C J Mieny, U Mennen: Principles of Surgical Patient Care - Volume II

Chapter 5: ENT, Maxillo-Facial Surgery and Ocular Emergencies

Chapter 5.1: Foreign Bodies in the Ear, Nose and Throat

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Introduction

The subject of foreign bodies in the ear, nose and throat is of great importance as they often constitute otolaryngologic emergencies. Foreign bodies are most common in children especially in the age group 1-4 years.

Surgical Anatomy and Physiology

The most common sites for foreign bodies in the upper respiratory tract are the nasal cavity, nasopharynx, palatine tonsil, vallecula, pyriform sinus and cervical oesophagus. Foreign bodies occur more commonly in the oesophagus than in the pharynx. Smooth objects are usually held up at or just below the cricopharyngeus sphincter. Sharp and irregular foreign bodies, however, may be arrested in the pharynx at sites such as the fauces, valleculae and piriform fossae.

Foreign bodies in the larynx area are rare as they usually pass through the glottis into the lower respiratory tract and end up in the right main bronchus.

Etiology

Foreign body in the head and neck region reach their destination either due to an accident or by intention. This occurs by inhalation, ingestion, deliberate placing or penetrating trauma. A gunshot wound is an example of the latter.

Inhalation of a foreign body often follows a sudden aspiration while the object is in the mouth. It may, however, result during general anesthesia, as can be the case with a dislodged tooth. Ingestion of food inadvertently containing a solid foreign body is a problem in debilitated persons or those wearing a full upper denture. The palatal sensation is inhibited and a piece of bone may be swallowed without prior detection.

A stricture of the pharynx or oesophagus will encourage the impaction of an otherwise safe bolus of food. A wide variety of items are found as foreign bodies including bits of sponge, beads, seeds, eraser ends, cotton wool, coins and jewellery, in fact all those small objects within the reach of young children.

A pre-existing irritation may lead to a patient to introduce a foreign body. An allergic or itchy nostril on occasion encourages a child to introduce a bead or other similar item into the nose to alleviate the symptoms. Cotton-wool used in the home treatment of otitis externa may end up out of reach, against the tympanic membrane. Insects can be inhaled or find their own way into the nose, throat or ear.

Classification

Foreign bodies can be classified on the basis of the following:

- Composition
    - organic
    - inorganic
- Physical properties. i.e. size and shape
- Chemical properties, i.e. pH, solubility, stability, toxicity
- Site in the body

Pathology

The pathology caused by a foreign body will depend on its position in the body, the duration of its presence as well as its other qualities. Button batteries are particularly dangerous and require prompt identification and rapid removal. Their contents are strongly alkaline and corrosion will lead to chemical burns and disruption of the organ concerned, i.e. in the oeophagus. An electrically active battery will allow a current to be generated with resulting tissue trauma in its vicinity.

A large blunt object can cause pressure necrosis or oedema. On the other hand, a sharp body will tend to migrate by penetrating deeper. This can result in haemorrhage or abscess formation.

Clinical Symptoms and Signs

The symptoms and signs of foreign bodies are greatly influenced by their position in the upper aerodigestive tract and ear. Table 5.1.1. illustrates the clinical findings in the various regions. Penetration of the middle and inner ear may cause vertigo, sensori-neural hearing loss and facial palsy. A clear otorrhoea could be due to cerebrospinal fluid or perilymph leakage.

Pain at the angle of the mandibula is indicative of involvement of the tonsillar fossa; a foreign body at the tongue base will give rise to pain under the chin. Retrosternal, suprasternal or back pain may arise from a foreign body in the oesophagus.

Diagnosis and Special Investigations

The diagnosis depends on an accurate history which is usually forthcoming and obvious. It does happen, however, that no relevant history is obtained or that a long time has elapsed since the initial incident and before the onset of the first symptoms.

An adequate and thorough examination is imperative and this should be done by a trained otolaryngologist and an experienced endoscopist. Local or general anaesthesia may be required. X-ray examination is usually very valuable and should always be used where feasible. Many foreign bodies are unfortunately radiolucent but other tell-tale findings may still help in the definitive diagnosis. A lateral X-ray of the upper aerodigestive tract is most

informative and is easy to perform. A contrast swallow will often indicate the site of a radiolucent foreign body.

Chest X-rays will help in diagnosing atelectasis, emphysema or a lung abscess in case of an inhaled foreign body.

Table 5.1.1. Symptoms and Signs of Foreign Bodies in the ENT

1. Ear
   - Deafness - both conductive and sensorineural
   - Tinnitus
   - Earache
   - Reflex cough
   - Dysequilibrium
   - Facial palsy
   - Otorrhoea
   - Tympanic membrane rupture
2. Nose
   - Unilateral foul-smelling discharge
   - Excoriation of vestibular skin
   - Nose bleeding
   - Pain
   - Sneezing
   - Watery rhinorrhoea
3. Pharynx
   - Localized pain
   - Odinophagia
   - Dysphagia
   - Referred earache
   - Hoarseness
   - Coughing
   - Salivary pooling
   - Bleeding
   - Haematoma
   - Gagging
4. Larynx
   - Dyspnoea
   - Stridor (inspiratory)
   - Hoarseness
   - Dysphagia
   - Odinophagia
   - Laryngeal oedema
   - Bleeding
   - Cough
   - Haemoptysis
   - Localized tenderness
   - Surgical emphysema
   - Loss of laryngeal crepitus
   - Loss of laryngeal contour
5. Trachea
   - Dyspnoea
   - Stridor (inspiratory and expiratory)
   - Dysphagia
   - Odinophagia
   - Cough
   - Haemoptysis
   - Local tenderness
   - Surgical emphysema
6. Bronchi
   - As for trachea.

Treatment

The correct treatment for a foreign body is its removal in such a way that no further damage is caused. This is possible only if there is close co-operation between the patient, surgeon and anaesthetist. Correct instruments must be available as well as good lighting, adequate magnification and facilities for suctioning. If the airway is in danger, a tracheotomy may have to be performed under local anaesthesia prior to removal. Complications must be avoided or treated effectively. Mediastinitis is an example of a severe complication which will need acitve intervention.

A pharyngotomy, laryngofissure or thoracotomy may have to be done for impacted items. The treatment of foreign bodies is outlined in table 5.1.2. Antibiotics and analgesics are often required.

Complications

A wide variety of complications are known to occur. There are shown in table 5.1.3.

Table 5.1.2. Treatment of Foreign Bodies in the ENT

1. Ear
    - Forceps removal, i.e. Hartmann's crocodile forceps
    - Syringing
    - Suctioning
    - Magnetic extraction
    - Hook removal, i.e. Jobson-Horne probe
    - Tympanotomy
2. Nose
    - Forcible nose blowing
    - Removal by forceps, hook, suctioning or magnet
    - Retrieval via nasopharynx
    - Lateral rhinotomy
3. Pharynx
    - Direct pharyngoscopy and removal by forceps
    - Lateral pharyngotomy

4. Larynx
    - Heimlich manoeuvre
    - Direct laryngoscopy and removal by forceps
    - Tracheostomy
6. Trachea
    - Heimlich maneouvre
    - Direct tracheoscopy and removal by forceps
    - Tracheotomy
6. Bronchi
    - Removal through bronchoscope
    - Thoracotomy
    - Tracheotomy

Table 5.1.3. Complications of Foreign Bodies in the ENT

1. Ear
   - Otitis externa
   - Excoriation of external canal skin
   - Dermal necrosis
   - Stenosis of the external canal
   - Chondritis
   - Persistent tympanic membrane perforation
   - Ossicular disruption
   - Facial paralysis
   - Otitis media
   - Deafness
   - Dysequilibrium
2. Nose
   - Septal perforation
   - Vestibular stenosis
   - Nasal synechia
   - Rhinitis
   - Rhinolith
   - Loss of smell
   - Pungent smell
   - Cerebro-spinal fluid rhinorrhoea
3. Pharynx
   - Laceration
   - Perforation
   - Surgical emphysema
   - Cellulitis
   - Retropharyngeal or parapharyngeal abscess
   - Mediastinitis
   - Stenosis
   - Pharyngo-cutaneous fistula
4. Larynx
   - Perichondritis
   - Stenosis
   - Vocal cord paralysis
   - Abscess formation
   - Mediastinitis
5. Trachea
   - Perichondritis
   - Stenosis
   - Abscess formation
   - Injury to recurrent laryngeal nerve
   - Mediastinitis
   - Aortic penetration
   - Tracheo-oesophageal fistula
6. Bronchi
   - Atelectasis
   - Emphysema
   - Lung abscess.

Comment

Foreign Body in the Ear, Nose and Throat

S L Sellars

With five major body orifices in the head and neck, foreign body problems are common in this region, especially in children. When impaction in the aerodigestive trafct has occurred in these sites, they may result in lethal consequences. Foreign body in the oesophagus and bronchial tree may be difficult to diagnose.

The use of special radiological studies, such as contrast and radioisotope, assist detection of bronchial foreign bodies. However, a good history is paramount and this often provides the most relevant information upon which clinical suspicion of the correct diagnosis can be founded.

Chapter 5.2: Acute Infections of the Ear and Upper Aerodigestive Tract

J G Swart

Introduction

More than half of all diagnoses made in children under the age of 10 are infections of the upper respiratory tract and ear. Otitis media is the most important of these.

Viral causes predominate in the early phase of the disease, only to be replaced by bacterial infections later. There is a clear correlation between low IgA in nasal secretion and upper respiratory tract infection.

Acute Infection of the External Ear

These infections involve either the skin, outer layer of the tympanic membrane or cartilage of the external ear and may be localized or diffuse.

The external ear consists of an outer cartilaginous portion including the pinna and an inner bony portion lined by skin. The skin of the medial part of the external meatus is particularly thin and contains no appendages.

Etiology

The causative factors often occur in combination, i.e. an infective agent such as *Staphylococcus aureus* and trauma due to a cotton bud or hairpin.

Generalized skin conditions such as psoriasis or impetigo can also result in an acute otitis externa. The organisms most commonly found are *Pseudomonas, Proteus, Staphylococcus* and even anaerobes.

Fungi are common but tend to cause a more chronic type of infection.

Classification of Otitis Externa

1. Localized otitis externa
   - Furuncle
   - Myringitis
   - Herpetic eruptions
   - Perichondritis.
2. Diffuse otitis externa
   - Diffuse infective otitis externa
   - Eczematous otitis externa
   - Seborrhoeic otitis externa
   - "Malignant" otitis externa.

Pathology

The most common form of localized otitis externa is the furuncle due to a staphylococcal infection of a hair follicle. It is usually single but may be multiple in immune compromised persons. Diffuse infective dermatitis usually starts near the external meatus from where it spreads in the epithelial or subepithelial layers of the canal.

Clinical Findings

The symptoms and signs of an acute infection of the external ear will vary depending on the site and severity of the inflammatory process. Table 5.2.1 contains a summary of the possible clinical findings. Note that pain is a very prominent feature and can be intense. Movement of the pinna will make it worse.

Table 5.2.1. Symptoms and Signs of Otitis Externa

- Itching
- Pain
- Inflamed and edematous external canal
- Desquamation and fissuring
- Serous discharge, usually scanty
- Hearing loss (very mild)
- Cellulitis extending to surrounding tissues
- Lymphadenitis
- Grossly oedematous and painful pinna
- Bullae or vesicles
- Trismus.

Diagnosis

The clinical diagnosis of acute otitis externa is usually relatively self-evident. To establish the cause and type of otitis externa requires a careful history and clinical assessment.

It is important to be mindful of predisposing factors such as swimming, aural cleaning, allergy to hair shampoo and underlying conditions such as psoriasis or diabetes mellitus.

Haemorrhagic bullous myringitis will present with a short history and very acute pain. On examination haemorrhagic bullae are usually seen involving the tympanic membrane. This should not be confused with the bulging of the tympanic membrane in an acute otitis media.

The eruptions due to herpes as in Ramsay-Hunt syndrome are typical of viral vesicles which follow a nerve distribution. Vertigo or facial palsy may accompany a herpetic otitis externa.

Treatment

Otitis externa can be prevented in many instances by avoiding known causes. The instillation of a few drops of 70% alcohol after swimming will aid in drying the canal. Intervention with cotton buds, tissues and hairpins should be avoided at all times. Careful selection of soaps and shampoos will be necessary for persons who have sensitive skins or who tend to be allergic.

Particular care should be taken after radiotherapy to the region. Warm, humid environment encourage otitis externa. The treatment modalities are outlined in table 5.2.2.

Malignant otitis media and perichondritis are particularly serious conditions requiring prompt action.

Table 5.2.2. Treatment of Acute Otitis Externa

1. Local
- External ear-canal cleaning
- Topical solutions
    - antibiotics
    - steroids
    - mild astringents, i.e. aluminium acetate
    - acidifying solution, i.e. 3% acetic acid
    - fungicides, i.e. clotrimazole
    - drying agent, i.e. glycerine and ichthamol

2. Systemic
    - Antibiotics
    - Analgesics
    - General, i.e. diabetes mellitus.

Prognosis and Copmplications

Otitis externa can be very difficult to treat. Malignant otitis externa is a pseudomonas infection which includes an osteitis of the underlying bone and can be fatal.

Perichondritis will result in rapid necrosis of cartilage and lead to gross scarring and deformity of the auricle.

A late complication of acute otitis externa is chronicity and stenosis of the external meatus.

Acute Infections of the Middle Ear and Mastoid

Acute suppurative otitis media is a mucosal infection involving the entire middle-ear cleft. Generally this is a disease of children. One-third of children will have at least one attack within the first 12 months of life. Approximately 50% of youngsters will have more than one episode of otitis media before the age of 4.

Children in nursing schools have a much higher incidence of acute middle ear infection than those remaining at home.

The middle ear is lined by respiratory epithelium in the protympanum and pharyngotympanic tube area and cuboidal epithelium elsewhere.

The cleft consists of the Eustachian tube, tympanic cavity, aditus, mastoid antrum and mastoid air cells. The Eustachian tubes play a key role in the pathology of middle ear disease.

Etiology

Infection of the middle ear cleft occurs most commonly via extension from the nasopharynx. Exposure of the middle ear cavity due to a perforation of the tympanic membrane or patent grommet will also predispose to secondary infection and hence otitis

media. More rarely hematogenous infection is possible. Upper respiratory infections such as rhinitis, sinusitis, tonsillitis and pharyngitis are well-known precursors to acute otitis media.

Excessive nose blowing, swimming and especially diving will tend to force contaminated or chemically laden water into the tympanic cavity.

