflammation of the vascular layer of the eyeball (uvea)
    - May progress to severe visual impairment and blindness
- **Development of the retina** (966)
    - Retina and optic nerve develop from the ***optic cup***, an outgrowth of the embryonic forebrain, the ***optic vesicle***
        - As it evaginates from the brain, the optic vesicle carries the developing meninges with it
            - Hence, the optic nerve is invested with cranial meninges and an extension of the subarachnoid space
            - The central artery and vein of the retina cross the subarachnoid space and run within the distal part of the optic nerve
        - The pigment cell layer of the retina develops from the outer layer of the optic cup, and the neural layer develops from the inner layer of the cup
- **Opthalmoscopy** (966)
    - Physicians use an ***opthalmoscope/funduscope*** to view the fundus (posterior part) of the eye
    - The retinal arteries and veins radiate over the fundus from the optic disc
        - The pale, oval disc appears on the medial side with the reginal vessels radiating from its center in an opthalmoscopic view of the retina

        - Pulsation of the retinal arteries is usually visible
    - Centrally, at the posterior pole of the eyeball, the macula appears darker than the reddish hue of the surrounding areas of the retina bc the black melanin pigment in the choroid and pigment cell layer is not screened by capillary blood
- **Retinal detachment** (966)
    - The layers of the developing retina are separated in the embryo by an intraretinal space
        - During the early fetal period, the embryonic layers fuse, obliterating this space
        - Although the pigment cell layer becomes firmly fixed to the coroid, its attachment to the neural layer is not firm
            - So, detachment of the retina may follow a blow to the eye
                - A detached retina usually results from seepage of fluid between the neural and pigment cell layers of the retina, perhaps days or even week after trauma to the eye
                - People with a retinal detachment may complain of flashes of light or spcks floating in front of the eye
- **Papilledema** (967)
    - An increase in CSF pressure slows venous return from the retina, causing *edema of the eye*
        - The edema is viewed during ophthalmoscopy as swelling of the optic disc = ***papilledema***
            - Normally, the disc is flat and does not form a papilla
            - Results from increased intracranial pressure and increased CSF pressure in the extension of the subarachnoid space around the optic nerve
    - A sudden reduction of pressure in the spinal subarachnoid space, as might occur with lumbar puncture, could result in a potentially fatal herniation of brain tissue into the vertebral canal if performed when intracranial pressure is elevated
- **Corneal abrasions and lacerations** (968)
    - Foreign objects such as sand or metal filings (particles) produce ***corneal abrasions*** that cause sudden, stabbing pain in the eyeball and tears
        - Opening and closing of the eyelids is also painful
    - ***Corneal lacerations*** are caused by sharp objects such as fingernails or the corner of a page of a book
- **Presbyopia and cataracts** (968)
    - As people age, their lenses become harder and more flattened
        - These changes gradually reduce the focusing power of the lenses = ***presbyopia***
    - Some people also experience a loss of transparency (cloudiness) of the lens from areas of opaqueness = ***cataracts***
        - *Cataract extraction* is a common operation
- **Hemorrhage into the anterior chamber** (968)
    - ***Hyphema*** (or ***hyphemia***) = hemorrhage within the anterior chamber of the eyeball
        - Usually results from blunt trauma to the eyeball, such as from a squash or racquet ball or a hockey stick
        - Initially, the anterior chamber is tinged red but blood soon accumulates in this chamber
        - Initial hemorrhage usually stops in a few days and recovery is usually good
- **Artificial eye** (972)
    - The fascial sheath of the eyeball forms a socket for an artificial eye when the eyeball has to be removed (***enucleated***)
    - After this operation, the eye muscles cannot retract too far bc their fascial sheaths remain attached to the fascial sheath of the eyeball
        - Thus some coordinated movement of a properly fitted artificial eyeball is possible
        - Bc the suspensory ligament supports the eyeball, it is preserved when surgical removal of the bony floor of the orbit is performed (eg during removal of a tumor)
- **Corneal reflex** (973)
    - During a neurological exam, the examiner touches the cornea with a wisp of cotton
        - A normal (positive) response is a blink
        - Absence of a blink response suggests a lesion of CN V_1
            - A lesion of CN VII (the motor nerve to the orbicularis oculi) may also impair this reflex
        - The examiner must be certain to touch the cornea (not just the sclera) to evoke the reflex
            - The presence of a contact lens may hamper or abolish the ability to evoke this reflex
- **Corneal ulcers and transplants** (973)
    - Damage to the sensory innervations of the cornea from CN V_1 leaves the cornea vulnerable to injury by foreign particles
    - People with scarred or opaque corneas may receive *corneal transplants* from donors
        - Corneal implants of non-reactive plastic material are also used
- **Oculomotor nerve palsy** (973)

- Complete oculomotor nerve palsy affects most of the ocular muscles, the levator palpebrae superioris, and the sphincter pupillae
  - The superior eyelid droops and cannot be raised voluntarily bc of the unopposed activity of the orbicularis oculi (supplied by CN VII)
  - The pupil is also fully dilated and non-reactive bc of the unopposed dilator pupillae
  - The pupil is fully abducted and depressed ("down and out") bc of the unopposed activity of the lateral rectus and superior oblique, respectively

