PLASTIC SURGERY

VOLUME 2

THE FACE

Part 1

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Contents

Volume 2

The Face (Part 1)

27

Paul N. Manson

Facial Injuries

Few injuries are as challenging as those of the face. Physicians have a dual responsibility: repair of the esthetic defect (restore the preinjury appearance) and restoration of function. A unique aspect of facial injuries is that the restoration of appearance may be the chief indication for treatment. In other cases, injuries might require surgery solely to restore function.

Although there are few facial emergencies, the literature has underemphasized the advantages of prompt definitive reconstruction of facial injuries and the contribution of early treatment to superior esthetic and functional results. Economic, sociologic, and psychologic factors operating in a competitive society make it imperative that an aggressive, expedient, and well-planned program be outlined, executed, and maintained in order to return the patient to an active, productive life as soon as possible with minimal esthetic and functional disability. A facial injury victim often sustains multiple injuries to other organ systems (Fig. 27–1). Thus, early definitive care of the maxillofacial injury must be accomplished safely at the same time that other (perhaps life-threatening) conditions are being evaluated and treated. After the life threatening injuries have been managed, the patient's principal concerns frequently involve residual facial deformity.

The incidence of facial injuries is high because the face is exposed and because there is little protective covering. Two-thirds of patients admitted to the Maryland Institute for Emergency Medical Services Systems (MIEMSS), an area-wide trauma center receiving injury victims from the state of Maryland, have injuries of the head and face. The causes of facial injuries in the United States

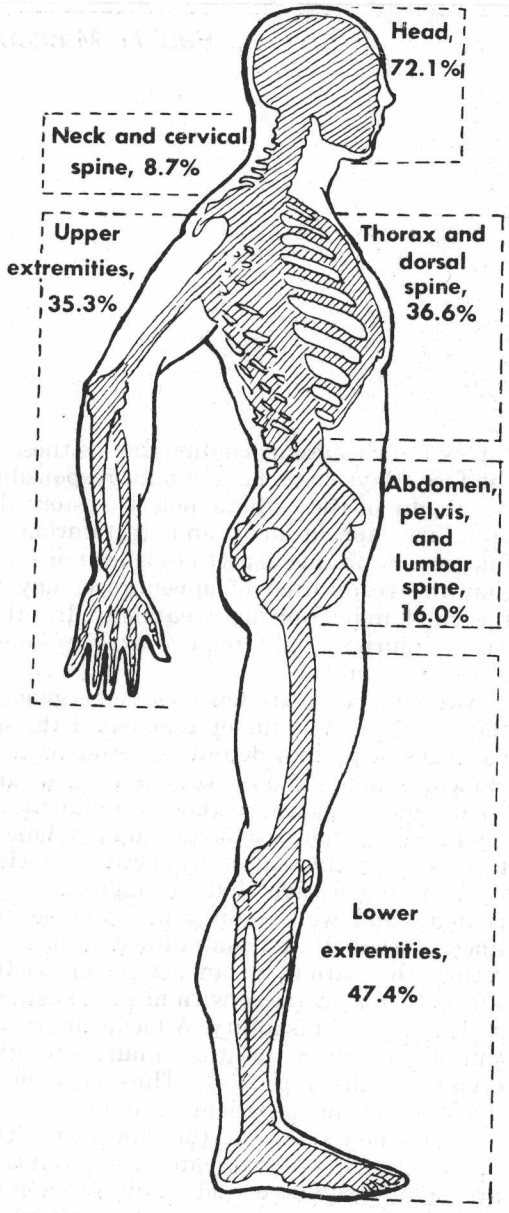


Figure 27–1. Motor vehicle accidents can result in multiple injuries. Two-thirds of the victims suffer injuries to the head and facial area. Other anatomic areas also are often involved. (From Patterns of Disease, a publication of Parke, Davis & Co.)

include motor vehicle accidents, assaults and altercations, animal bites, bicycle accidents, home and industrial accidents, and athletic injuries (Rowe and Killey, 1968; Dingman and Natvig, 1964; Kazanjian and Converse, 1974). The automobile is frequently responsible for the most devastating facial injuries.

In automobile accidents, injuries to the head, face, and cervical spine occur in over 75 per cent of all victims. There are over 50,000 traffic fatalities each year in the U.S. In addition to the number killed, 40 patients require hospitalization for every person who is fatally injured. Thus, over 4,000,000 people are injured in automobile accidents in the U.S. each year and many have a facial injury.

Statistics on the number of facial injuries due to various etiologic factors are not significant: there is a wide variation in different samples because of social, economic, and geographic factors. Whereas smaller emergency rooms may see a greater proportion of injuries due to altercations, falls, and home and athletic accidents, the major trauma centers treat a patient group in whom the etiologic factor is either a motor vehicle accident or a ballistic injury. Alcohol abuse is frequently a contributing factor. The concepts advanced in this chapter were developed at MIEMSS. The proportion of severe (as opposed to minor or moderate) injuries is high. The concepts, however, can be modified appropriately for general use in the treatment of lesser degrees of facial trauma.

There have been a number of advances in the construction of automobiles and the regulation of traffic that relate to protection from injury. The use of restraints, the introduction of padded dashboards, the multilaminated windshield, and improvements in the design of rear-view mirrors and steering wheels have reduced the severity of injuries. The introduction of the 55 mph speed limit resulted in a decreased incidence of major (Le Fort and panfacial) fractures. Other factors, such as check points, stiffer penalties for "drunk driving," and the increased economic burden of more expensive motor fuels have contributed to the decrease in facial injuries from motor vehicle accidents. At MIEMSS fewer facial ballistic injuries have been observed and, in those currently seen, less destructive weapons have been involved. Unfortunately, the popularity of the motorcycle is still a major factor in the etiology of major facial trauma.