Pathogenic bacteria include haemolytic streptococcus, *Streptococcus pneumoniae, Staphylococcus aureus* and *Haemophilus influenzae.*

Pathophysiology

The cycle of pathology starts with tubal obstruction and resorption of the entrapped air in the middle ear cleft and hence a negative pressure. Further progression of the disease is as follows:

- Inflammation of the mucosa
- Exudation
    - serous
    - mucopurulent
- Raised intratympanic pressure with bulging of the tympanic membrane
- Rupture of the membrane and over mucopurulent otorrhoea
- Osteitis of the mastoid air cell system, i.e. acute mastoiditis with its sequelae, i.e. subperiosteal abscess.

Clinical Features

Four distinct phases exist during the pathogenesis, each with its own distinctive clinical picture:

- Acute tubal obstruction with retraction of the drum membrane and mild hearing loss. There is usually no pain during this interim period although a fullness in the ear is described.

- Acute otitis media prior to perforation
    - increasing deafness
    - earache
    - hyperaemia and bulging of the tympanic membrane

- Acute otitis media after perforation
    - otorrhoea
    - sudden relief of pain
    - improved hearing
    - resolution and spontaneous healing of the perforation

- Acute mastoiditis
    - mastoid pain
    - post-auricular oedema and redness
    - profuse mucopurulent otorrhoea.

Diagnosis

Otoscopy will reveal tympanic membrane changes in keeping with the stage of the disease, i.e. retraction, injection, bulging or perforation. If ruptured, the purulent discharge will be evident in the external canal.

Tuning fork tests will demonstrate a mild to moderate conductive hearing loss. X-ray examination of the tympanic bone will show an opacified mastoid process or a coalescent mastoiditis with loss of intercellular septae.

The differential diagnosis between acute otitis externa and media is shown in table 5.2.3.

Table 5.2.3. Distinguishing Features Between Acute Otitis Externa and Otitis Media

	AOE	AOM
Season	Summer	Winter
Eardrum	Normal or mildly inflamed	Retracted, hyperaemic, bulging or perforated
Hearing	Normal	Reduced
External canal	Oedematous, hyperaemic	Normal
Otorrhoea	Scanty, serous	Mucopurulent if TM perforated
Tragal movement	Painful	Asymptomatic
Lymphadenopathy	Pre- and post-auricular and upper cervical	Rare
Purexia	Seldom	Frequent

Treatment

The treatment of acute otitis media will be influenced by the phase of the disease. Table 5.2.4 indicates the treatment.

Table 5.2.4. Treatment of Acute Otitis Media

1. Local

- Prior to rupture
  - Myringotomy
  - Vasoconstrictor nose drops
- After rupture
  - Antral toilet
  - Antibiotic eardrops
  - Mastoidectomy

2. Systemic

- Analgesics
- Antibiotics, i.e. amoxycillin, erythromycin
- Sedation
- Rest.

Complications

The adverse results of otitis media may be:

- Chronic otitis media
- Facial palsy
- Labyrinthitis and vertigo
- Otogenic intracranial complications, i.e. meningitis
- Petrositis with sixth nerve palsy and diplopia
- Complications of mastoiditis.

Acute Upper Respiratory Aerodigestive Tract Infections

Rhinitis

Acute rhinitis seldom occurs in isolation and is usually part of a rhinosinusitis.

The common cold is a typical example of an acute rhinitis. The cause is a viral infection with secondary bacterial invasion. Viruses include influenza, parainfluenza, respiratory syncitial and "picorna" viruses. Secondary organisms are *Streptococcus influenzae, Pneumococcus* and *Staphylococcus.*

The pathogenesis is a transient ischemia which rapidly changes to hyperaemia, congestion and rhinorrhoea. Based on the above, four categories of symptoms and signs are to be found:

- Firstly a widely patent nose with burning sensation in the ischaemic phase.

- This is followed by a blocked runny nose during the congestive stage.

- Secondary infection characterizes the third phase in which there is a thick profuse mucopurulent discharge.

- The fourth phase is one of resolution.

Systemic treatment of rhinitis consists of bedrest, analgesics, pseudo-ephedrine and antibiotics.

Local therapy includes vasoconstrictor sprays for the acutely obstructive phase.

Acute Sinusitis

As in the case of rhinitis, the initial cause of acute sinusitis is most often viral. Suppurative sinusitis results when there is a bacterial infection with the formation of pus in one or several sinuses.

Each of the paranasal sinuses drains via ostia into the nasal cavity. Any swelling of the nasal mucosa will lead to obstruction of the sinus opening and a cessation of drainage and aeration.

There are definite predisposing factors in the etiology and pathogenesis of acute sinusitis. These include rhinitis, swimming and especially diving. Allergic rhinitis and mechanical obstruction such as is the case with polyps or a deviated nasal septum, encourage sinusitis.

The normal ciliary movement, replacement of the mucous blanket and the presence of lysozymes all help to protect the mucosa.

Symptoms and Signs

The symptoms and signs of acute sinusitis will vary depending on the particular sinuses involved. A summary of the clinical findings of acute sinusitis is given in table 5.2.5.

Table 5.2.5. Symptoms and Signs of Acute Rhinosinusitis

1. Local
a. Pain
- Frontal - frontal sinusitis
- Maxillary, dental, nasal or over cheek - maxillary sinusitis
- Peri-orbital, retro-orbital or temporal - ethmoid sinusitis
- Occipital or retro-orbital - sphenoid sinusitis
b. Percussion tenderness and reduced transillumination
c. Oedema of nasal mucosa especially middle meatus
d. Mucopus in the nose
e. Peri-orbital cellulitis, erythema or chemosis
f. Proptosis
g. Anosmia
h. Obstruction
i. Epistaxis
2. General
a. Malaise
b. Pyrexia.

Diagnosis

The diagnosis of acute sinusitis is confirmed by X-rays of the sinuses which will show mucosal thickening, a fluid level or bony involvement. The latter may be limited to sclerosis of the margins of the sinus or be overt osteitis with bone destruction. Computerized tomography is extremely valuable.

Treatment

The treatment of acute sinusitis includes analgesics, antibiotics, nasal decongestants and surgical drainage or irrigation.

The type of drainage will depend on the particular sinus involved. The frontal sinus is cleared by trephine of the floor of the sinus. Antral puncture may be necessary if there is an air-fluid level in the maxillary sinus that does not respond after 24-48 hours of medical treatment.

Acute ethmoiditis that persist despite antral puncture, humidification, decongestants and systemic medication calls for a formal ethmoidectomy.

Persistent sphenoiditis is an indication for sphenoidectomy and lavage.

Complications

Acute suppurative sinusitis is particularly dangerous and requires early and adequate intervention if complications are to be avoided. The complications of acute sinusitis are listed in table 5.2.6.

Table 5.2.6. Complications of Acute Rhinosinusitis

- Frontal osteitis
- Peri-orbital cellulitis
- Orbital abscess
- Meningitis
- Cavernous sinus thrombosis
- Brain abscess
- Mucocoele
- Pyocoele
- Otitis media.

Acute Pharyngo-Tonsillitis

As was the case with the nose and paranasal sinuses, infections of the pharynx and tonsils can occur concurrently or separately and are viral or bacterial in origin. Acute tonsillitis is either parenchymatous or follicular in nature. In the latter the crypts contain pus. Acute membranous pharyngitis is caused by a mixed infection of spirochaeta denticola, anaerobic streptococci and a fusiform bacillus. The characteristic features are ulcerative lesions in the presence of poor oral hygiene.

Symptoms and Signs

The symptoms and signs of acute pharyngo-tonsillitis are depicted in Table 5.2.7.

Table 5.2.7. Symptoms and Signs of Acute Pharyngo-Tonsillitis

1. Local
- Sore throat
- Odinophagia
- Referred earache
- Hyperaemia and oedema of the mucosa and uvula
- Cervical lymph node enlargement
- Halitosis
- Ulceration
- Membrane formation

2. General
- Malaise
- Pyrexia
- Loss of appetite
- Rigors
- Headaches.

In the case of acute tonsillitis the pharyngeal signs are less marked and membrane formation is limited to the faucial tonsils.

Diagnosis

The clinical findings are very obvious. A throat swab for culture and sensitivity will aid in making a definitive diagnosis. Beta-haemolytic *Streptococcus* must be looked for in acute tonsillopharyngitis especially in children.

Treatment

Adequate bedrest and fluids are essential. It may be necessary to administer intravenous fluids if swallowing is too painful. Penicillin is the antibiotic of choice followed by erythromycin and chloramphenicol in case of allergy. Analgesics and antipyretics will invariably be required as this is a particularly painful condition associated with fever and often rigors. An antiseptic gargle is useful and soothing. Tonsillectomy is contra-indicated in acute tonsillitis.

Complications

The sequelae of acute pharyngo-tonsillitis include the following:

- Peritonsillar abscess
- Parapharyngeal and retropharyngeal abscess
- Rheumatic fever
- Myocarditis
- Glomerulonephritis
- Airway obstruction
- Trismus.

A peritonsillar abscess forms posterior to the superior pole of the tonsil and is usually confined to one side. It is preceded by a peritonsillar cellulitis and presents as an acute pharyngotonsillitis. Trismus, otalgia and salivation are common. Incision and drainage, or abscess tonsillectomy and tracheotomy may be necessary.

Parapharyngeal space suppuration will result in an abscess lateral to the tonsil. This may progress and cause respiratory obstruction due to gross local oedema.

A retropharyngeal abscess is situated near the midline and anterior to the prevertebral fascia and is most common in young children as a result of lymphadenitis of the retropharyngeal lymph nodes. Stridor and dysphagia are often present as well as neck rigidity. Incision and tracheotomy may be called for if the abscess impinges on the airway.

Epiglottitis

Epiglottitis is a localized acute inflammation of the epiglottis usually caused by *Haemophilus influenzae*. Classically the onset is very rapid and the consequences may be dire due to the extreme swelling that develops in the supraglottis. The mucosa of the supraglottis has a loose stromal attachment and therefore can swell up very quickly. The clinical features are respiratory obstruction, a muffled voice, dysphagia and salivation. The patient is most comfortable in a sitting position with the neck extended anteriorly. Any attempt at examination by indirect laryngoscopy or spatula may lead to sudden and total airway occlusion and should therefore be avoided. The safest and most informative investigation is a lateral soft-tissue X-ray of the neck, but time should not be wasted in doing non-essential investigations.

Endotracheal intubation must be performed as soon as possible. Intravenous antibiotics, close observation in hospital and systematic steroids are often required. The antibiotics of choice are ampicillin or chloramphenicol and should be continued for seven to ten days.

Extubation is usually possible after 48 hours. It may be necessary to perform an emergency tracheotomy initially. If intubation is prolonged, i.e. > 72 hours, an elective tracheotomy should be considered.

Acute Laryngotracheobronchitis (Croup)

Croup is usually a viral infection of the larynx, trachea and bronchi. It is sometimes caused by *Staphylococci*, *Pneumococci* or *Haemophilus influenzae*. Diphteric laryngitis is possible in non-immunized persons. The symptoms and signs of acute laryngotracheobronchitis are characteristic and comprise the following:

- A loud raspy cough
- Dyspnoea
- Inspiratory stridor
- Hoarseness
- Oedema of the larynx
- Thick mucus and tendency to crusting
- Expiratory bronchi
- Upper respiratory tract infection
- Pneumonia.

The diagnosis of croup is usually quite easy. A significant subglottic oedema is clear on X-rays, especially on the anteroposterior views. Culture of secretions will confirm the causative organisms but treatment should commence immediately and be adjusted later if necessary.

Hospitalization is mostly indicated. Humidification, and nebulized adrenaline inhalations (1 mL 1:1000 adrenaline plus 1 mL saline) are essential in all but grade 1 croup. Inhalations may have to be repeated at half-hourly intervals if obstruction is severe. Tracheostomy or endotracheal intubation will be called for in severe cases and should be done if the respiratory or heart rate increases or cyanosis develops.

Antibiotics should be used in case the causative organism is non-viral. Steroids may be used if herpes simplex is not present. Anxiety or restlessness compound the problem and should be kept to a minimum. Light sedation which does not cause respiratory depression is to be encouraged, i.e. trimeprazine. Diphtheria antitoxin should be given to susceptible individuals or when clinically signs are found.

The complications include pneumonia, atelectasis and total respiratory obstruction. The sequelae of intubation and tracheotomy are ever present, i.e. tracheal stenosis or pneumothorax.

Acute Stomatitis

Acute inflammatory conditions of the oral mucosa are common and can be classified as in table 5.2.8. The clinical findings may be any of the following:

- vesicles
- ulcerations
- oedema
- hyperaemia
- Koplik's spots
- gingivitis
- foetor
- pain.

Table 5.2.8. Classification of Acute Stomatitis

1. Local

- Aphthous stomatitis
- Traumatic stomatitis
    - Mechanical
    - Chemical
    - Thermal
    - Ionizing
- Allergic stomatitis
- Acute pyogenic stomatitis
- Acute ulcerative stomatitis (Vincent's angina)
- Herpangina
- Herpetic gingivo-stomatitis

2. Systemic

- Acute viral stomatitis
- Measles
- Herpes simplex
- Behçet's disease.

The diagnosis of acute stomatitis may be difficult despite cultures and histological examination. Treatment will depend on the etiology and could include:

- systemic steroids
- analgesics
- systemic antibioticsa or fungicides
- meticulous oral hygiene.

Complications include bacteraemia, laryngeal oedema, and Ludwig's angina. Ludwig's angina is most commonly dentogenic in origin and is a cellulitis of the oral floor which presents as a brawny induration. Abscess formation is a late phenomenon.

The presenting features are dysphagia, local pain, fever, gross swelling in the floor of the mouth and a compromised airway. The tongue often protrudes or is displaced superiorly.

Therapy includes hospitalization, intravenous antibiotics and hydration. A tracheotomy will circumvent airway obstruction. Endotracheal intubation is difficult and should not be attempted. Wide surgical drainage is necessary if abscess formation has taken place. Complications include gross fibrosis, aspiration and asphyxia.

Comment

Acute Infections of the Ear and Upper Aerodigestive Tract

P Sellars

This is a very large subject and reference to the bibliography provided is necessary for a fuller understanding of the various subsections of this chapter.

The ear is a complex organ which commonly suffers from both dermal and mucosal disease. The principles of management of acute infections of the outer ear including the external ear canal are essentially dermatological and if these are adhered to, the results are invariably satisfying.