- **Horner syndrome** (973)
  - Results from interruption of a cervical sympathetic trunk
    - Is manifest by the absence of sympathetically stimulated functions on the ipsilateral side of the head
    - Includes the following signs:
      - Constriction of the pupil = ***miosis***
        - Bc the parasympathetically stimulated sphincter of the pupil is unopposed
      - Drooping of the superior eyelid = ***ptosis***
        - Bc of the paralysis of the smooth muscle fibers interdigitated with the aponeurosis of the levator palpebrae superioris that collectively constitute the superior tarsal muscle, supplied by sympathetic fibers
      - Redness and increased temperature of the skin = ***vasodilation***
      - Absence of sweating = ***anhydrosis***
- **Paralysis of the extraocular muscles** (973)
  - One or more extraocular muscles may be paralyzed by disease in the brainstem or by a head injury, resulting in ***diplopia*** (double vision)
  - Paralysis of a muscle is apparent by the limitation of movement of the eyeball in the field of action of the muscle and by production of 2 images when one attempts to use the muscle
    - When the abducent nerve supplying only the lateral rectus is paralyzed, the individual cannot abduct the pupil on the affected side
      - The pupil is fully adducted by the unopposed pull of the medial rectus
- **Glaucoma** (975)
  - When drainage of aqueous humor through the sclera venous sinus into the blood circulation decreases significantly, pressure builds up in the anterior and posterior chambers of the eye = ***glaucoma***
  - Blindness can result from compression of the inner layer of the eyeball (retina) and the retinal arteries if aqueous humor production is not reduced to maintain normal intraocular pressure
- **Blockage of the central artery of the retina** (975)
  - Bc terminal branches of the central artery of the retina are end arteries, obstruction of them by an embolus results in instant and total blindness
  - Blockage of the artery is usually unilateral and occurs in older people
- **Blockage of the central vein of the retina** (976)
  - Bc the central vein of the retina enters the cavernous sinus, *thrombophlebitis* of this sinus may result in the passage of a thrombus to the central retinal vein and produce a blockage in one of the small retinal veins
  - Occlusion of a branch of the central vein of the retina usually results in slow, painless loss of vision
- **Mandibular nerve block** (981)
  - An anesthetic agent is injected near the mandibular nerve where it enters the infratemporal fossa
    - In the extraoral approach, the needle passes through the mandibular notch of the ramus of the mandible into the infratemporal fossa
    - Usually anesthetizes the auriculotemporal, inferior alveolar, lingual, and buccal branches of CN V_3
- **Inferior alveolar nerve block** (981)
  - Anesthetizes the inferior alveolar nerve, a branch of CN V_3
  - Site of injection is around the *mandibular foramen*, the opening into the mandibular canal on the medial aspect of the ramus of the mandible
    - This canal gives passage to the inferior alveolar nerve, artery, and vein
    - When the nerve block is successful, all mandibular teeth are anesthetized to the median plane
      - The skin and mucous membrane of the lower lip, the labial alveolar mucosa and gingivae, and the skin of the chin are also anesthetized bc they are supplied by the mental nerve, a branch of the inferior alveolar nerve

- **Dislocation of the TMJ** (986-987)
    - Sometimes during yawning or taking a large bite, excessive contraction of the lateral pterygoids may cause the heads of the mandible to dislocate anteriorly (pass anterior to the articular tubercles)
        - In this position, the mandible remains wide open and the person is unable to close it
    - Most commonly, a sideways blow to the chin when the mouth is open dislocates the TMJ on the side that received the blow
    - Dislocation of the TMJ may also accompany fractures of the mandible
        - Posterior dislocation is uncommon, being resisted by the presence of the postglenoid tubercle and the strong intrinsic lateral ligament
        - Usually in falls or on direct blow to the chin, the neck of the mandible fractures before dislocation occurs
    - Bc of the close relationship of the facial and auriculotemporal nerves to the TMJ, care must be taken during surgical procedures to preserve both the branches of the facial nerve overlying it and the articular branches of the auriculotemporal nerve that enter the posterior part of the joint
        - Injury to the articular branches of the auriculotemporal nerve supplying the TMJ, associated with traumatic dislocation and rupture of the articular capsule and lateral ligament, leads to laxity and instability of the TMJ
- **Arthritis of the TMJ** (987)
    - The TMJ may become inflamed from degenerative arthritis, for ex
    - Abnormal function of the TMJ may result in structural problems such as dental occlusion and joint clicking = ***crepitus***
        - The clicking is thought to result from delayed anterior disc movements during mandibular depression and elevation
- **Cleft lip** (990)
    - Also known as ***harelip***
    - A congenital anomaly (usually of the upper lip) that occurs in 1/1000 births
        - 60-80% of affected infants are males
    - Clefts vary from a small notch in the transitional zone and vermilion border to a notch that extends through the lip into the nose
        - In severe cases, the cleft extends deeper and is continuous with a cleft in the palate
    - May be unilateral or bilateral
- **Cyanosis of the lip** (990-991)
    - The lips, like the fingers, have an abundant, relatively superficial blood flow
        - Bc of this, they can lose a disproportionate amount of body head when exposed to a cold environment
        - Both are provided with sympathetically innervated arteriovenous anastomoses, capable of redirecting a considerable portion of the blood back to the body core, reducing head loss while producing cyanosis of the lips and fingers
    - ***Cyanosis***, a dark bluish or purplish coloration of the lips and mucous membranes, results from deficient oxygenation of capillary blood and is a sign of many pathologic conditions
        - The common blue discoloration of the lips owing to cold exposure does not indicate pathology
            - Instead, it results from decreased blood flow in the capillary beds supplied by the superior and inferior labial arteries and the increased extraction of oxygen
                - Simple warming restores the normal coloring of the lips
- **Nasopalatine block** (1000)
    - Nasopalatine nerves can be anesthetized by injecting anesthetic into the incisive fossa in the hard palate
        - A needle is inserted immediately posterior to the incisive papilla
    - Both nerves are anesthetized by the same injection where they emerge through the incisive fossa
        - The affected tissues are the palatal mucosa, the lingual gingivae and alveolar bone of the 6 anterior maxillary teeth, and the hard palate
- **Greater palatine block** (1000)
    - Greater palatine nerve can be anesthetized by injecting anesthetic into the greater palatine foramen
        - The nerve emerges between the 2nd and 3rd molar teeth
        - This nerve block anesthetizes all the palatal mucosa and lingual gingivae posterior to the maxillary canine teeth and the underlying bone of the palate
        - Branches of the greater palatine arteries should be avoided
        - The anesthetic should be injected slowly to prevent stripping of the mucosa from the hard palate
- **Cleft palate** (1000)
    - With or without cleft lip, it occurs in approx 1/2500 births
        - More common in females than males
    - May involve -

        - Only the uvula, giving it a fishtail appearance
        - May extend through the soft and hard regions of the palate
        - In severe cases associated with cleft lip, it extends through the alveolar processes of the maxillae and the lips on both sides
    - Embryological basis
        - Failure of mesenchymal masses in the lateral palatine processes to meet and fuse with each other, with the nasal septum, and/or with the posterior margin of the median palatine process
- **Gag reflex** (1007)
    - It is possible to touch the anterior part of the tongue without feeling discomfort
    - When the posterior part is touched, the individual gags
        - CN IX and CN X are responsible for the muscular contraction of each side of the pharynx
            - Glossopharyngeal branches provide the afferent limb of the gag reflex
- **Paralysis of the genioglossus** (1007)
    - When the genioglossus muscle is paralyzed, the tongue has a tendency to fall posteriorly, obstructing the airway and presenting the risk of suffocation
        - Total relaxation of the genioglossus muscles occurs during general anesthesia
            - An airway is inserted in an anesthetized person to prevent the tongue from relapsing
- **Injury to the hypoglossal nerve** (1007)
    - Trauma, such as a fractured mandible, may injure CN XII
    - Results in paralysis and eventual atrophy of one side of the tongue
    - The tongue deviates to the paralyzed side during protrusion bc of the action of the unaffected genioglossus muscle on the other side
- **Sublingual absorption of drugs** (1007)
    - For quick absorption of a drug (for ex when nitroglycerin is used as a vasodilator in angina) the pill or spray is put under the tongue where it dissolves and enters the deep lingual veins in <1 min
- **Lingual carcinoma** (1007)
    - In the posterior part of the tongue metastasizes to the superior deep cervical lymph nodes on both sides
    - A tumor in the anterior part usually does not metastasize to the inferior deep cervical lymph nodes until late in the disease
        - Bc these nodes are closely related to the IJV, metastases from the tongue may be widely distributed through the submental and submandibular regions along the IJVs in the neck
- **Frenectomy** (1007)
    - An overly large lingual frenulum (tongue-tie) interferes with tongue movements and may affect speech
        - In usual cases a ***frenectomy*** (cutting the frenulum) in infants may be necessary to free the tongue for normal movement and speech
- **Thyroglossal duct cyst** (1007)
    - A cystic remnant of the thyroglossal duct, associated with development of the thyroid gland, may be found in the root of the tongue and be connected to a sinus that opens at the foramen cecum
        - Surgical excision of the cyst may be necessary
        - Most are in the neck, close or just inferior to the body of the hyoid
- **Aberrant thyroid gland** (1007-1008)
    - Aberrant thyroid glandular tissue may be found anywhere along the path of the embryonic thyroglossal duct
        - Although uncommon, the thyroglossal duct carrying thyroid-forming tissue at its distal end may fail to descend to its definitive position in the neck
        - Aberrant thyroid tissue may be –
            - In the root of the tongue
            - Just posterior to the foramen cecum
            - In the neck
        - Cystic remnants of the thyroglossal duct may be differentiated from an undescended thyroid by radioisotopic scanning
        - An aberrant thyroid gland may be the only thyroid tissue the person has
            - If so, removal will require the person be continually medicated with thyroid hormone
- **Excision of the submandibular gland and removal of a calculus** (1009)
    - Excision of a submandibular gland bc of a calculus (stone) in its duct or a tumor in the gland is not uncommon