Acute infections of the mucosal-lined middle ear cleft are common, especially in children and tend to produce symptoms excessive for the extent of the disease process. Nonetheless prompt treatment based on the correct diagnosis is required to arrest the process. The distinction between early acute suppurative bacterial otitis media and viral otitis media or myringitis is often clinically difficult. However, when in doubt, systemic antibiotics are appropriate. Surgery (myringotomy) is rarely now utilized for acute otitis media, but acute mastoiditis is a surgical emergency. Although this latter has now become an uncommon disorder, it remains a dangerous complication of middle ear cleft infection. When it occurs in the presence of chronic atticoantral (cholesteatoma) disease the risk of intracranial infection is high.

The diagnosis of infection of the middle ear requires good otoscopical examination, and if possible, this should be carried out with the operating microscope and if necessary even under general anaesthetic.

Acute infections of the nasal cavities are common and usually self-limiting. Diagnosis is self-evident and treatment is symptomatic and palliative. Infection of the paranasal sinuses becomes more problematical as a consequence of interrupted drainage of secretions, the result of sinus ostia obstruction. These infections produce a severe symptomatology and when suppurative require a curative approach to therapy. Antibiotics in the first instance will bring about satisfactory resolution in most cases, but when symptoms are incapacitating, prompt resolution has failed to occuyr and when complications are present, surgical drainage of the entrapped pus becomes necessary.

Acute infections of the throat are likewise common and their natural history is also one of self-resolution. However, the condition of *B. haemolytic* streptococcal tonsillitis,

although not dangerous in itself, can be complicated by rheumatic fever and glomerulonephritis. All patients with suspected bacterial tonsillitis must be treated with penicillin to avoid these serious long-term health-threatening diseases. Local complications of acute bacterial throat infection occur commonly in the form of abscesses, which must be treated by incision and drainage.

Acute laryngeal infections producing symptomatology of hoarseness, irritation and cough are of nuisance value, but are rarely incapacitating. Two specific conditions, acute epiglottitis and acute laryngotracheobronchitis are of major importance. The former is a mucosal infection of the supraglottic larynx by the organism *Haemophilus influenzae* in which submucosal inflammatory oedema occurs to the point of airway obstruction. It can be lethal if not recognized and treated appropriately. Acute laryngotracheobronchitis occurs in small children. It is viral in origin and its mucosal inflammatory pathology is confined to the subglottic larynx and below where at the level of the cricoid cartilage the constricted lumen of the airway may become so narrow as to obstruct with secretions. The cardinal signs of this condition is stridor and this must be monitored closely in order to assess failure of primary therapy and the need for endotracheal intubation. The presence of laryngeal-mucosal ulceration implies herpes simplex infection and this contra-indicates translaryngeal intubation in favour of tracheostomy.

Chapter 5.3: Injuries of the Facial Skeleton

K-W Bütow

Injuries of the facial skeleton are divided into two main groups:

- Mid-facial (middle facial third or maxillofacial) injuries.
- Mandibular (lower facial third) injuries (Fig. 5.3.1).

The upper facial third or frontal skull injury resorts under head injuries, and is commonly treated by the neurosurgeons.

Mid-Facial Injuries

Definition

Mid-facial injuries include all fractures ranging from the maxillary dento-alveolar arch to the skull base.

Surgical Anatomy

The mid-facial region includes the following skeletal bones:

- maxilla
- zygoma
- nasal bone
- ethmoids
- lacrimal bone.

There are a few adjacent bony processes of the skull which may also be involved in mid-facial injuries, such as:

- the nasal process of the frontal bone
- the superior orbital ridge and/or zygomatic process of the frontal bone
- the zygomatic process of the temoporal bone (the arcus)
- the pterygoid plates of the sphenoid bone.

The left and right sides of the mid-face consist of basically three pillars, and these are located in the following regions:

- the perinasal and frontal process of the maxilla
- the malar and the frontal process of the zygoma
- the tuberosita (palatal bone) and the pterygoid plates of the sphenoid bone (Fig. 5.3.2).

These three pillars or vertical struts are surrounded by the following bone cavities:

- the nasal cavity and the ethmoidal sinuses
- the maxillary sinus and the orbita
- the infra-temporal fossa.

The mid-face is reinforced horizontally by:

- the maxillary dento-alveolar arch
- the inferior orbital margin
- the nasal bridge
- the superior orbital margin.

The unique mechanical construction of the mid-face allows heavy occlusal forces (the average bite strength is 75 kg) to be transmitted in a supero-inferior dimension.

A sudden force originating from the inferior part of the face will be transmitted to the skull base, with very little damage to the mid-facial region. Any sudden force from any other direction, thus from anterior, antero-lateral or lateral and which is directedat the mid-fac, will result in fractures of these pillars or a crumbling of the mid-facial region, with or without dislocation of the mid-face from the skull base. The vital structures in the skull are thus protected against these abnormal forces. These fractures usually present as a particular type of fracture known as the Le Fort fracture.

Aetiology

Mid-facial fractures occur after trauma. The type and direction of the force will produce various types of mid-facial fractures. The types of trauma which cause mid-facial fractures are:

- motor-vehicle accidents
- assaults
- sport injuries
- missile injuries and
- industrial injuries.

The head and neck region has the highest prevalence of injuries sustained in motor vehicle accidents, namely 54%.

Pathological fractures involving the mid-facial region occur very rarely.

Classification

Mid-facial fractures may be classified according to the three main areas of the mid-face, namely the central, the lateral and the centro-lateral areas (Fig. 5.3.3). This basic classication may be further subdivided for a more comprehensive fracture classification.

Central Mid-Facial Fractures

- Midpalatal fracture
- Maxillary dento-alveolar fracture
- Le Fort I fracture
- Nasal complex fracture
    - nasal bone fracture
    - naso-ethmoidal fracture
    - medial orbital blow-out fracture
- Le Fort II fracture

Lateral Mid-Facial Fractures

- Zygoma complex fracture
    - arcus fracture
    - lateral or supero-lateral orbital margin fracture
    - inferior orbital blow-out fracture
    - zygomatic bone fracture

Centro-Lateral Mid-Facial Fractures

- Le Fort III fracture
- Combined Le Fort fracture
- Comminuted mid-facial fracture
    - without bone loss
    - with bone loss.

Anatopathology

Midpalatal Fracture

The midpalatal fracture is usually located between the maxillary central incisors (anterior nasal spine) and the intermaxillary suture. The fracture line ends at the posterior nasal spine. The less common para-midpalatal fracture involves the lateral incisor or canine.

This type of fracture does not occur in isolation, but is seen in conjunction with a Le Fort I, Le Fort II, Le Fort II, combined Le Fort fracture, or a comminuted mid-facial fracture.

Maxillary Dento-Alveolar Fracture

The maxillary dento-alveolar fracture is also known as the low horizontal maxillary fracture. The periodontal ligaments keep the teeth firmly anchored in the dento-alveolar bone. When an impact occurs simultaneously against two or more teeth, the adjacent bone, thus the alveolar process, may fracture and become displaced, together with the relevant teeth.

The fracture may involve any part of the dento-alveolar arch and may be classified according to its location:

- an anterior dento-alveolar fracture (which involves the incisors and/or canines)

- a posterior dento-alveolar or tuberosita fracture (which generally involves the floor of the maxillary sinus) or

- a combined antero-posterior dento-alveolar fracture.

These fractures are often mistakenly diagnosed as Le Fort I fractures.

When a tuberosita fracture is present, any attempt at extracting a tooth from that particular dento-alveolar segment will result in an avulsion of the tuberosita together with its maxillary sinus floor.

A dental fracture, in other words a fracture of the crown or root of a tooth, should not be included in the dento-alveolar fractures as this type of fracture has an entirely separate identity.

Le Fort I Fracture

René Le Fort described three basic types of mid-facial fractures which he classified numerically (fig. 5.3.4).

The Le Fort I fracture is also known as the Guérrin or low level maxillary or high horizontal maxillary fracture. The classical clinical description is that of a "floating jaw" where nothing unusual may be seen extra-orally, although the entire dento-alveolar arch with the palate may passively be moved in one piece.

The fracture line runs through the posterior wall of the maxillary sinus and the malar process of the zygomatic bone. The canine fossa area, the perinasal area of the maxially bone, the nasal wall in the inferior metaus, as well as the nasal septum and the vomer are thus involved and become dislocated from the palate. This fracture usually involves both maxillas, but may also be present as a unilateral Le Fort I fracture with a mid-palatal fracture.

Nasal Bone Fracture

Minor trauma may involve the nasal bones. In general, both nasal bones are fractured and the nasal septum may be partially dislocated. The direction of such an impact is usually antero-lateral or lateral to the nasal skeleton.

Naso-Ethmoidal Fracture

This type of fracture occurs in isolation where a more severe blow is struck against the nasal skeleton. The direction of the trauma force is mostly from anterior and is caused by an object of approximately two to three centimeters wide.

A smaller object would penetrate this particular mid-facial region and a larger object would result in an additional Le Fort II or Le Fort III fracture. Most naso-ethmoidal fractures are associated with a Le Fort II, Le Fort III or a combined Le Fort fracture.

The naso-ethmoidal fracture involves the nasal bones, the nasal process of the frontal bone as well as the medial, and occasionally the inferior, orbital margin. The medial canthal ligaments, with or without bony fragments attached to them, are always laterally displaced and a traumatic telecanthus is thus always present.

Medial Orbital Blow-Out Fracture

A direct blunt blow against the eyeball may cause a fracture of one of the thin orbital walls.

A fracture of the orbital wall of the ethmoidal bone is known as a medial orbital blow-out fracture. Parts of the orbital content may be displaced with a rather typical impairment of the medio-lateral movemebt of the globe.

Le Fort II Fracture

The Le Fort II fracture is also known as the pyramidal or infra-zygmatic mid-facial fracture. The nasal fracture line usually involves the fronto-nasal suture. However, when it is more superiorly located with cribriform plate involvement, an anterior cranial fossa fracture may also be present.

The Le Fort II fracture line runs through the infra-orbital margin, the lacrimal sulcus and the fronto-nasal suture and thus involves the posterior wall of the maxillary sinus, the malar process of the zygomatic bone, the canine fossa and the infraorbital foramen. The fracture may also occur adjacent to the foramen with or without the involvement of the

infraorbital nerve in the infraorbital canal. An isolated unilateral Le Fort II fracture with a midpalatal fracture may be seen occasionally.

Arcus Fracture

The arcus or temporal process of the zygomatic bone and zygomatic process of the temporal bone may be involved without any fractures of the zygomatic bone itself. A fracture of the arcus, on its own, usually presents with three fractures of this bony arch and the fracture fragments will be displaced medially. A single fracture of the arcus is normally found when it occurs in conjunction with a zygomatic bone of a Le Fort III fracture.

Lateral or Supero-Lateral Orbital Margin Fracture

A direct blow against the supero-lateral margin of the orbita may result in this relatively rare type of fracture. The fracture may be simple or it may be comminuted.

Inferior Orbital Blow-Out Fracture

As in the case of a "medial orbital blow-out fracture" the inferior orbital blow-out fracture occurs after a direct blunt trauma force has been exerted against the globe. This is the most common type of orbital blow-out fracture.

The fracture involves the orbital floor or the roof of the maxillay sinus without any involvement of the infra-orbital margin.

The orbital floor may be cracked or comminuted, with or without displacement of parts of the orbital contents into the maxillay sinus.

Zygomatic Bone Fracture

The zygomatic bone may be described as having "three feet" namely the frontal process, the temporal process and the malar process (adjacent to the maxillo-zygomatic suture), hence the name "tripod", trimalar or malar-maxillary fracture. The zygomatic bone fracture is also known as the "quadrimalar" fracture, because it is possible to diagnose four fractures surrounding the malar bone. These four fractures involve the following areas: the fronto-zygomatic suture, the temporo-zygomatic suture, the inferior region of the malar process, and the infra-orbital margin.

A zygomatic bone fracture may be undisplaced, or displaced in the medial (mostly) direction. However, it may be displaced laterally, or rotationally in the antero-posterior or supero-inferior dimension. The zygomatic bone may also be comminuted with bone fragments dislodged into the maxillary sinus. As in the Le Fort I and Le Fort II fractures, the maxillary sinus is always involved.

Le Fort III Fracture

This type of fracture is also known as a supra-zygomatic or a transverse facial fracture. The fracture line is in the region of the nasion and is usually one centimetre more superior

than that of the Le Fort II fracture line. Both zygomatic bones, as well as the maxilla's and usually the naso-ethmoidal region, are thus involved.

When there is a Le Fort II fracture the total mid-face is dislocated from the skull base. The fracture line thus involves the arcus, the fronto-zygomatic suture, the lateral, the inferior and medial orbital walls, as well as the nasal process of the frontal bone. In most cases one can expect the cribriform plate to be fractured.

Combined Le Fort Fracture

In a combined Le Fort fracture, any combination of a Le Fort I, Le Fort II and Le Fort III fracture is possible, and this is the most common type of mid-facial fracture (fig. 5.3.5). The fracture lines differ on the left and right sides of the face and are often accompanied by nasal or naso-ethmoidal and/or zygomatic bone fractures.

Comminuted Mid-Facial Fractures

Comminuted mid-facial fractures cannot be included in the Le Fort classification. These multiple fracture lines do not correspond to any standard description. They are usually located unilaterally, but may involve the whole mid-face.

Comminuted Mid-Facial Fracture - Without Bone Loss

There might be multiple bony fragments involving the whole facial skeleton, but it is especially the three main pillars of each facial side that may be severely crumbled.

Comminuted Mid-Facial Fracture - With Bone Loss

This type of comminuted mid-face fracture is a compound fracture associated with bone loss. The amount of bone lost may only be measured once the proximal and distal ends of the fracture have been approximated. Soft-tissue loss is also quite common.

Clinical Signs and Symptoms

Midpalatal Fracture

There is usually an anterior diastema between the incisor teeth as well as an ecchimosis at the midpalatal aponeurosis. One might also find gingival laceration or a step in the dental arch.

Maxillary Dento-Alveolar Fracture

Displacement of more than one adjacent tooth from the dental arch is an obvious indication of this fracture (fig. 5.3.6). The gingiva adjacent to the step is usually lacerated with some initial bleeding in that region.

Le Fort I Fracture

Ecchimosis and/or haematoma formation is usually present in the alveolar sulcus. The occlusion is often affected and associated signs of trauma may be seen on the teeth, lips and cutaneous areas paranasally.

Nasal Bone Fracture

A displaced nasal skeleton and epistaxis are the most common initial signs. After a while oedema of the nasal complex and paranasal region, with ecchimosis and/or a haematoma infra-orbitally, may be seen without any clear indication of displaced nasal bones.

Naso-Ethmoidal Fracture

A posteriorly displaced nasal complex with a deep indentation of the nasion, with or without laceration in that region, is indicative of this fracture. Epistaxis is initially usually quite severe with oedema, ecchimosis, or a haematoma paranasally and infraorbitally. A traumatic telecanthus, thus the lateral displacement of the medial canthus ligaments, is always present with this fracture (fig. 5.3.7). An anterior cranial fossa fracture may be expected with the usual clinical sign of cerebrospinal rhinorrhea.

Medial Orbital Blow-Out Fracture

In the initial phase only periorbital oedema may be present. In rare instances there may be subconjunctival bleeding next to the cornea. The patient usually complains a few days later of a diplopia, especially with lateral and medial eye movement. An endophthalmus may also be seen as one of the more unusual clinical signs.

Le Fort II Fracture

The patient has a typical dishface appearance because the mid-facial region is displaced posteriorly and inferiorly. Ecchimosis and haematoma are present infraorbitally and there is a rapid increase in oedema of the mid-face with a blepharospasm. Epistaxis is quite common, but a cerebrospinal rhinorrhea occurs rarely.

Early dental contact posteriorly with no occlusion of the anterior teeth is the rule. The patient can thus not close the mouth and might also have airway obstruction due to the postero-inferior displacement of the mid-face (fig. 5.3.8). This displacement is also present in the soft palate which is relocated in its relationship to the oropharynx.

Arcus Fracture

When there is no oedema, a marked depression can be seen between the lateral orbital margin and the tragus. The patient is usually unable to open or close the mouth or if able to do so, then only with great discomfort. Ane ecchimosis or haematoma rarely develops in this region.

Lateral or Supero-Lateral Orbital Margin Fracture

Crepitations will be felt in this bony region. Periorbital ecchimosis and oedema, with or without blepharospasm, may be present in the lateral or supero-lateral orbital margin.

Inferior Orbital Blow-Out Fracture

Initially no sign or symptom may be prsent apart from a blepharospasm with pericorneal subconjunctival ecchimosis and sometimes also epistaxis. A few days later the patient will complain of diplopia and on examination a restricted supero-inferior globe movement will be present, with or without an endophtalmus and paresthesia of the region supplied by the infraorbital nerve.

Zygomatic Bone Fracture

Periorbital oedema with a haematoma or ecchimosis, a lateral subconjunctival bleeding, epistaxis, as well as a displaced zygomatic bone (seen as an unusual flatness) are the first clinical signs.

The patient's main complaint is that of paresthesia of the region supplied by the infraorbital nerve, but there is also, in some cases, diplopia, early occlusal contact of the molars on the side of the fracture, and pain over the malar process.

The patient may also complain of a restricted mandibular movement, especially in the lateral dimension.

Le Fort III Fracture

Before the onset of oedema, the patient will present with a severe "dishface" appearance. However, marked oedema over the whole mid-facial region with blepharospasm, cerebrospinal rhinorrhea and an open bite with early occlusal contact of the molars are usually present at examination. The clinical picture is basically the same as that of a Le Fort II fracture, but it is more severe because the zygomatic bones are also involved in this mid-facial fracture.

Combined Le Fort Fracture

The clinical signs are basically the same as or a combination of those described for a Le Fort I, Le Fort II and a Le Fort III fracture.

Comminuted Mid-Facial Fracture

The clinical signs of this type of mid-facial fracture are very similar to those of a combined Le Fort fracture.

Where bone loss occurs in a compound comminuted fracture, the clinical picture is quite obvious.

Diagnosis and Special Investigations

Midpalatal Fracture

The diastema beween the incisors and the ecchimosis in the mid-palatal apneurosis is diagnostic of this type of fracture. The lateral dento-alveolar arches can be moved independently. A maxillary occlusal radiograph will clearly indicate the presence of this fracture.

Maxillary Dento-Alveolar Fracture

The displacement of more than one tooth from the dental arch is diagnostic. Mobility of the involved segment will indicate the extent of the fracture. The fracture lines will be seen on an orthopantomo-radiograph.

Le Fort I Fracture

On the basis of clinical signs and symptoms alone this type of fracture may easily remain undiagnosed. A mobility test whereby the anterior teeth are moved passively and the nasal skeleton is palpated for its rigidity at the same time will indicate if a Le Fort I fracture is present. The whole dento-alveolar arch may be moved passively without any signs of movement of the nasal skeleton. The fracture may be seen on two different occipito-mental rotation (+5 and -5) radiographs, an orthopantomogram, as well as a lateral skull radiograph.

Nasal Bone Fracture

Crepitation of the fracture should be felt on palpation. Other clinical signs such as oedema and paranasal/infraorbital ecchimosis are diagnostic.

A lateral skull radiograph will identify mid-facial damage but no fractures of the nasal skeleton, while a lateral nasal bone radiograph will indicate the fracture lines of the nasal skeleton.

Naso-Ethmoidal Fracture

A bony step can usually be felt on the medio-inferior orbital margin. A traumatic telecanthus is a diagnostic sign of a naso-ethmoidal fracture.

A lateral skull and an occipito-mental radiograph will clearly demonstrate the outline of this type of fracture.

Medial Orbital Blow-Out Fracture

When this type of fracture is suspected, it should be investigated further by special radiographic techniques.

Coronal tomography of the ethmoidal bone and its sinuses, and in more difficult diagnostic cases, a coronal computerized axial tomography scanning of a particular area, should clearly indicate the displaced orbital contents into the ethmoidal sinus(es).

Le Fort II Fracture

The anterior maxillary teeth should be moved passively in an antero-posterior direction. The nasal skeleton, as well as the zygomatic bone, should be palpated at the same time that the teeth are being moved. A Le Fort II fracture is diagnosed when the dento-alveolar arch as well as the nasal skeleton, but not the zygomatic bones, are mobile. The fracture lines should be palpated further for step formation.

An occipito-mental, a postero-anterior skull and an orthopantomo radiograph should demonstrate the particular fracture lines.

The more facial oedema, the less likely it is for this type of mid-facial fracture to be clinically and radiologically accurately diagnosed.

Arcus Fracture

A lateral facial indentation may easily be palpated.

This particular fracture may be seen on a basal skul or intracranial radiograph.

Lateral or Supero-Lateral Orbital Margin Fracture

The clinical signs are diagnostic in most instances. The extent of the fracture may clearly be determined on an occipito-mental and a postero-anterior skull radiograph.

Inferior Orbital Blow-Out Fracture

The clinical signs are diagnostic, and should be investigated further by special radiographic techniques. Radiographic examination with the aid of occipito-mental and coronal tomography of the maxillary bone and its sinus will usually reveal the particular fracture. In more difficult diagnostic cases a coronal computerized axial tomography will clearly demonstrate the fracture.

Zygomatic Bone Fracture

The clinical signs are again diagnostic, especially where the displacement of the globe is concerned.

Special investigations by means of radiographs, occipito-mental, postero-anterior skull and a basal skull radiograph, will demonstrate the relevant fracture lines. Special attention has to be given to the outline of the orbit, the opaqueness (due to bleeding) of the maxillary sinus and the fracture displacement.

Le Fort III Fracture

Palpation of the fracture lines will result in pain. As in the Le Fort I and Le Fort II fractures, the dento-alveolar arch may be moved passively, but in this type of fracture the nasal skeleton as well as the zygomatic bones are mobile. This unusual mobility of the whole mid-facial region is diagnostic of a Le Fort III fracture.

Radiograph examination with a postero-anterior and occipito-mental radiograph should, in most cases, confirm this type of fracture.

Combined Le Fort Fracture

Careful examination by palpation, as performed for a Le Fort I, Le Fort II and Le Fort III fracture, should confirm the diagnosis of this particular fracture.

Radiographic examination with the aid of an occipito-mental, a postero-anterior skull and an orthopantomo radiograph will usually reveal the particular fracture lines.

Comminuted Mid-Facial Fracture

Even a thorough palpation of a closed comminuted mid-facial fracture will not reveal the extent of the facial skeletal trauma. Very good mid-facial radiographs are necessary to indicate all the fracture lines which do not run in a particular pattern. An open, thus a comminuted fracture with bone loss of the mid-facial region, is diagnostic by its clinical appearance.

Computerized axial tomography is a helpful aid in establishing the extent of trauma to the facial skeleton as well as to the skull base in both types of comminuted mid-facial fractures.

Treatment

Initial Treatment

Airway

The initial most vital procedure is the maintenance of an open airway. Where the patient is conscious, the maxilla may be stabilized by , means of wooden spatulas and a head bandage.

When the patient with facial trauma is unconscious, he should be intubated so that the airway may be maintained and aspiration of blood may be avoided until at least his general condition has been stabilized and consciousness has been regained.

When the unconscious patient has a head injury and/or severe mid-facial trauma, a tracheostomy is indicated. In every case of mid-facial trauma, there is the possibility of aspirating blood.

Haemorrhage and Shock

Severe bleeding from mid-facial fracture occurs rarely but, when present, should firstly be dealt with by direct compression (extra-oral bleeding), re-alignment of the mid-facial region and suturing of the soft tissue (intra and extraoral) as well as the placement of intranasal packs.

Arteries and/or veins may be directly ligated when necessary and when they can be reached. Unnecessary dissection should be avoided as vital structures may be damaged. Ignorance of this fact can lead to injudicious vessel clamping, accidental motor and sensory facial nerve injury and much pain.

Embolization, which is seldom applied, is a useful alternative procedure to stop bleeding and should be attempted before considering a dissection. Embolization is mostly indicated in profuse haemorrhage from the anterior ethmoidal or maxillary arteries.

Constant blood loss, especially from missile wounds, can lead to shock and should therefore be treated promptly whenever there is the slightest sign of haemorrhage. Prolonged hypotension and acute anaemia associated with blood loss may rarely occur as a result of a solitary mid-facial injury.

Tissue Perfusion and Necrosis

As a rule, debridement of facial tissue should be avoided if possible, because of the immensely unsatisfactory reconstruction possibilities of the facial hard and soft tissue.

Only tissue which appears completely "black" should be removed. Tissue which is ischaemic, i.e. "blue" or "purple" should be repositioned and/or sutured to its original location. In almost all instances only very little tissue, if any, will be lost by sloughing or sequestration, as the ischaemia is merely transient as a result of the displacement.

The more hard and soft tissue saved, the more satisfactory the long-term results. Primary major reconstruction is always possible in the facial region because of its excellent blood supply. A patient will therefore benefit greatly if primary major reconstruction is done in the initial treatment.

Main Facial Treatment

The treatment principle varies for each mid-facial fracture and depends to a great extent on the dental occlusion for certain mid-facial fractures.

In the case of a Le Fort I, Le Fort II, Le Fort III, combined Le Fort and comminuted mid-facial fracture, the treatment is entirely based on "the occlusal and mandibular availability" in that these mid-facial fractures can only be accurately re-positioned according to the occlusion.

Classification of Occlusal and Mandibular Availability

Natural teeth present for an occlusion:

- occlusion with a stable mandible
- occlusion without a stable mandible.

No natural teeth present for an occlusion:

- an "artificial" occlusion (dentures) with a stable mandible
- no occlusion possible.

Treatment Planning

Each treatment for facial skeletal trauma depends on:

- an accurate clinical assessment
- good facial radiographs (these are often very difficult to produce).

The treatment which is then to be applied is chosen according to the following:

- the patient's general condition

- head injuries present (especially in view of the timing of a surgical intervention and the use of cranio-facial fixation procedures)

- severe ophthalmologic lesions (especially globe perforation, corneal defects, hyphema, lenticular displacement, and orbital apex syndrome)

- the occlusal and mandibular availability

- the lacerations in the facial region which may be utilized as entrances for bony open reductions and fixation procedures.

The timing of a surgical intervention depends on:

- the neurosurgical and the general physical condition of the patient

- the severity of the trauma to the facial region

- the time elapsed since the injury was sustained. The treatment is more accurate when it is done before oedema has occurred or after the facial oedema has subsided.

- compound or closed fractures of the facial skeleton

- injuries which might influence the administration of a general anaesthetic such as cervical injuries, pneumothorax, partial rupture of the trachea or other injuries

- laceration of the facial region

- time required for the manufacturing of a custom-made technical facial-occlusal apparatus.

Specific Treatment

Midpalatal Fracture

Intramaxillary wiring may be applied where there are teeth (premolars and/or molars) available (fig. 5.3.9). Where the maxilla is edentulous, an acrylic occlusal splint has to be manufactured.

Maxillary Dento-Alveolar Fracture

Once the fracture has been reduced, a special arch bar has to be placed so that the displaced and adjacent undisplaced teeth are fixed to one another. These arch bars are known as Jelenko, Erich or Risdon arches or wirings. A custom-made acrylic occlusal splint may also be placed.

Le Fort I Fracture

The "occlusal and mandibular availability" will allow the application of various specific treatment modalities:

- maxillo-mandibular or intermaxillary wiring with zygomatic arch or circum-zygomatic suspension wires

- maxillo-mandibular wiring with miniplate and screws osteosynthesis

- the use of a denture, modified as a Gunning's splint, with zygomatic arch suspension wires, circumferential mandibular wires and a maxillo-mandibular wiring (fig. 5.3.10)

- a direct open reduction with a wire or suture osteosynthesis.

These different procedures are not interchangeable but must be applied according to the edentulous state or occlusion and mandibular stability.

Nasal Bone Fracture

External nasal bone stabilisation with a nasal splint, and an internal nasal bone stabilization with a nasal pack are normally sufficient.

Naso-Ethmoidal Fracture

Lateral nasal compression plates have to be used for the traumatic telecanthus, and external and internal nasal bone stabilization applied for the nose. A direct open reduction with wire or suture osteosynthesis is sometimes necessary for the reduction and fixation of

an infraorbital margin fracture. A cranio-facial fixation, with additional stabilization of the naso-ethmoidal complex, is seldom indicated.

Medial Orbital Blow-Out Fracture

A medio-supero-orbital (Lynch) incision approach will allow sufficient access to the fracture region. A small defect may be bridged by a lyophilized dura transplant, whereas a large defect requires a thin bone transplant. In cases where a pre-trauma chronic sinusitis of the ethmoid sinuses was present, one has to supply additional drainage from the sinus to the nasal cavity.