        - Skin incision is made at least 2.5cm inferior to the angle of the mandible to avoid injury to the marginal mandibular branch of the facial nerve
        - Caution must also be taken not to injury the lingual nerve when incising the duct
            - The submandibular duct passes directly over the nerve inferior to the neck of the 3rd molar
- **Sialography of the submandibular ducts** (1010)
    - The submandibular salivary glands may be examined radiographically after injection of a contrast medium into their ducts
        - Special type of radiograph called a ***sialograph*** – demonstrates the salivary ducts and some secretory units
    - Bc of the small size of the ducts of the sublingual glands and their multiplicity, one cannot usually inject contrast medium into these ducts
- **Transantral approach to the pterygopalatine fossa** (1011, 1013)
    - Surgical access to the deeply placed pterygopalatine fossa is gained through the maxillary sinus
        - After elevating the upper lip, the maxillary gingiva and anterior wall of the sinus are transverse to enter the sinus
        - The posterior wal is then chipped away as needed to open the anterior wall of the pterygopalatine fossa
    - In the case of chronic ***epistaxis*** (nosebleed), the 3rd part of the maxillary artery may be ligated in the fossa to control the bleeding
- **Nasal fractures** (1014)
    - Bc of the prominence of the nose, fractures of the nasal bones are common facial fractures in car accidents and sports
        - Fractures usually result in deformation of the nose, particularly when a lateral force is applied by someone's elbow, for ex
        - ***Epistaxis*** usually occurs
        - In severe fractures, disruption of the bones and cartilages results in displacement of the nose
        - When the injury results from a direct blow, the cribriform plate of the ethmoid bone may also fracture
- **Deviation of the nasal septum** (1014)
    - The nasal septum is usually deviated to one side or the other
        - Could be the result of a birth injury, but more often the deviation results during adolescence and adulthood from trauma (eg during a fist fight)
        - Sometimes the deviation is so severe that the nasal septum is in contact with the lateral wall of the nasal cavity
            - Often obstructs breathing or exacerbates snoring
        - Can be corrected surgically
- **Rhinitis** (1019)
    - The nasal mucosa becomes swollen and inflamed (***rhinitis***) during severe upper respiratory infections and allergic reactions (eg hayfever)
        - Swelling of the mucosa occurs readily bc of its vascularity
        - Infections of the nasal cavities may spread to the –
            - Anterior cranial fossa through the cribriform plate
            - Nasopharynx and retropharyngeal soft tissues
            - Middle ear through the *pharyngotympanic tube* (auditory tube), which connects the tympanic cavity and nasopharynx
            - Paranasal sinuses
            - Lacrimal apparatus and conjunctiva
- **Epistaxis** (1019)
    - Nosebleed is relatively common bc of the rich blood supply to the nasal mucosa
        - In most cases, the cause is trauma and the bleeding is from an area in the anterior 1/3 of the nose = Kiesselbach area
        - Also often associated with infections and hypertension
        - Spurting of blood from the nose results from rupture of arteries
        - Mild epistaxis may also result from nose picking, which tears veins in the vestibule of the nose
- **Sinusitis** (1019)
    - Bc the paranasal sinuses are continuous with the nasal cavities through apertures that open into them, infection may spread from the nasal cavities
        - This produces inflammation and swelling of the mucosa of the sinuses (***sinusitis***) and local pain
        - Sometimes several sinuses are inflamed = ***pansinusitis***
            - The swelling of the mucosa may block one or more openings of the sinuses into the nasal cavities
- **Variation of the frontal sinuses** (1019)
    - The R and L frontal sinuses are rarely of equal size

        - The septum between them is not usually situated entirely in the median plane
        - Vary in size from approx 5 mm to large spaces extending laterally into the greater wings of the sphenoid
    - Often a frontal sinus has 2 parts – a vertical part in the squamous part of the frontal bone and a horizontal part in the orbital part of the frontal bone
        - One or both parts may be large or small
            - When the supraorbital part is large, its roof forms the floor of the anterior cranial fossa and its floor forms the roof of the orbit
- **Infection of the ethmoidal cells** (1019)
    - If nasal drainage is blocked, infections of the ethmoidal cells may break through the fragile medial wall of the orbit
        - Severe infections from this source may cause blindness bc some posterior ethmoidal cells lie lose to the optic canal, through which the optic nerve and ophthalmic artery pass
        - Spread of infection from these cells could also affect the dural nerve sheath of the optic nerve = ***optic neuritis***
- **Infection of the maxillary sinuses** (1022)
    - Most commonly infected sinuses, probably bc their ostia are commonly small and are located high on their superomedial walls
    - When the mucous membrane of the sinus is congested, the maxillary ostia are often obstructed
        - Bc of the high location of the ostia, when the head is erect it is impossible for the sinuses to drain until they are full
        - Bc the ostia of the R and L sinuses lie on the medial sides (ie are directed toward each other), when lying on one's side only the upper sinus drains
            - A cold or allergy involving both sinuses can result in nights of rolling from side to side in an attempt to keep the sinuses drained
        - A maxillary sinus can be cannulated and drained by passing a cannula from the nares through the maxillary ostium into the sinus
- **Relationship of the teeth to the maxillary sinus** (1022)
    - The close proximity of the 3 maxillary molars to the floor of the maxillary sinuses poses potentially serious problems
        - During removal of a molar, a fracture of a root may occur
        - If proper retrieval methods are not use, a piece of the root may be driven superiorly into the maxillary sinus
            - A communication may be created between the oral cavity and the maxillary sinus as a result, and an infection may occur
    - Bc the superior alveolar nerves (branches of the maxillary nerve) supply both the maxillary teeth and the mucous membrane of the maxillary sinuses, inflammation of the mucosa of the sinus is frequently accompanied by a sensation of toothache in the molar teeth
- **Transillumination of the sinuses** (1022)
    - Performed in a darkened room
        - How -
            - A bright light is placed in the patient's mouth on one side of the hard palate
            - The light passes through the maxillary sinus and appears as a crescent-shaped, dull glow inferior to the orbit
        - If a sinus contains excess fluid, a mass, or a thickened mucosa, the glow is decreased
    - The frontal sinuses can also be transilluminated by directing the light superiorly under the medial aspect of the eyebrow, normally producing a glow superior to the orbit
    - Bc of the great variation in the development of the sinuses, the pattern and extent of sinus illumination differs from person to person
    - The ethmoidal and sphenoidal sinuses cannot be examined by transillumination
- **External ear injury** (1025)
    - Bleeding within the auricle resulting from trauma may produce an ***auricular hematoma***
        - A localized collection of blood forms between the perichondrium and the auricular cartilage, causing distortion of the contours of the auricle
        - As the hematoma enlarges, it compromises the blood supply to the cartilage
        - If untreated (eg by aspiration of blood), fibrosis (formation of fibrous tissue) develops in the overlying skin, forming a deformed auricle
            - This is known as cauliflower or boxer's ear seen in some professional fighters
- **Otoscopic examination** (1025)
    - Examination of the external acoustic meatus and tympanic membrane begins by straightening the meatus
        - How –
            - In adults, the helix is grasped and pulled posterosuperiorly (up, out, and back)