Le Fort II Fracture

The involved mid-facial region has to be reduced and fixated in the anterior and superior direction, because the mid-face has been displaced posteriorly and inferiorly. As in the case of a Le Fort I fracture, the treatment is chosen according to the four different "availabilities of occlusion and a stable mandible".

Arcus Fracture

The displaced bony fragments must be repositioned to their original location. Different areas of approach, such as the temporal, supraorbital and intraoral approaches, but no direct approach, are available for this repositioning procedure.

Inferior Orbital Blow-Out Fracture

An infra-orbital approach is usually sufficient for the repositioning of the prolapsed orbital content. Lyophilized dura or fascia lata may be placed over a small defect, but a large defect requires a bony transplant (fig. 5.3.11). In some cases, especially where there is a large comminuted fracture of the orbital floor, an antral pack in the maxillary sinus is necessary to support the orbital floor, an antral pack in the maxillary sinus is necessary to support the orbital floor inferiorly.

Zygomatic Bone Fracture

The basic principle in the treatment of a zygomatic bone fracture is the correct repositioning and stabilization of the zygoma.

The reduction may be achieved by a direct approach using a malar hook, or by a temporal or supraorbital elevation. Fixation is mostly done at the fronto-zygomatic fracture line and in some cases additionally at the infraorbital margin and/or at the malar process.

When the zygomatic bone fracture is comminuted, an antral pack is imperative for the support of the comminuted lateral wall.

Le Fort III and Combined Le Fort Fractures

As in both the Le Fort I and Le Fort II fractures the four types of reduction and fixation possibilities have to be specifically applied according to the availability of an occlusion and/or stable mandible.

The choice of which stabilization method to use in the Le Fort III or combined Le Fort fracture depends on the available osteosynthesis material. The more superior the fracture lines are in a combined Le Fort fracture the more superior the open reduction (fig. 5.3.12) and the more rigid the osteosynthesis material have to be.

Comminuted Mid-Facial Fractures

The four major types of fixation/reduction treatment methods depend, once again, on the occlusion and the stable mandible. However, the presence of either a unilateral or a bilateral comminuted mid-facial fracture will also influence the type of treatment employed.

A unilateral comminuted mid-facial fracture should be treated as a Le Fort I, Le Fort II, Le Fort III or combined Le Fort fracture whereas a bilateral comminuted mid-facial fracture must be treated with an external cranio-facial fixation. Last mentioned may be a skull-pinned halo headframe or a supra-orbital pin fixation. These will stabilize the mid-facial region in a supero-inferior dimension where there is an occlusion (natural teeth or denture) and stable mandible to be used. Where there is neither a stable mandible nor a dental occlusion possible the external cranio-facial fixation has to stabilize the mid-facial region in a supero-inferior as well as an antero-posterior dimension.

Where bone loss has occurred in the mid-facial region, an immediate bone transplant may be done, depending on the condition and amount of soft tissue available for covering the area as well as on the blood supply and the amount of contamination present. Major primary reconstruction has a better functional and aesthetic advantage in the long term than any major secondary reconstruction.

Prognosis and Complications

In general, very good functional and aesthetic results may be achieved in the majority of mid-facial skeletal trauma. The exception here is the bilateral comminuted mid-facial fracture with bone loss which is mostly a result of missile trauma.

Certain basic principles have to be applied in the primary treatment of mid-facial fractures:

- the bony edges of the fracture line have to be perfectly approximated

- the occlusion has to be perfectly aligned and must interdigitate, as six or more micrometers discrepancy in the occlusion will be felt by the patient. Readjustment of the occlusion postoperatively is generally difficult and very costly

- bone transplantation must be considered in the primary treatment where loss of bone, especially of the important structural pillars, has occurred. Good facial contours and function may be achieved in this way. Where there is not enough soft tissue to cover the bone transplant, it should not be attempted.

- The reduction of facial fractures must be approached with caution so that any cerebrospinal fluid leak may be sealed off and healing may take place.

Possible complications after the primary treatment of mid-facial fractures are the following:

- occlusal discrepancies
- trismus
- diplopia
- ptosis
- traumatic telecanthus
- facial contour defects
- cerebrospinal fluid leakage
- infection at the fracture lines
- sinusitis
- immediate and late post-operative bleeding.

Some of these patients will need further special treatment. In the short term, for secondary reconstruction, the following will receive attention:

- facial contour defects
- diplopia and endophthalmus (for surgical correction)
- canthopexy
- neurosurgical intervention for a dure laceration (cerebrospinal rhinorrhea or otorrhea)
- bone transplantation for severe compound comminuted mid-facial fractures
- pre-prosthodontic surgery for vestibuloplasty, rib augmentation and sub or endosteal implants.

In the long term the following may arise:

- prosthodontic rehabilitation for the partial loss of dentition
- orthodontic alignments of teeth (seldom)
- ophthalmological correction for retinal detachment and refractory diplopia
- sinusitis
- plastic surgery for scar revision.

Mandibular Injuries

Definition

Skeletal trauma to the lower facial third is known as mandibular injuries. These injuries include those affecting the temporo-mandibular joint.

Surgical Anatomy

The mandible has a thick cortical layer of compact bone which is reinforced on its inferior border so that the torque, i.e. the occlusal forces exerted by dentition, may be accomodated. The alveolar sockets are surrounded by the spongiosum and the dental forces are transferred via the periodontal ligament to the alveolar bone and from there to the basal bone.

The forces released through the dentition are further transmitted through the bone trabeculae, then the compact bone from a supero-inferior to an inferior to an antero-posterior dimension and they eventually become concentrated at the condyle head. The temporo-mandibular joint is thus a weight-bearing joint. From here the force spreads to the squamous part of the temporal bone for distribution over the skull base.

This anatomical construction of the mandible and its relation to the mid-face and skull base will result in a fracture occurring in the region of the force of impact as well as, usually, at an area of weakness lying in the vector of the force - a *countre-coup* fracture. Thus the overall majority of mandible trauma will present with two or more fractures (fig. 5.3.14).

Aetiology

The most common cause of mandibular fractures is a direct force against the lower third region, as seen in:

- motor-vehicle accidents
- assaults
- sport injuries
- industrial injuries.

However, there might be other rarer causes of fractures of the mandible. These are:

- endocrine disturbances
    - hyperparathyroidism
    - postmenopausal osteoporosis
- systemic disturbances
    - reticulo-endothelium disorders
    - Paget disease
    - osteomalacia
- local destruction
    - cyst
    - tumours.

Classification

Mandible fractures may be classified according to the type, the area of the fracture, the dentition present as well as the muscular action on the fractured segment.

The classification mainly aids in the choice of possible treatment modalities.

Type of Fracture

- Simple fracture
- Greenstick fracture
- Open fracture
- Comminuted fracture (closed of compound)
- Double or triple fracture
- Fracture with bone loss
- Direct fracture
- *Contre-coup* fracture.

Area of Fracture

- Symphyseal fracture
- Para-symphyseal fracture
- Corpus fracture
- Ramus fracture
- Angle fracture
- Condylar neck fracture
- Coronoid fracture
- Condylar head fracture (extra-capsular and intra-capsular)
- Mandibular dento-alveolar fracture
- Parade-ground fracture.

Dentition Bordering the Fracture

- Class I fracture
- Class II fracture
- Class III fracture.

Muscular Action on the Fragments

- Horizontal favourable fracture
- Horizontal unfavourable fracture
- Vertical favourable fracture
- Vertical unfavourable fracture
- Mylohyoid muscle action on a double corpuscle fracture
- Pterygoid muscle action on the condylar head/neck fracture
- Suprahyoid/geniohyoid muscle action on a bilateral parasymphyseal fracture
- Temporalis muscle action on the coronoid fracture.

In the "type of fracture" the involvement of the cortex is described as a simple, greenstick, comminuted and double/triple fracture. The fracture could be closed or compound. Last-mentioned may be caused by an extra-oral cutaneous or intra-oral muco-periosteal laceration. When teeth are involved in the fracture line, the fracture is always open. When a fracture is found at the area of impact, thus a direct fracture, a *contre-coup* fracture is also usually present (fig. 5.3.14).

The "area of fracture" describes the location of the fracture. A dead-central impact against the mentum, as in a parade-ground fracture, will result in fractures of the symphysis as well as both condylar necks.

The dentition plays a vital role in the treatment of a mandibular fracture. In a class I fracture teeth are present on both sides of the fracture. In a class II fracture teeth are present in only one of the fragments, whereas in a class III fracture no teeth are present on either side of the fracture, the patient thus being edentulous.

Certain fragments of the mandible may become dislodged by muscular action. The horizontal and vertical favourable and unfavourable fractures are descriptive for ramus displacement. "Favourable" means that the muscles, in this instance mainly the medial pterygoid muscle, will not displace the ramus. "Unfavourable", however, means that the specific muscle here will displace the ramus medially (in a vertical unfavourable fracture) and/or horizontally (in a horizontal unfavourable fracture) (fig. 5.3.15). Any muscle such as the mylohyoid, lateral pterygoid, temporalis, suprahyoid and geniohyoid muscles which implants on a part of the mandible, may displace a segment (fig. 5.3.16).

Anatopathology

Certain areas in the mandible are inherently weaker than others owing to the anatomical construction of the mandible. A fracture will more commonly occur in these regions, i.e.:

- the symphyseal area - the left and right corpus with their stress lines fused in this region

- the mental foramen area - a displacement of the stress lines, occurs at the forament

- the gonion - the corpus and ramus join in a near right angle and the stress lines are reflected proportionally

- the condyle neck area - the stress lines bundle into a proportionally smaller area than in the rest of the mandibular bone and force rectangular to the stress lines will cause a fracture in that region.

In general, a fracture may occur in any part of the mandible, yet certain areas are more susceptible because they are weaker in their construction, or because they are more prominent (symphysis and mental region).

Clinical Signs and Symptoms

The most prominent sign of a mandibular fracture is that the patient will complain of disturbances in his occlusion, where natural teeth or dentures are present.

The other clinical signs and symptoms are easily detected when a thorough visual and palpation examination is made. This examination must be directed extra- as well as intra-orally. The signs and symptoms are:

Visual Examination

Extra-Orally

- oedema in the region of trauma

- traumatic laterognathism

- laceration (generally small) and/or ecchimosis or hematoma in the region of the fracture

- hemorrhage from the external auditory canal could indicate a fracture of the condylar head and mandibular fossa or/and a fracture of the petrous bone (a cerebrospinal fluid leak or Battle's sign will confirm last-mentioned).

Intra-Orally

- step formation and displacement of parts of the dentition

- traumatic diastema between the teeth and quite often the loss of a tooth in the line of the fracture

- laceration of the gingiva at the fracture site

- oedema in the floor of the mouth with haematoma or echimosis.

Palpation Examination

Extra-Orally

- Pain in the region of a direct fracture, but also in the area of the *contre-coup* fracture

- step formation on the inferior border of the mandible

- movement of the fragments.

Intra-Orally

- pain in the region of the fracture line

- step formation may be created when the fragments are moved passively in a supero-inferior and in a bucco-lingual direction.

Diagnosis and Special Investigations

The clinical signs as found in the visual and palpation examination are generally diagnostic for the type and location of the mandibular fracture.

Radiographs may reveal the extent, the precise location, the dental involvement and any dislocation due to muscular action on the fracture. The radiographs should always be made and then also scrutinized in all three dimensions. For this purpose two standard radiographs should be taken, namely:

- an orthopantomogram

- a postero-anterior facial-skull radiograph.

Certain areas of the mandible and skull base have to be radiographed more specifically so that the exact location and extent of the fracture may be determined. These specialized radiographs are:

- a Towne's radiograph for an antero-posterior view of the condyle neck and head

- an occlusal or status X radiograph for the symphyseal and para-symphyseal areas

- a lateral facial-skull or trans-cranial radiograph for the condylar neck and head, the mandibular fossa region and the associated skull base

- an oblique-lateral mandibular radiograph for the mandibular angle and also for when an orthopantomogram is not possible.

Treatment

The basic principles in mandibular fracture treatment are:

- accurate positioning and reduction of the fractured segment according to the dental occlusion (six micrometers discrepancy will be felt by the patient as a major disturbance)

- fixation of these segments over time so that the fracture may unite.

Reduction and Fixation Methods

Closed Reduction and Fixation

This is the least complicated way of reducing a fracture. The fracture must be simple, a greenstick or closed comminuted, class I or class III type, with little dislocation.

The different types of treatment are:

- a maxillo-mandibular (or intermaxillary) dental wiring is issued where there are natural teeth present, an Ivy (fig. 5.3.17), Stout, Risdon, Obwegeser, etc. wiring may be done

- arch stabilizers in the form of pre-fabricated metal arches (Erich, Jelenko, etc) are available, and usually used for a mandibular (and maxillary) dento-alveolar fracture

- custom-made splints which may consist of cast splints made from impression models and are sometimes essential, especially in cases of mixed dentition (children). They may be made of acrylic (for children) or silver (for adults)

- circumferential wiring (fig. 5.3.10) is used in cases where the mandible is edentulous, but a denture is available, a modified Gunning's splint may be made and used to stabilize the fracture by means of circum-mandibular wiring

- skeletal pin fixation (fig. 5.3.18) - these extra-oral devices are used in extensive comminuted or severely septic fractures.

Open Reduction and Fixation

When a closed reduction is not possible, an extra- or intra-oral open reduction procedure is indicated according to the type, the area, the dentition present (mainly class II and III fractures) and muscular displacement action. An open reduction generally also implies the use of a fixation technique and as the reduction is achieved under direct vision, good fracture alignment is usually possible.

The open reduction and fixation procedures may be utilized intra- and extra-orally, the choide depending entirely on the accessibility of the fracture, the required fixation strength, and the type of osteosynthesis material available.

Intra-oral open reduction and fixation materials are:

- wire osteosynthesis

- Kirschner pin (with or without compression wire) osteosynthesis

- bone plate (and screws) osteosynthesis (mono-cortical and bicortical types (fig. 5.3.13)), or bone screws on their own.

Extra-oral open reduction and fixation material and approaches:

The different fixation techniques used for an intra-oral open reduction may basically also be used in an extra-oral approach, as well as more extensive types of wire osteosynthesis (four-hole method) and metallic meshplate procedures.

In general, the intra-oral open reductionis the first choice, because:

- less soft-tissue dissection is necessary, with less post-operative discomfort to the patient

- no facial scar will remain.

There are various extra-oral surgical approaches for reaching the mandible:

- the Risdon approach (submandibular, for access to the angle of the mandible)

- the general submandibular or supra-hyoid approach (for access to any other submandibular region)

- the pre-auricular approach (for access to the condylar neck and head).