        - These movements reduce the curvature of the external acoustic meatus, facilitating insertion of the otoscope
    - The meatus is relatively short in infants, therefore extra care must be exercised to prevent injury to the tympanic membrane
        - The meatus is straightened in infants by pulling the auricle inferoposteriorly (down and back)
  - Why -
    - The examination also provides a clue to tenderness, which can indicate inflammation of the auricle and/or meatus
  - What you see -
    - The tympanic membrane is normally translucent and pearly gray
    - The handle of the malleus is usually visible near the center of the membrane (the umbo)
    - From the inferior end of the handle, a bright *cone of light* is reflected from the otoscope's illuminator
        - This *light reflex* is visible radiating anteroinferiorly in the healthy ear

- **Acute otitis externa** (1026)
  - ***Otitis externa*** is an inflammation of the external acoustic meatus
    - Infection often develops in swimmers who do not dry their meatus after swimming and/or use ear drops
    - May also be the result of a bacterial infection of the skin lining the meatus
      - Affected individuals complain of itching and pain in the external ear
      - Pulling the auricle or applying pressure on the tragus increases the pain
- **Otitis media** (1029)
  - An earache and a bulging red tympanic membrane may indicate pus or fluid in the middle ear = a sign of ***otitis media***
    - Infection of the middle ear is often secondary to upper respiratory infections
    - Inflammation and swelling of the mucous membrane lining the tympanic cavity may cause partial or complete *blockage of the pharyngotympanic tube*
    - The tympanic membrane becomes red and bulges, and the person may complain of "ear popping"
    - An amber-colored bloody fluid may be observed through the tympanic membrane
  - If untreated, otitis media may produce impaired hearing as the result of scarring of the auditory ossicles, limiting their ability to move in response to sound
- **Perforation of the tympanic membrane** (1029)
  - "ruptured eardrum" may result from otitis media and is one of several causes of middle ear deafness
    - Perforation may also result from foreign bodies in the external acoustic meatus, trauma, or excessive pressure (eg during scuba diving)
    - Minor ruptures often heal spontaneously
    - Large ruptures usually require surgical repair
      - Bc the superior half of the tympanic membrane is much more vascular than the inferior half, incisions to release pus from a middle ear abscess, for ex, are made posteroinferiorly through the membrane
        - This incision also avoids injury to the chorda tympani nerve and auditory ossicles
- **Mastoiditis** (1029)
  - Infections of the mastoid antrum and mastoid cells = ***mastoiditis***
    - Results from a middle ear infection that causes inflammation of the mastoid process
      - Infections may spread superiorly into the middle cranial fossa through the petrosquamous fissure in children and cause ***osteomyelitis*** (bone infection) of the tegmen tympani
    - Since the advent of antibiotics, mastoiditis is uncommon
    - During operations for mastoiditis, surgeons remain conscious of the course of the facial nerve to avoid injuring it
      - One point of access to the tympanic cavity is through the mastoid antrum
      - In children, only a thin plate of bone must be removed from the lateral wall of the antrum to expose the tympanic cavity
      - In adults, bone must be penetrated for 15 mm or more
      - At present, most mastoidectomies are endaural = performed through the posterior wall of the external acoustic meatus
- **Blockage of the pharyngotympanic tube** (1030)
  - The pharyngotympanic tube forms a route for an infection to pass from the nasopharynx to the tympanic cavity
    - It is easily blocked by swelling of its mucous membrane, even as a result of mild infections (eg a cold) bc the walls of its cartilaginous part are normally already in apposition

        - When the tube is occluded, residual air in the tympanic cavity is usually absorbed into the mucosal blood vessels, resulting in lower pressure in the tympanic cavity, retraction of the tympanic membrane, and interference with its free movement
            - Hearing is affected
- **Paralysis of the stapedius** (1032)
    - The tympanic muscles have a protective action in that they dampen large vibrations of the tympanic membrane resulting from loud noises
    - Paralysis of the stapedius (eg resulting from a lesion of the facial nerve) is associated with excessive acuteness of hearing = ***hyperacusis*** or ***hyperacusia***
        - Results from uninhibited movement of the stapes
- **Motion sickness** (1036)
    - The maculae of the membranous labyrinth are primarily static organs, which have small dense particles (***otoliths***) embedded among hair cells
        - Under the influence of gravity, the otoliths cause bending of the hair cells, which stimulate the vestibular nerve and provide awareness of the position of the head in space
            - The hairs also respond to quick tilting movements and to linear acceleration and decoration
        - ***Motion sickness*** results from discordance between vestibular and visual stimulation
- **Dizziness and hearing loss** (1036)
    - Injuries of the peripheral auditory system cause 3 major symptoms
        - *Hearing loss* – usually conductive hearing loss
        - *Vertigo* – dizziness, when the injury involves the semicircular ducts
        - *Tinnitus* – buzzing or ringing, when the injury is localized in the cochlear duct
            - Tinnitus and hearing loss may result from lesions anywhere in the peripheral or central auditory pathways
            - 2 types of hearing loss –
                - *Conductive hearing loss* – resulting from anything in the external or middle ear that interferes with movement of the oval or round windows
                    - People with this type of hearing loss often speak with a soft voice bc, to them, their own voices sound louder than background sounds
                - *Sensorineural hearing loss* – resulting from defects in the cochlea, cochlear nerve, brainstem, or cortical connections
- **Ménière Syndrome** (1036)
    - Related to blockage of the cochlear aqueduct
    - Characterized by recurrent attacks of tinnitus, hearing loss, and vertigo
        - These symptoms are accompanied by a sense of pressure in the ear, distortion of sounds, and sensitivity to noises
        - A characteristic sign is ballooning of the cochlear duct, utricle, and saccule caused by an increase in endolymphatic volume
- **High tone deafness** (1036)
    - Persistent exposure to excessively loud sounds causes degenerative changes in the spiral organ, resulting in high tone deafness
        - This type of hearing loss commonly occurs in workers who are exposed to loud noises and do not wear protective earmuffs (eg individuals working for long periods of time around jet engines)
- **Otic barotraumas** (1036)
    - Injury cause dot the ear by an imbalance in pressure between ambient (surrounding) air and the air in the middle ear = ***otic barotraumas***
        - Usually occurs in fliers and divers

Cranial Nerves

- **Cranial Nerve Injuries** (1124, 1129)
    - Frequent complication of a fracture in the base of the cranium
    - Excessive movement of the brain within the cranium may tear or bruise CN fibers, especially CN I
    - Paralysis of cranial nerves as a result of trauma can usually be detected as soon as the patient's state of consciousness permits
        - But, in some people, the paralysis may not be evident for several days
    - Bc of their location within the confined cranial cavity, relatively fixed positions, and sometimes close relationships to bony or vascular formations, the intracranial portions of certain cranial nerves are also susceptible to compression owing to a tumor or aneurysm

        - In this case, the onset of symptoms usually occurs gradually, and the effects depend on the extent of the pressure exerted
    - Bc of their close relationship to the cavernous sinus, CN III, CN IV, CN V_1, and especially CN VI are susceptible to compression or injury related to pathologies (infections, thrombophlebitis) affecting the sinus
- **Anosmia – loss of smell** (1130-1131)
    - Loss of olfactory fibers usually occurs with aging
        - So, elderly people often have reduced acuity of the sense of smell, resulting from progressive reduction in the number of olfactory receptor neurons in the olfactory epithelium
    - The chief complaint of most people with anosmia is the loss or alteration of taste
        - But, clinical studies reveal that in all but a few people, the dysfunction is in the olfactory system
        - The reason is that most people confuse taste with flavor
    - Transient olfactory impairment occurs as a result of viral or allergic rhinitis – inflammation of the nasal mucous membrane
    - *To test the sense of smell* –
        - Person is blindfolded and asked to identify common odors such as freshly ground coffee placed near the external nares (nostrils)
        - One naris is occluded and the eyes are closed
        - Each naris is tested separately bc anosmia is usually unilateral
            - If the loss of smell is unilateral, the person may not be aware of it without clinical testing
    - Injury to the nasal mucosa, olfactory nerve fibers, olfactory bulbs, or olfactory tracts may also impair smell
        - In severe head injuries, the olfactory bulbs may be torn away from the olfactory nerves, or some olfactory nerve fibers may be torn as they pass through a *fractured cribriform plate*
            - If all the nerve bundles on one side are torn, a complete loss of smell with occur on that side
                - So, anosmia may be a clue to a fracture of the cranial base and CSF rhinorrhea (leakage of fluid through the nose)
        - A tumor and/or abscess (collection of pus) in the frontal lobe of the brain or a tumor of the meninges (meningioma) in the anterior cranial fossa may also cause anosmia by compressing the olfactory bulb and/or tract
- **Olfactory hallucinations** (1131)
    - Occasionally ***olfactory hallucinations*** (false perceptions of smell) may accompany lesions in the temporal lobe of the cerebral hemisphere
        - A lesion that irritates the lateral olfactory area (deep to the uncus) may cause *temporal lobe epilepsy* or "unicate fits," which are characterized by imaginary disagreeable odors and involuntary movements of the lips and tongue
- **Demyelinating diseases and the optic nerve** (1135)
    - Bc the optic nerves are actually CNS tracts
        - The myelin sheath that surrounds the sensory fibers from the point at which the fibers penetrate the sclera is formed by oligodendrocytes (glial cells)
        - Rather than by neurolemma (Schwann) cells, as in other cranial or spinal nerves of the parasympathetic nervous system (PNS)
    - Consequently, the optic nerves are susceptible to the effects of demyelinating diseases of the CNS, such as multiple sclerosis (MS), which usually do not affect other nerves of the PNS
- **Optic neuritis** (1135)
    - Refers to lesions of the optic nerve that cause diminution of visual acuity
        - Can be with or without changes in peripheral fields of vision
    - May be caused by inflammatory, degenerative, demyelinating, or toxic disorders
        - Many toxic substances (eg methyl and ethyl alcohol, tobacco, lead, and mercury) may also injure the optic nerve
    - The optic disc appears pale and smaller than usual on opthalmoscopic examination
- **Visual field defects** (1135)
    - Result from lesions that affect different parts of the visual pathway
    - The type of defect depends on where the pathway is interrupted
        - Complete section of an optic nerve results in blindness in the temporal and nasal visual fields of the eye
        - Complete section of the optic chiasm reduces peripheral vision and results in *bitemporal hemianopsia*, the loss of vision of one half of the visual field of both eyes
        - Complete section of the right optic tract at the midline eliminates vision from the left temporal and right nasal fields
            - A lesion of the R or L optic tract causes a *contralateral homonymous hemianopsia*, indicating that visual loss is in similar fields