General Considerations

Teeth in Line of the Fracture

When teeth are involved in the fracture line:

- 25% of the teeth will develop a necrotic pulp (the blood supply to the tooth has been interrupted)

- 25% of the teeth will be denervated, but with an intact blood supply; the tooth is thus vital but will not respond to any tests for pulp vitality

- 50% of the teeth will have been unharmed with a normal blood and nerve supply.

The decision as to whether a tooth should be extracted or not depends entirely on whether the tooth is fractured, the pre-traumatic general oral hygiene and the condition of the dentition. When the oral hygiene is poor and when the dentition has been neglected and/or when there is a fractured tooth in line of the fracture in the mandible, the tooth has to be extracted so that any infection in the fracture, adjacent tissue and in the bone may be avoided. If the patient had maintained good oral hygiene and the dentition is well cared for, extended antibiotic therapy with follow-up vitality tests are indicated. When the tooth remains non-vital, a pulpectomy with follow-up endodontic treatment is recommended as soon as the maxillo-mandibular wiring has been removed. A tooth with a partially formed root located in the fracture line as seen in a child and an adolescent should not be extracted as the tooth remains vital.

Condylar Head and Neck Fractures

The extra-capsular fracture is treated as any other mandibular fracture by means of a closed reduction or an open reduction procedure. In an intra-capsular or intra- and extra-capsular fracture, i.e. a high condylar neck and head fracture, the mandible may be immobilized for ten to fourteen days only. Active movement must follow this initial period. A longer immobilization period will give rise to a fibrous or bony ankylosis of the joint due to the reorganization of the blood in a haemarthrosis. Children should be treated with functional orthodontic appliances as they have a greater predisposition to post-traumatic ankylosis.

Extensive Bone Loss

The amount of bone loss and whether there is a possible infection or not will determine whether one cannot only bridge the bony defect, but still achieve an ideal alignment and function. This is possible with the use of an external pin-fixation procedure (fig. 5.3.18).

In a case where sufficient soft-tissue coverage is available and the wound is clinically aseptic, an immediate bone transplantation may be performed.

When it is doubtful whether the wound is aseptic and soft tissue has also been lost so that a facial and/or intra-oral soft tissue flap(s) has to be raised, an internal extended bone plate may be placed, partially for function but mainly to achieve and maintain a good facial profile.

As in mid-facial trauma, debridement should be kept to an absolute minimum in the lower third of the face.

Fixation Period

The extent of the skeletal injury determines the fixation period. The maxillo-mandibular fixation period varies according to the age of the patient:

- aduld - average 6 weeks (5-7 weeks)

- child - average 4 weeks (3.5-4.5 weeks) in a simple fracture

  - average 2 weeks with a greenstick fracture.

Prognosis and Complications

Whenever an accurate interdental occlusal contact has been achieved in the lower facial-third injury, a very good functional and aesthetic result may usually be expected. A mandibular fracture with extensive bone loss, mostly following a missile injury, may have the least satisfactory functional and aesthetic results.

Possible complications of mandibular fractures are:

- occlusal malalignment and/or displacement of fractured segments

- infection and/or abscess formation at the fracture site, sometimes with extensive adjacent soft-tissue breakdown

- osteomyelitis in the fracture and adjacent to the fracture

- non-union or fibrous union of the fracture

- fibrosis in the adjacent muscles with trismus

- dislocated condylar head, mostly antero-medially, seldom into the mid-cranial fossa, with accompanying laterognathism

- post-traumatic functional disturbance of the temporo-mandibular joint in the form of a derangement of the meniscus

- ankylosis (fibrous or bony) of the temporomandibular joint, and

- disturbance of mandibular growth in a child with condylar injury.

Long-term specialized treatment may be necessary, such as:

- pre-prosthodontic surgery and prosthodontic rehabilitation of the dental occlusion

- an internal derangement treatment of the joint

- orthognathic surgery for the repositioning of the mandible for a malunited facture(s).

In general, the mid-facial skeletal injury presents with less complications than the lower facial-third (mandibular) injury. This may be contributed to the embriological origination of bone, as the mid-facial bones are of a membranous type with good collateral blood supply, whereas the mandibular bone is of an endochondral type with less good collateral blood supply.

Comment

Injuries to the Facial Skeleton

F W Grotepass

From experience I have found that a lof of facial fractures have been missed out due to other more serious conditions requiring the attention of the various clinicians. Once the patient has stabilized, his face has swollen to such an extent that the diagnosis of facial fractures is greatly compromised by the severe swelling in the face. The patient is very often in some form of orthopaedic traction, or greatly immobilized by various lines placed for life support, so that the diagnosing of facial fractures is very often postponed or completely forgotten. It is also difficult at that stage to make use of special investigations, and the clinician must again rely on his clinical accument to make a thorough diagnosis of the facial fractures. If the clinical picture is systematically approached very few if any facial fractures will be missed. The following points should be noted:

The History

The type of injury, be it a motor-car accident, sport injury or industrial accident, will give an idea of what to expect and the involvement of the trauma. If the patient can be examined shortly after the injury, a deformity will be evident and this is particularly important with the zygomatic arch as well as the trauma fractures.

Swelling

The facial soft tissues react to trauma with severe swelling. This swelling can have its onset within minutes to hours after the trauma and can be the greatest obstacle to eventual clinical diagnosis of the injury involved. In extreme swelling of the soft tissue of the face, the

classical "moon face" swelling with circumorbital swelling renders the face almost impossible for clinical evaluation.

Bleeding

Bleeding from the various orophises re No1, the external auditory meatus - distinction must here be made if the trauma has come from a base-of-skull fracture or from a penetrating wound to the external auditory canal from a condylar neck (mandibular-condylar neck fracture penetrating the wall of the meatus). In the orbital region subconjunctival bleeding can be a sign of fracture of the orbital rim and the consequent bleeding below the conjunctiva. From the nasal cavity a distinction must be made if the bleeding has come from direct trauma of the nose or if the bleeding has come from the maxillary antrum. Very often blood is running from the nose after changing the posture of the patient's head. This is very often seen with rugby injuries of the cheek bone. Intra-oral bleeding is either from direct lacerations of the soft tissue or it may be indicative of a fracture through the dento-alveolar processes of the jaws.

Cerebral Spinal Fluid

The discharge of cerebral spinal fluid from the nasal cavity or the exterior auditory meatus is indicative that the facial bones have broken free from the base of the skull and a basal skull fracture must be considered as well. Loss of cerebral spinal fluid can very often not be noted as cerebral spinal fluid will run unnoticed down the nasopharynx. With severe trauma of the face, this must always be investigated and the general rule is to expect a patient with heavy facial trauma to have cerebral spinal fluid leakage unless there is proof to the contrary.

Loss of Sensation

As so many branches of the sensory nerves in the face run through foramina in the facial skeleton, the sensory status of the face after trauma is of extreme importance. On the zygomatic complex the status of the inferior infraorbital nerve can lead to positive diagnosis of the fracture. Fractures through the medial orbital wall can very often be confirmed by loss of sensation on the tip of the nose due to involvement of the anterior ethmoidal nerve. Orbital floor fractures can also be confirmed by loss of sensation in the upper lip due to intrafracture posterior to the mental foramen. This involves the ramus of the mandible and will invariably give loss of sensation of the lower lip on the side of the fracture as well. In the total evaluation of the traumatic patient the careful examination of all cranial nerves is absolutely imperative and the loss of either motor or sensory supply will lead to positive diagnosis of underlying fractures. In the severely swollen face this is very often the only clue available as the orbits and the content cannot be examined easily.

Pain

Pain as a rule is not severe in mid-facial fractures, but fractures of the mandible do involve pain with movement. Due to the anatomical structure of the mandible and its great portional forces, any movements of the mandible in protrusion or in lateral expressions will

produce pain if a fracture is present. The patient may protect a condylar neck fracture by muscle spasm and lack of movement.

Crepitus

Crepitus is not always necessarily present in facial injuries. Sometimes the zygomatic fracture is impacted without movement but crepitus can be felt on most Le Fort fractures as well as in mandibular fractures.

Loss of Function

In the facial skeleton loss of function is divided under:

Eyes

Under eyes we firs distinguish between the actual visual perception of the eye itself. This would have been covered under the examination of the cranial nerves and from the functional point of of view the eyes must be examined in all their planes of movement. The muscles mostly involved are the muscles of the inferior compartment, the inferior rectus and the inferior oblique due to a direct muscle trauma resulting form injury of the orbital floor fracture.

The second symptom of loss of function is nerve involvement.

Mechanical intraction of the muscle is the third indication of function loss.

Any of these conditions will present with diplopia on testing the eyes in the various planes of movement.

The Nasal Airway

The nasal airway can be impaired first due to swelling of the mucus membranes of the nasal airway, and secondly as a result of bony involvement and disturbance of the nasal airway.

Occlusion

Disturbance of the occlusion is a very important clinical feature of facial fracture, and is due to the extreme sensitivity of the periodontal ligament. The patient is very quickly aware of the slightest disturbance in the facial skeleton.

Summary

The clinician who is acutely aware of the abovementioned aspect of the clinical picture of facial fractures will very seldom misdiagnose any facial fracture other than the crack fracture which has no long-term functional importance.

After carefully doing this clinical examination based on the abovementioned principles, the fracture lines can be confirmed with radiographic examination and in the areas where diagnosis is difficult to make with conventional radiographs, it can be supported by computerized axial tomography.

Chapter 5.4: Laryngotracheal Trauma

J G Swart

Introduction

Laryngotracheal trauma is relatively uncommon, but it can have dire consequences. Complications are frequent and often serious or debilitating. Asphyxiation is a very real problem immediately post-injury. The presence of other major injuries may result in the diagnosis being missed.

Definition

This is a traumatic condition involving any portion of, or the entire laryngotracheal complex. It follows either internal or external trauma which may be penetrating of blunt, and results in disruption of the larynx and trachea.

Surgical Anatomy and Physiology

The anatomy of the larynx is depicted in fig. 5.4.1. Note that the larynx is situated at the junction of the digestive and respiratory passages at the level of the third tothe sixth cervical vertebrae. It consists of three unpaired cartilages of which the thyroid cartilage is the largest. The cricoid cartilage is thicker and stronger than the thyroid cartilage and is the only structure which forms a complete ring of cartilage in the laryngotracheal area. A cuffed tube situated within the cricoid will therefore easily give rise to pressure necrosis.

A third unpaired cartilage is the petal-shaped epiglottis which lies in the midline posterior and inferior to the tongue. It is attached to the posterior surface of the thyroid cartilage. The arytenoid, corniculate and cuneiform cartilages are all paired. Of these the arytenoid cartilages are the largest and most important because the vocal folds attach to their muscular processes. This cartilage can be dislocated from its articulation with the cricoid cartilage leading to a prolapsed and flaccid true vocal cord.

The functions of the larynx are to protect the lower air passages, to produce voice and to serve as a conduit and regulator for respiration. Closure of the laryngeal glottis allows fixation of the thoracic cage which is essential for straining efforts requiring raised intra-abdominal pressure. Protection rests on a three-tier sphincter system consisting of the true cords, false cords and ary-epiglottic folds.

The epiglottis deflects the food bolus into one of the piriform fossae, and the larynx is lifted upwards and is shielded by the base of the tongue during deglutition. Very sensitive gag and cough reflexes ensure rapid response by the pharynx, larynx and trachea to unwelcome foreign material.

It is clear that the laryngo-pharyngo-tracheal complex is intricate and highly efficient, and therefore that injury to this region can result in serious disruption of the normal physiology.

Etiology

The causes of injury to the laryngotracheal complex are mainly mechanical and of the blunt external type. Penetrating injuries or iatrogenic damage following intubation do not occur commonly. Thermal, caustic or ionizing injuries are well known, usually resulting from radiotherapy for malignancies in the region.

The larynx is protected by the mandible above, sternum inferiorly and strong musculature laterally. Thus with the neck in flexion the larynx is quite safe. Sudden hyperextension as happens in a motor-vehicle accident will allow the larynx and upper trachea to be crushed between the steering wheel or the dashboard and the cervical spine. Stretched cables, chains or wires wil likewise cause considerable damage, should the anterior neck strike against them during running or cycling.

A child's swing is also potentially hazardous to the larynx or trachea, should inadvertent collision take place.

Classification

Table 5.4.1 illustrates a classification of laryngotracheal injuries based on the etiology. Classification should also indicate whether the trauma is acute or chronic, and define the sites involved. Bryce classifies external laryngotracheal injuries as follows:

- cricotracheal separation
- supraglottic fracture
- lateral glottic fracture
- combined frontal comminuted fracture.

Table 5.4.1. Classification of Laryngo-Tracheal Injuries Based on Etiology

Acute or Chronic

1. Mechanical

    - Blunt trauma

        - External, i.e. motor vehicle accident
        - Internal, i.e. intubation, cuffed tube, exploration

    - Sharp trauma

        - External penetrating, i.e. knife, gunshot
        - Internal penetrating, i.e. intubation, foreign body

2. Thermal

- Inhalation of hot fumes

3. Caustic

- Ingestion of strong alkali or acid

4. Ionizing rays

- Radiotherapy.

A classification based on the anatomicalsite is illustrated in fig. 5.4.2.

Pathology

The pathological changes after trauma vary from mild bruising to severe fractures, and at a later stage extensive fibrosis. Thus any of the following may be found alone or in combination:

- bruising of skin
- submucosal haemorrhage
- haematoma
- mucosal laceration or ulceration
- oedema
- cartilage fracture
- joint disarticulation
- adhesions
- stenosis
- perichondritis
- pneumothorax.

Association injuries include:

- soft-tissue injury to head, neck, chest wall
- cervical spine fracture
- recurrent laryngeal nerve palsy
- vascular injuries, i.e. carotid, aorta, innominate artery with bleeding or false aneurysm
- oesophageal rupture or transection
- tracheo-oesophageal fistula.

Clinical Findings

The severity of injuries to the larynx, trachea and related structures should never be underestimated. Of all the symptoms those resulting in interference with respiration are the most important. The symptoms and signs are depicted in table 5.4.2.

Table 5.4.2. Symptoms and Signs of Laryngo-Tracheal Trauma

- Dyspnoea
- Hoarseness
- Aphonia
- Haemoptysis
- Pain
- Dysphagia/odinophagia
- Aspiration
- Endolaryngeal oedema
- Local tenderness
- Crepitus
- External swelling
- External bruising
- Submucosal haemorrhage
- Subcutaneous emphysema
- Overt bleeding
- Loss of laryngeal contour
- Prolapse of arytenoid cartilage
- Flaccidity or immobility of vocal cord

A subtle presentation may be misleading and lead to gross cicatrization due to late intervention.