        - This defect is the most common form of visual field loss and is often observed in patients with strokes
    - Defects of vision can be caused by compression of the optic pathway, as may result from tumors of the pituitary gland or berry aneurysms of the internal carotid or the precommissural part of the anterior cerebral arteries
        - These may produce only part of the visual losses described here for complete section of the pathway
        - Patients may not be aware of changes in their visual fields until late in the course of disease
            - Bc lesions affecting the visual pathway often develop insidiously
- **Injury to the oculomotor nerve** (1137)
    - Results in *ipsilateral oculomotor palsy* – explained in head section
- **Compression of the oculomotor nerve** (1137)
    - Rapidly increasing intracranial pressure (eg resulting from an extradural hematoma) often compresses CN against the crest of the petrous part of the temporal bone
        - Bc the autonomic fibers in CN III are superficial, they are affected first
            - As a result, the pupil dilates progressively on the injured side
            - So, the first sign of CN III compression is ipsilateral slowness of the pupillary response to light
- **Aneurysm of the posterior cerebral or superior cerebellar artery** (1137)
    - Aneurysm of either of these arteries may also exert pressure on CN III as it passes between these vessels
        - The effects of this pressure depend on its severity
    - Bc CN III lies in the lateal wall of the cavernous sinus, injuries or infections of the sinus may also affect this nerve
- **Injury to the trochlear nerve** (1137)
    - CN IV is rarely paralyzed alone
    - Lesions of this nerve or its nucleus cause paralysis of the superior oblique and impair the ability to turn the affected eyeball inferomedially
    - CN IV may be torn when there are severe head injuries bc of its long intracranial course
    - The characteristic sign of trochlear nerve injury is *diplopia* (double vision) when looking down (eg when going down stairs)
        - Diplopia occurs bc the superior oblique normally assists the inferior rectus in depressing the pupil (directing gaze downward) and is the only muscle to do so when the pupil is adducted
    - In addition, bc the superior oblique is the primary muscle producing intorsion of the eyeball, the primary muscle producing extorsion (the inferior oblique) is unopposed when the superior oblique is paralyzed
        - Thus the direction of gaze and rotation of the eyeball about its anteroposterior axis is different for the 2 eyes when an attempt is made to look downward, and especially when looking downward and medially
        - The person can compensate for the diplopia by inclining the head anteriorly and laterally toward the side of the normal eye
- **Injury to the trigeminal nerve** (1139, 1141)
    - CN V may be injured by trauma, tumors, aneurysms, or meningeal infections
        - It may be involved occasionally in poliomyelitis and generalized polyneuropathy, a disease process involving several nerves
            - The sensory and motor nuclei in the pons and medulla may be destroyed by intramedullary tumors or vascular lesions
        - An isolated lesion of the spinal trigeminal tract may also occur with MS
    - Injury to CN V causes the following
        - Paralysis of the muscles of mastication with deviation of the mandible toward the side of the lesion
        - Loss of the ability to appreciate soft tactile, thermal, or painful sensations in the face
        - Loss of corneal reflex (blinking in response to the cornea being touched) and the sneezing reflex (stimulated by irritants to clear the respiratory tract)
    - Common causes of facial numbness are dental trauma, herpes zoster (infection caused by a herpes virus), cranial trauma, head and neck tumors, intracranial tumors, and idiopathic trigeminal neuropathy (a nerve disease of unknown cause)
    - *Trigeminal neuralgia* (tic douloureux), the principal disease affecting the sensory root of CN V, produces excruciating, episodic pain that is usually restricted to the areas supplied by the maxillary and/or mandibular division of this nerve – discussed in Head section
- **Dental anesthesia** (1141-1142)
    - Anesthetic agents are commonly administered by injection to block pain during dental procedures
        - CN V is of great importance in the practice of dentistry bc it is the sensory nerve of the head, serving teeth and mucosa of the oral cavity

- Bc the superior alveolar nerves (branches of CN V_2) are not accessible, the maxillary teeth are locally anesthetized by injecting the agent into the tissues surrounding the roots of the teeth and allowing the solution to infiltrate the tissue to reach the terminal (dental) nerve branches that enter the roots
- By contrast, the inferior alveolar nerve (CN V_3) is readily accessible and is probably anesthetized more frequently than any other nerve
    - Explained in "inferior alveolar nerve block" in Head section

- **Injury to the abducent nerve** (1142)
    - Bc CN VI has a long intracranial course, it is often stretched when intracranial pressure rises, partly bc of the sharp bend it makes over the crest of the petrous part of the temporal bone after entering the dura
    - A space-occupying lesion, such as a brain tumor, may compress CN VI, causing paralysis of the lateral rectus
        - Complete paralysis of CN VI causes medial deviation of the affected eye – that is, it is fully adducted owing to the unopposed action of the medial rectus
            - This leaves the person unable to abduct the eye
        - *Diplopia* is present in all ranges of movement of the eyeball, except on gazing to the side opposite the lesion
    - Paralysis of CN VI may also result from
        - An aneurysm of the cerebral arterial circle (at the base of the brain)
        - Pressure from an atherosclerotic internal carotid artery in the cavernous sinus, where CN VI is closely related to this artery
        - Septic thrombosis of the sinus subsequent to infection in the nasal cavities and/or paranasal sinuses
- **Injury to the facial nerve** (1143, 1145)
    - Among motor nerves, CN VII is the most frequently paralyzed of all the CNs
    - Depending on the part of the nerve involved, injury to CN VII may cause paralysis of facial muscles without loss of taste on the anterior 2/3 of the tongue, or altered secretion of the lacrimal and salivary glands
        - *A lesion of CN VII near its origin* or near the geniculate ganglion is accompanied by loss of motor, gustatory (taste), and autonomic functions
            - The motor paralysis of facial muscles involves superior and inferior parts of the face on the ipsilateral side
        - *A central lesion of CN VII* (lesion of the CNS) results in paralysis of muscles in the inferior face on the contralateral side
            - Consequently, forehead wrinkling is no visibly impaired bc it is innervated bilaterally
        - *Lesions between the geniculate ganglion and the origin of the chorda tympani* produce the same effect as that resulting from injury near the ganglion, except that lacrimal secretion is not affected
    - Bc it passes through the facial canal in the temporal bone, CN VII is vulnerable to compression when a viral infection produces inflammation (viral neuritis) and swelling of the nerve just before it emerges from the stylomastoid foramen
    - Where is it susceptible to injury?
        - Bc the branches of CN VII are superficial, they are subject to injury from knife and gunshot wounds, cuts, and birth injury
        - Damage to CN VII is common with fracture of the temporal bone and is usually detectable immediately after the injury
        - CN VII may also be affected by tumors of the brain and cranium, aneurysms, meningeal infections, and herpes viruses
    - Although injuries to CN VII cause paralysis of facial muscles, sensory loss in the small area of the skin on the posteromedial surface of the auricle and around the open of the external acoustic meatus is rare
        - Similarly, hearing is not usually impaired, but the ear may become sensitive to low tones when the stapedius (supplied by CN VII) is paralyzed, this muscle dampens vibration of the stapes – discussed in Head section
        - ***Bell palsy*** is a unilateral facial paralysis of sudden onset resulting from a lesion of CN VII – discussed in Head section
- **Injuries of the vestibulocochlear nerve** (1146)
    - Although the vestibular and cochlear nerves are essentially independent, peripheral lesions often produce concurrent clinical effects bc of their close relationship
        - Hence lesions of CN VIII may cause *tinnitus* (ringing or buzzing in ears), *vertigo* (dizziness, loss of balance), and impairment or loss of hearing
        - Central lesions may involve either the cochlear or vestibular divisions of CN VIII
- **Deafness** (1146)
    - There are 2 kinds of deafness – ***conductive deafness*** and ***sensorineural deafness***
        - ***Conductive deafness*** – involves the external or middle ear (eg otitis media, inflammation in the middle ear)
        - ***Sensorineural deafness*** – results from disease in the cochlea or in the pathway from the cochlea to the brain
- **Acoustic neuroma** (1146)

- An ***acoustic neuroma*** (neurofibroma) is a slow-growing benign tumor of the neurolemma (Schwann) cells
  - Tumor begins in the vestibular nerve while it is in the internal acoustic meatus, but the early symptom of an acoustic neuroma is usually loss of hearing
  - Disequilibrium (derangement of the sense of equilibrium) and tinnitus occur in approx 70% of patients

- **Trauma and vertigo** (1146)
  - People with head trauma often experience headaches, dizziness, vertigo, and other features of posttraumatic injury
    - ***Vertigo*** is a hallucination of movement involving the person or the environment
      - It often involves a spinning sensation but may be felt as a swaying back and forth or falling
      - These symptoms, often accompanied by nausea and vomiting, are usually related to a peripheral vestibular nerve lesion

- **Lesions of the glossopharyngeal nerve** (1149)
  - Isolated lesions of CN IX or its nuclei are uncommon and are not associated with perceptible disability
    - Taste is absent on the posterior 1/3 of the tongue, and the gag reflex is absent on the side of the lesion
    - Ipsilateral weakness may produce a noticeable change in swallowing
  - Injuries of CN IX resulting from infection or tumors are usually accompanied by signs of involvement of adjacent nerves
    - Bc CN IX, CN X, and CN XI pass through the jugular foramen, tumors in this region produce multiple cranial nerve palsies, called ***jugular foramen syndrome***
  - Pain in the distribution of CN IX may be associated with involvement of the nerve in a tumor in the neck

- **Glossopharyngeal neuralgia** (1149)
  - Also known as ***glossopharyneal tic***
  - Uncommon and its cause is unknown
  - The sudden intensification of pain is of a burning or stabbing nature
    - These paroxysms of pain are often initiated by swallowing, protruding the tongue, talking, or touching the palatine tonsil
    - Pain paroxysms occur during eating when trigger areas are stimulated

- **Lesions of the vagus nerve** (1151)
  - Isolated lesions of CN X are uncommon
    - Injury to pharyngeal branches of CN X results in *dysphagia*
    - Lesions of the superior laryngeal nerve produce anesthesia of the superior part of the larynx and paralysis of the cricothyroid muscle
      - The voice is weak and tires easily
    - Injury of a recurrent laryngeal nerve may be caused by aneurysms of the arch of the arota and may occur during neck operations
      - Causes hoarseness and *dysphonia* (difficulty speaking) bc of the paralysis fo the vocal folds (cords)
      - Bc of its longer course, lesions of the L recurrent laryngeal nerve are more common than those of the R
    - Paralysis of both recurrent laryngeal nerves causes *aphonia* (loss of voice) and *inspiratory stridor* (a harsh, high pitched respiratory sound)
      - Usually results from cancer of the larynx and thyroid gland and/or injury during surgery on the thyroid gland, neck, esophagus, heart, and lungs
    - Proximal lesions of CN X also affect the pharyngeal and superior laryngeal nerves, causing difficulty in swallowing and speaking

- **Injury to the spinal accessory nerve** (1153)
  - Bc of its nearly subcutaneous passage through the posterior cervical region, CN XI is susceptible to injury during surgical procedures such as lymph node biopsy, cannulation of the IJV, and carotid endarterectomy
  - See Neck section for more information

- **Injury to the hypoglossal nerve** (1154)
  - Paralyzes the ipsilateral half of the tongue
    - After some time, the tongue atrophies, making it appear shrunken and wrinkled
    - When the tongue is protruded, its apex deviates toward the paralyzed side bc of the unopposed action of the genioglossus muscle on the normal side of the tongue