Diagnosis and Special Investigations

A careful and methodical physical examination is the mainstay of the diagnosis. Indirect laryngoscopy should be attempted, but may be difficult to execute. Immobilization of the neck to protect the cervical spine in case of instability should precede any attempts at examination.

The use of direct fibre-optic laryngoscopy is becoming more popular and does not require extension of the neck to perform. It can be done transnasally if necessary which will be convenient i cases with concomitant mandibular fractures. Plain radiographs of the neck will give valuable information and are quick and easy to perform.

Computerized tomography is imperative, but should not be attempted in the acute phase. It is particularly helpful in deciding between conservative and surgical intervention. Contrast studies of the oesophagus will indicate the integrity of this vulnerable organ.

Laryngograms and laryngeal polytomography are not as informative as computerized tomography, and can be omitted if the later is available.

The diagnostic work-up is outlined in table 5.4.3.

Table 5.4.3. The Diagnostic Work-Up

1. General and local physical examination
2. Laryngoscopy
    - Indirect
    - Direct
        - Fibre-optic
        - Rigid laryngoscope
3. X-rays
    - Lateral soft-tissue X-rays neck
    - Cervical spine
    - Chest X-rays
    - Laryngogram
    - Laryngeal tomography
    - Laryngeal computerized tomography
    - Contrast swallow
    - Angiography.

Treatment

The primary concerns are airway patency and protection of the cervical spine. Major bleeding may occur after penetrating injuries and this will require attention as soon as possible after securing a safe airway.

The principle of management are as follows:

- Airway control by tracheotomy rather than intubation
- Cervical spine protection
- Control of bleeding
- Assessment of associated injuries
- Early exploration with emphasis on meticulous mucosal repair and accurate frame reconstruction
- Close postoperative monitoring and control of granulations by CO_2 laser.

The treatment has the following long-term goals, namely to:

- ensure an adequate laryngo-tracheal air passage
- prevent aspiration
- ensure optimal voice production.

Figure 5.4.3 illustrates a management algorithm for acute, blunt and penetrating laryngotracheal trauma after Gussack *et al.* The use of silicone laryngeal stents, or T-tubes will be necessary in comminuted or unstable fractures of the larynx or upper trachea.

A silicone keel can be used to prevent anterior commissure adhesions. Identification of recurrent laryngeal nerves in a traumatized neck is hazardous and is best avoided.

The management of established scarring is difficult and may be an indication for a permanent tracheotomy or total laryngectomy. Supraglottic laryngectomy with removal of the entire epiglottis, ary-epiglottic folds, false cords and the upper portion of the thyroid cartilage may be required in case of cicatrization limited to the supraglottis.

Likewise partial cricoidectomy including removal of the upper trachea is feasible for subglottic stenosis.

Up to 4 cm of trachea can be resected, should the problem be tracheal obliteration or collapse. This may require tracheal mobilization in the upper thorax or ptosis of the larynx by suprahyoid dissection. Clearly prevention of sequelae is much better than complicated repair procedures later.

Prognosis and Complications

Early exploration, i.e. within the first 24 hours, greatly reduces complications. As much as 40% of cases will develop sequelae if not treated early.

The complications following laryngo-tracheal trauma are listed in table 5.4.4.

Table 5.4.4. Complication of Laryngotracheal Trauma

1. Early complications
    - Shock
    - Airway obstruction
    - Stroke
    - Loss of voice or hoarseness
    - Dysphagia
    - Aspiration
    - Complications of related trauma
        - Quadriplegia
        - Pneumothorax
        - Tracheo-oesophageal fistula
    - Mediastinitis
    - Complications of tracheotomy

2. Late complications
    - Stenosis/stricture
    - Vocal cord paralysis
    - A-V fistula
    - Inability to swallow
    - Aspiration
    - Tracheotomy.

The severity of laryngotracheal injuries as part of trauma to the neck cannot be overemhasized.

Comment

Laryngotracheal Trauma

S L Sellars

This condition is much less common than anticipated. However, its occurrence can present a real life-threatening emergency and inexperience or unpreparedness in its management has lethal consequences. Such patients are often multiple injured, and in these the airway injury can easily be overlooked, especially if on account of head trauma and breathing difficulties the patient undergoes endotracheal intubation before adequate assessment has been possible. The time interval between the critical change from a sufficient airway to a seriously obstructed airway can be very short, a matter of minutes in all forms of laryngeal trauma.

The basic principles of surgical management apply with these injuries and include debridement, primary repair of soft-tissue lacerations, correction of skeletal deformities and arrest of function. Securing an airway and arrest of haemorrhage are the major first considerations. Diagnosis of the extent of the injury becomes the second consideration, and this can be achieved by clinical and surgical exploratory measures. However, awareness of the extent of injury by the use of modern sophisticated investigation, and instrumentation by fibreoptic endoscopy, computerized tomography and angiography are of great assistance in selecting the correct initial surgical option and approach.

Long-term neglect of laryngeal injuries is followed by the same outcome as with the other injuries, i.e. permanent deformity and dysfunction. Therefore accurate diagnosis, debridement, prompt primary surgery with attention to exact repair, and the correction of skeletal deformities reduce these unsatisfactory consequences of misdiagnosis and inactivity.

Respect of the importance of other injuries must be maintained and among thee cervical spine and head injuries are of greatest significance.

Chapter 5.5: Tracheotomy

J G Swart

Introduction

This procedure is very rewarding and often lifesaving if properly performed for the correct indications.

Definition

Tracheotomy is an opening through the anterior wall of the upper cervical trachea, usually in the vicinity of the second to fourth cartilaginous rings. This creates a tracheo-cutaneous fistula which acts as a bypass airway.

Surgical Anatomy and Physiology of the Trachea

The trachea is a tube of 10-11.5 cm in length in the adult, which extends from the level of C6 in the neck to T5 in the thorax. The inner diameter is 11-18 mm.

It consists of 16 to 20 C-shaped rings of cartilage connected by fibrous tissue and smooth muscle fibres. The rings are incomplete posteriorly where the gap is filled by smooth muscle and fibrous tissue, also called the trachealis muscle.

A fibrous membrane enclosed the cartilage in the inner and outer aspects, and also connects the tracheal rings to each other by short, elastic ligaments. These ligaments enable the trachea to be stretched longitudinally.

The musculature of the dorsal wall can alter the diameter of this conduit. The mucosa is firmly adherent and consists of ciliated columnar epithelium which is extremely sensitive to any irritants.

The inferior thyroid artery is the main source of blood supply, and venous drainage is via the thyroid plexus. Nerve supply is from the recurrent laryngeal nerve, and the sympathetic trunk. Lymphatic drainage is to the pretracheal and paratracheal nodes.

The anterior relations of the cervical trachea consist of the skin and the superficial and deep cervical fasciae, the jugular arch connecting the two anterior jugular veins and the sternohyoid and sternothyroid muscles which meet each other in the midline as a raphe.

The isthmus of the thyroid gland crosses the second to fourth tracheal rings, and thus lies just inferior to the cricoid cartilage. This cartilage forms the most prominent horizontal structure in the neck and as such it is a constant and valuable landmark. An anastomosing vessel joining the two superior thyroid arteries passes just above the isthmus.

Somewhat lower the innominate artery and brachiocephalic vein cross obliquely in front of the trachea at the root of the neck.

The oesophagus lies behind the trachea with the recurrent laryngeal nerves in the groove between these two tubular structures. The common carotid arteries, internal jugular veins, inferior thyroid arteries and the vagus nerves lie on each side of the trachea. It is prudent to remember that there are some significant differences in the anatomy of the trachea in young children, in comparison to adults. The isthmus of the thyroid lies somethat higher in infants and the innominate arytery can be found above the manubrium sterni. The thymus gland will be present in front of the trachea, low down in the neck. When the neck is hyper-extended in a child, almost all of the trachea lies cervically with the bifurcation very near the suprasternal notch. The lung apices reach higher up into the base of the neck than in adults and this may result in inadvertent injury, and a pneumothorax or surgical emphysema.

Type of Tracheotomy

Tracheotomies are classified as:

- emergency
- elective.

There are considerable differences in the indications, approach and techniques between these two.

Emergency tracheotomy is indicated when respiratory obstruction is too severe to allow time for proper and orderly preparation.

Elective tracheotomy is performed when there are definite indications for this procedure, but there is adequate time for formal and proper preparation. Access to the airway is also possible by creating a vent above the trachea through the cricohyoid membrane. This is essentially a laryngotomy, and is usually a short-term and urgent alternative to the emergency tracheotomy.

Emergency tracheotomy is hazardous and should be avoided, if at all possible, by anticipation, early planning and endotracheal intubation. Ventilation by means of a bronchoscope is also available in avoiding an emergency tracheotomy.

Indications for Tracheotomy

Essentially the indications for tracheotomy may be classified as:

- supratracheal and upper tracheal respiratory obstruction
- accessa to tracheobronchial tree for cleansing
- respiratory failure.

The causes of upper respiratory obstruction are listed in tables 5.5.1-5.5.6. Nasal and nasopharyngeal obstruction are of particular importance in infants, but may be significant in adults, i.e. very large tumours. Elective surgical procedures of the upper respiratory and other head and neck areas may require a tracheotomy prior to the operation.

Table 5.5.1. Etiology of Nasal and Nasopharyngeal Obstruction

Congenital

- Nasal agenesis
- Choanal atresia
- Encephalocele
- Meningocele
- Glioma
- Thornwald cyst.

Acquired

- Adenoid hypertrophy
- Trauma
- Foreign body
- Angiofibroma
- Nasopharyngeal malignancies, i.e. carcinoma, sarcoma.

Table 5.5.2. Etiology of Oropharyngeal and Hypopharyngeal Obstruction

Congenital

- Thyroglossal duct cyst
- Lingual thyroid
- Cystic hygroma
- Haemangioma
- Retention cysts.

Acquired

- Tonsillar hypertrophy
- Trauma - oedema, haematoma
- Foreign body
- Peritonsillar abscess
- Retropharyngeal abscess
- Parapharyngeal abscess
- Infectious mononucleosis
- Anaphylactic reaction
- Neoplasms.

Table 5.5.3. Etiology of Oral Airway Obstruction

Congenital

- Macroglossia
- Micrognathia
- Lymphangioma
- Haemangioma
- Dermoid cyst.

Acquired

- Ludwig's angina
- Ranula
- Trauma:
    - Fracture of mandible
    - Oedema of the uvula
- Foreign body
- Allergy:
    - Angio neurotic oedema
- Neoplasms:
    - Oral carcinoma, lymphoma.

Table 5.5.4. Etiology of Laryngeal Obstruction

Supraglottis

Congenital

- Laryngomalacia
- Cysts
- Webs.

Acquired

- Epiglottitis
- Allergic supraglottic oedema
- Trauma.

Glottis

Congenital

- Webs
- Atresia
- Stenosis.

Acquired

- Bilateral vocal cord paralysis
- Laryngitis, i.e. diphtheria
- Laryngotracheobronchitis
- Trauma, post-irradiation, thyroid fracture
- Foreign body
- Haemophilia
- Papillomatosis
- Neoplasms, carcinoma, rhabdomyosarcoma.

Subglottis

Congenital

- Subglottic stenosis
- Haemangioma.

Acquired

- Subglottic stenosis NB!
- Laryngotracheitis
- Trauma:
    - post-intubation
    - cricoid fracture
- Foreign body.

Table 5.5.5. Etiology of Upper Tracheal Obstruction

Congenital

- Stenosis
- Vascular ring
- Tracheoesophageal fistula.

Acquired

- Stenosis
- Tracheitis
- Trauma - cricotracheal separation
- Foreign body in trachea
- Foreign body in oesophagus.

Table 5.5.6. Conditions Causing Secretory Retention

- Bulbar paralysis
- Polyneuritis
- Tetanus
- Myasthenia gravis
- Coma:
    - head injuries
    - drug overdose
    - meningitis
- Cervical spine injuries
- Facial and mandibular fractures
- Pulmonary disease:
    - chronic bronchitis
    - emphysema.

Access to the tracheobronchial tree with a view to its cleaning and protection, is necessary if the following pertain:

- aspiration of saliva, food, gastric contents
- retention of bronchial secretions.

The use of a properly inflated, cuffed tracheotomy tube will prevent or minimize aspiration. The tracheostoma allows adequate suctioning and lavage. It is also a port of entry should bronchoscopy be necessary for the removal of inspissated pus or crusts.

Conditions that may lead to aspiration or stagnation of secretion are listed in table 5.5.6.

Tracheostomy may be required to maintain respiration, even if there is no upper airway obstruction or lower airway soiling. The aim is to allow positive pressure ventilation, and to reduce dead space area in those cases where long-term endotracheal intubation would otherwise be necessary. The possible causes of respiratory failure or inadequacy are indicated in table 5.5.7.

Table 5.5.7. Conditions Leading to Respiratory Insufficiency

- Neuro-muscular in-coordination
- Central disorders
- Flail chest.

Criteria for Tracheotomy

Emergency operations can be avoided in most instances. Cases with marginal obstruction can be supported with oxygen until a more elective procedure can be scheduled. Undue manipulation may displace a foreign body leading to acute obstruction. Positioning manoeuvers may help, and include the following:

For Unconscious Patients

- *Lateral position, head sideways and down, no pillow.* This head-down position allows the drainage of saliva and lets the tongue fall away from the posterior pharyngeal wall.

- *The head-tilt manoeuvre.* The patient is supine and the back of the neck is lifted while gently extending the neck and simultaneously pushing the head towards the shoulders. This is the usual position for mouth-to-mouth respiration. It cannot be used if a cervical spine injury is present or suspected.

- *Mandibular lift* as is often used during general anaesthesia when a mask is used.

For Conscious Patients

Sitting upright while extending and protruding the neck. Typically a child with epiglottitis will want to sit up and lean forward.

The use of steroids, intravenous hydration, humidification and nebulized racemic epinephrine may also be effective in delaying imminent obstruction. The signal for an emergency tracheotomy is when the following signs are present in the absence of facilities to intubate or perform an orderly tracheotomy:

- stridor
- cyanosis
- suprasternal, epigastric and intercostal recession
- pallor
- sweating
- tachypnea
- tachycardia or bradycardia
- PCO_2 exceeding 70 mm Hg.

Patients requiring IPPR should never have to undergo an emergency operation.

Technique for Emergency Trachetomy

- **Position:** The ideal position is with the patient supine and the neck hyperextended. This is achieved by placing a rolled towel under the shoulders. By doing this the trachea is elevated and landmarks such as the thyroid and cricoid cartilages are accentuated. If the patient is unable to lie down, the procedure is done in a semi-sitting position.

- **Anaesthesia:** General anaesthesia with intubation is convenient if it is at all feasible. Failing this, local infiltration with 0.5-1% lignocaine is required. In a dire emergency no anaesthesia is used.

- **Incision:** A midline and vertical incision from the lower border of the thyroid cartilage to near the suprasternal notch is performed. This incision includes the skin, subcutaneous tissue and platysma.

- The strap muscles are separated in the midline raphe.

- The prominence of the cricoid cartilage is identified and a small horizontal incision is made through the pre-tracheal fascia just inferior to the cartilage.

- The thyroid isthmus is mobilized by finger, hemostat or scissor dissection and displaced inferiorly.

- A vertical incision is made through the second and third tracheal ring in a child. In an adult a disc is excised. Cartilage should not be removed in a child. The trachea is held open with a dilator or hemostat and suctioned.

- **Insertion of a tube:** A suitable tube is inserted. It is often possible to introduce an endotracheal tube through the tracheotomy at this point to administer a general anaesthesia. Control of bleeding is essential.

- **Tube selection:** The choice of tracheotomy tube will be influenced by the special requirements that may pertain. A cuffed tube is essential in cases where aspiration is a problem or if the IPPR is called for. Cuff-pressure should be such that an adequate seal is just obtained and must not exceed 25 cm H_2O. The cuff must be completely symmetrical and have a wide contact area.

- **Closure:** The wound must be lightly sutured.

Technique for Elective Tracheotomy

- **Position:** Supine with neck hyperextended.

- **Anaesthesia:** General via endotracheal tube is preferable.

- **Incision:** The incision is horizontal 2 cm below the cricoid cartilage. It is 5 cm in length. The initial incision is carried through skin, subcutaneous tissue and platysma exposing the underlying strap muscles.

- The median raphe of the sternohyoid muscles is sectioned vertically downwards from the level of the cricoid cartilage for a distance of 2-2.5 cm.

- A small horizontal incision is made between the thyroid isthmus and the cricoid cartilage. The isthmus is freed and displaced inferiorly or, even better, it is transected after prior clamping and suturing.

If the operation is being done under local anaesthesia, 2 mL of 1% lignocaine is injected into the tracheal lumen. A vertical incision in the anterior midline through the second and third rings is made in children. A disc is removed in the case of adults. Cutting the trachea may be difficult once calcification has taken place. This requires care to avoid inadvertent injury to important structures. The wound is lightly sutured after the tracheotomy tube is in situ.

Care Following Tracheotomy

The tracheotomy tube must be cleaned regularly. Preferably a tube that has an inner tube should be used. The inner cannula should be removed and cleaned every two to three hours for the first 72 hours and then as required.

The maintenance of a high humidity of about 90% and an even room temperature of 23-25 °C is ideal. Cold humidification is much better than using warm vapour as in steam. Crusting can further be prevented by placing a moist gauze in front of the tracheotomy tube, or by introducing 1-2 mL of normal saline or Ringer's lactate into the trachea every two hours. The additional use of a mucolytic agent such as acetylcysteine (Mistabron) may be helpful.

Suctioning should be done with a disposable soft catheter with a Y connection or a venturi port. Suction should only take place when the catheter is being withdrawn and the diameter of the catheter must not exceed one-third of that of the tracheotomy cannula.

The tracheotomy tube should be left in situ for the first few days before changing if possible. This will ensure the formation of a safe tract for reintubation.

Cuff pressure should be carefully monitored, and never exceed 25 cm H_2O. An inflated cuff should be deflated for 5 minutes in every hour to avoid pressure necrosis. This is, however, not always possible if the patient is on IPPR.

The tracheotomy wound should be kept clean and an antibiotic ointment should be applied regularly. Stitches are to be removed on the fifth to seventh day. Care should be taken not to overlook the stitches, as they are usually hidden behind the flange of the tracheotomy tube. Purulent secretions should be cultured for microbial identification and antibiotic sensitivity. The tracheotomy tube should be removed at the earliest convenience.

Complications of Tracheotomy

Complications may occur peri-operatively, immediately postoperatively or much later.

The complications are listed in table 5.5.8.

Table 5.5.8. Complications of Tracheostomy

Intraoperative Complications

- Large-vessel haemorrhage
- Pneumothorax
- Atelectasis
- Recurrent laryngeal nerve trauma
- Subcutaneous surgical emphysema
- Mediastinal surgical emphysema
- Air embolism
- Apnea
- Hypotension
- Tracheo-oesophageal fistula
- Dislocation of tracheotomy tube.

Immediate Post-Operative Complications

- As above
- Profuse bronchial secretions
- Aspiration
- Aerophagia.

Late Complications

- Granuloma formation
- Tracheal stenosis
- Tracheal obstruction
- Disruption of the cannula due to material fatigue
- Infection of the tract, trachea or bronchi
- Tracheo-oesophageal fistula
- Haemorrhage
- Dysphagia
- Keloid formation
- Difficult decannulation
- Persistent tracheotomy tract after decannulation
- Psychological addiction.

Comment

Tracheotomy

S L Sellars

Conditions causing airway obstruction that can be overcome by tracheotomy are confined to the oropharynx, larynx and cervical trachea.

The emergency tracheotomy has become almost obsolete, because of readily available endotracheal intubation in most emergency care situations. Nonetheless this operation is still to be considered a life-safing procedure and every medical practitioner should have the capability to perform it when the urgent need arises and to be aware of the alternative measures that are used to avoid it. The un-planned urgently performed operation has a high morbidity and mortality rate.

The operation, both emergency and elective, is best limited to its most simple, and the midline vertical skin incision, midline soft tissue dissection and displacement of thyroid gland isthmus either up or down away from the tracheal entry site avoides difficulties and complications.

In children a midline incision of the second, third or fourth tracheal ring with outward distraction of the tracheal incision margins permits easy insertion of the tracheotomy tube. In adolescents and adults the excision of a small squate of anterior tracheal wall at its second, third or fourth tracheal ring level permits insertion of a tracheotomy tube of a size that fits comfortably and loosely within the tracheal lumen.

Postoperative tracheotomy tube care by informed and experienced staff is essential to avoid life-threatening complications.

Chapter 5.6: Ophthalmic Trauma

R C Stegman

History

A complete and careful history is absolutely vital in all cases of ophthalmic trauma regardless of how minor the injury may appear to naked eye examination, as usually occurs in casualty stations. The following points should be borne in mind:

- The exact time and date of occurrence.

- Did the injury occur during the patient's time of employment?

- Were safety goggles worn at the time of the injury, especially for cases of WCA claims?

- In cases where a patient is unable to give a history personally, attempts should be made to question witnesses regarding details of the injury.

- Description of the object causing the injury. This is most important in cases where there is a suspicion of a penetrating foreign body. If there is any doubt at all that a penetrating injury has resulted in an intra-ocular foreign body, detailed radiological examination are called for.

- As far as possible the composition of a suspected foreign body should be determined as this may aid in deciding the urgency of surgical intervention.

- The visual acuity of both eyes before the accident should be determined and any previous ophthalmic trauma or disease noted.

- It is most important to establish the course of events from the time of the accident until the time of the examination.

Examination

- Visual acuity must be determined before any treatment is considered and this must include both the impaired and unimpaired eye.

- The normal Snellen chart at a distance of 6 m will suffice for the determination of the visual acuity. Confrontation field determination may be carried out at the time of examination in cases where intracranial involvement may be present or in cases where retinal detachment has occurred.

- **Examination of lids and adnexae**

Lacerations should be carefully examined and the depth, extent and involvement of the canalicular apparatus determined, as well as any retained foreign bodies in the tissues. The presence of ptosis should be determined in lid lacerations which will point to levator muscle damage and early treatment for such conditions facilitates good prognosis.

- **Examination of the conjunctiva**

This should be carried out as carefully as possible with attention being paid to the presence of lacerations, haemorrhages or foreign bodies present.

- **Examination of the cornea**

Attention should be directed towards ascertaining whether lacerations or retained foreign bodies are present before referral to specialist treatment.

- Examination of the anterior chamber

Care should be taken to determine the presence of blood in the anterior chamber and whether it is clotted or fresh blood as well as the amount present. Gross determination of foreign body presence must be undertaken.

- Examination of the iris and pupil

Tears in the iris should be searched for, which will result in pupillary abnormality with regard to shape, size and reaction to light. The pupillary light reflex should be examined for both direct and consensual reactions.

- Examination of the lens

Attention should be paid to the presence of traumatic dislocation and/or cataract.

- Testing of ocular motility

This should be carried out only after determining whether a large laceration of the globe exists since such examinations may cause extrusion of intra-ocular contents.

Auxiliary Diagnostic Tests

These procedures are best carried out under specialist supervision but may be requested before referral under certain circumstances.

X-rays to determine the presence of orbital fractures, utilizing Caldwell, Waters, lateral, base and optic foramen views. It is important to note that 20% of foreign bodies penetrate the eye without causing noticeable pain. If the remotest suspicion of an intra-ocular foreign body exists, X-rays should be taken. CT scans are very useful in precisely locating foreign bodies not visible on X-ray or ultrasonography. Ultrasonography is helpful in eyes with opaque media and may help to determine the presence of dislocated lenses, vitreous haemorrhages and retinal detachments.

Treatment

In brief the repair of a penetrated eye is viewed as a small war between the surgeon and the eye itself. The surgeon should appreciate that for eons the eye has been repairing itself following injury from claw or thorn. The goals of the "natural" repair seem to be to:

- plug the leak

- defend against infection.

These are, of course, also surgeon's objectives, but in trying to do what is best for the eye, the surgeon and the eye will usually oppose each other. In a sense the eye becomes its own worst enemy. For example, the natural way to plug a corneal laceration is to prolapse the iris into the opening. This is effective; however, it leads to much greater astigmatism than

if the surgeon cleans off both wound edges, replaces the iris, and sutures the wound together under microscopic control.

Objectives of the First Stage of Repair

- Reduce:
    - infection (antibiotics)
    - inflammation
    - fibrin formation.

- Remove:
    - fibrin
    - vitreous
    - foreign body
    - necrotic tissue and blood
    - cataract.

- Reconstruct:
    - iris
    - cornea and sclera
    - ciliary body connection.

The penetrated eye should be treated prophylactically with antibiotic drops, ensuring as wide an antibacterial spectrum possible. Experience has shown that cephalosporin/gentamycin combination is most effective against bacterial infection and may be administered at hourly intervals into the conjunctival sac. Cases showing signs of infection may need subconjunctival injection of this antibiotic combination.

It goes without saying that all cases of penetrating injury should be referred to ophthalmological care as soon as possible in order to ensure the best possible prognosis.

The incidence of culture proven endophthalmitis following penetrating trauma to the eye has been reported to range from 2.4% to 7.4%. Because of the devastating nature of this complication (only 17.5% achieve visual acuity of 20/400 or better) antibiotic prophylaxis is absolutely mandatory. During the period preceding surgery, hourly topical administration of gentamycin sulphate and cephalosporin sodium drops is recommended. Just prior to surgery it is recommended that gentamycin sulphate (40 mg/mL) and cephazolin sodium (120 mg/mL) be administered sub-conjunctivally, 0.1 mL of each being given into a different quadrant of the eye.

Comment

Ophthalmic Trauma

A A Stulting

Eye injuries are a common occurrence in South Africa. It is therefore of the utmost importance to remember that useful vision in many patients with severe eye injuries can be

maintained only if such injuries are diagnosed at an early stage and correctly treated. Even the smallest injury may lead to permanent blindness.

The author stressed the importance of taking a complete and careful history. During the examination of the injured eye, it is useful to remember to conduct the examination in a careful manner and never to press hard on the eyeball. The author proposed that the examination of all the eye structures should be performed in a systematic manner from anterior to posterior. It should be emphasized, however, that both eyes should be examined in this manner and compared (for example to detect if one pupil is larger than the other). A good light and magnification should be used where necessary. Everting the eyelid should be part and parcel of any eye examination.

The use of fluorescein will enable the physician to detect a corneal abrasion or foreign body on the cornea easier. The management of a foreign body on the cornea can be summarized as follows:

- The removal of such a foreign body is much easier when a slit lamp is available. If not, it is better for the patient to lie down. The patient is reassured and correctly informed about the procedure.

- Local anaesthetic eye drops (Novesine, Amthocaine or Ophthetic) are used to anaesthetise the cornea (1-2 drops) only.

NB. Local anaesthetic eyedrops should **never** be used as treatment for any eye condition. It is used solely for the execution of a procedure, for example to measure the intraocular pressure or to remove a foreign body.

Local anaesthetics, if used indiscriminately, retard wound healing and may lead to corneal perforation.

- The patient should open both eyes and look directly at a specific target with the uninjured eye.

- While the eyelids of the eye with the foreign body are being held open with the thumb and forefinger of the nondominant hand, the dominant hand is being used for removing the foreing body.

- The flat surface of a no 20 or 21 sterile needle, on a syringe, is placed against the cornea and the foreing body is slightly elevated and removed.

- Local antibiotic ointment, such as Chloramphenicol, is used routinely for a few days to prevent secondary infection.

- If the eye is very red, one drop of a short-acting mydriatic drop could be used to relieve spasm of the ciliary muscle.

- The eye is patched for one or two days to immobilize the eyelid. This will ensure rapid healing of the corneal epithelium.

- The patient should be re-examined within 24 hours to rule out secondary bacterial infection. This will present as a definite greyish area of the surrounding cornea or when the symptoms of the patient indicate that the eye is becoming more painful and red. Immediate referral to an ophthalmologist is now indicated.

- The eye should be examined on a daily basis until no more staining with fluorescein is present.

- If a rust ring is observed which surrounds the foreign body, it is best to remove it after 24-48 hours. It will be much easier at this later stage.

- The following corneal foreign bodies should be referred to the ophthalmologist:

  - If the foreign body is in the visual axis or within 2 mm from the visual axis. Damage to Bowman's membrane or the corneal stroma may lead to a permanent scar in the central visual field of the patient.

  - If there is any difficulty in removing the corneal foreign body with ease.

Intraocular foreign bodies are true ophthalmic emergencies. Patients should be referred to the ophthalmologist as soon as this condition is suspected. The value of a good history cannot be underestimated.