INITIAL ASSESSMENT

The management of facial fractures has undergone significant changes within the last ten years.

1. The injuries are now diagnosed with a high degree of radiologic accuracy through

the routine use of computed tomographic (CT) scanning. The scans visualize both soft tissue and bone with unexcelled clarity. Relationships previously not discernible from plain films are clearly apparent.

2. The advent of regional trauma centers has provided improved diagnostic and supportive care for multiply injured patients. A system of invasive diagnosis and continuous monitoring of all organ systems allows patients with facial injuries to be operated on at an early time with safety.

3. The application of craniofacial techniques of exposure (Jones, Whitaker, and Murtagh, 1977; Wolfe, 1982) has improved the ability to restore the preinjury facial appearance.

4. The techniques (Gruss, 1985; Gruss and associates, 1985b; Manson and associates, 1985, 1986b, 1988) of extended open reduction of facial fractures and replacement of missing or unusable bone with grafts as a primary procedure, and the use of multiple interfragment wire or plate and screw fixation have improved the functional and esthetic results of facial fracture treatment.

Timing of Facial Injury Treatment

Timing is especially important in the optimal management of facial injuries. It is axiomatic that soft tissue and bone injuries in the facial area be managed as soon as is consistent with the patient's general condition (Mektubjian, 1982). Time and time again, it has been the author's impression that early, skillful management decreases the possibility of permanent facial disfigurement and limits serious functional disturbances. Although facial soft tissue and bone injuries are rarely acute surgical emergencies (as far as closure of the wounds or reduction of fractures is concerned), there are few patients whose injuries cannot be definitively managed within a short time after admission. Some exceptions to acute treatment include patients who have ongoing significant blood loss (such as pelvic fractures), whose intracranial pressure exceeds 25 torr, or whose pulmonary ventilation pressures are rapidly increasing.

Table 27–1. Glasgow Coma Scale (GCS)

I. Best Verbal Response	
None	1
Incomprehensible sound	2
Inappropriate words	3
Confused	4
Oriented	5
II. Eyes Open	
None	1
To pain	2
To speech	3
Spontaneously	4
III. Best Motor Response	
None	1
Abnormal extension	2

Evaluation of the Multiply Injured Patient

Patients with dramatic facial injuries are often rapidly (and inappropriately) assigned to a subspecialty service. It is important, therefore, that subspecialists consider first whether the patient has been adequately evaluated for the presence of multiple injuries (see Fig. 27–1) (Schultz, 1967; Gwyn and associates, 1971; Christian, 1976). This includes provision for control of the airway, control of external bleeding, insertion of intravenous lines, and insertion of a Foley catheter. The usual protocol for systems evaluation at MIEMSS includes examination for head injuries (Glasgow Coma Scale) (Table 27–1), upright chest and cervical spine radiographs, peritoneal lavage, and radiographs of the pelvis and appropriate extremities. Diagnostic failures occur in 12 per cent of motor vehicle accident victims and 23 per cent of motorcycle victims in some series (Chan, Ainscow, and Sikorski, 1980). Frequent errors include clinical misjudgments, failure to follow routine systems protocols, false interpretation of obtained examinations, and inadequate radiographs. In multiply injured or comatose patients, all organ systems must be evaluated by protocol and continuously monitored throughout the initial resuscitation and operative treatment.

While the protocol systems examinations are in progress, the face may be examined. Facial wounds may be cleansed and protected with a sterile dressing, or the margins of the wound may be tacked together with a few well-placed sutures. These measures limit further contamination. Bleeding facial lacerations are usually controlled with direct pressure. Blind probing or clamping with hemostats without direct visualization is contraindicated, to avoid injury to delicate structures such as branches of the facial nerve. It should be noted that branches of the facial

nerve are frequently located adjacent to arterial branches.

Head Injuries

Cerebral injury includes that due to mechanical damage to neurons and that resulting from secondary ischemia and edema (Gurdjian and Webster, 1958). Ischemia is aggravated by the presence of mass lesions, brain swelling, and increased intracranial pressure, which lead (in a progressive cycle) to intracranial hypertension, increased pressure, and progressive ischemia. Patients with head injuries should be evaluated by a clinical examination that classifies the severity of injury according to the Glasgow Coma Scale (Table 27–1). This scale relates the patient's level of consciousness, eye opening response, and ability to speak and move extremities to the prognosis. A CT scan identifies mass lesions, cerebral contusion, shift of the midline, extradural or intradural hematoma, skull fractures, and intracranial air. Patients with head injuries have a less favorable prognosis with increasing age, decreasing Glasgow Coma score, decreasing systemic blood pressure, and abnormal posturing. Additional factors correlating with prognosis include spontaneous and reflex eye movements and pupil reactivity to light. Accompanying spinal injuries, pulmonary injuries, and shock worsen the prognosis. Children have a more favorable prognosis than do adults.

The presence of coma should not contraindicate the treatment of a maxillofacial injury (Teasdale and Jennett, 1974; Becker and associates, 1977). Neurosurgical studies have shown that patients in coma that has lasted more than one week to one month have a hopeful prognosis in terms of returning to a functional role in society. In one study, one-fourth of patients in coma whose duration exceeded one week died, one-fourth were disabled, and one-half returned to useful work (McDonald, 1980). Thus, the presence of coma should never be used as an excuse to defer treatment of the facial injury. This practice relegates the esthetic and functional result that might be achieved by treatment to a substandard level. Head injury patients who survive especially need the benefit of the improved esthetic and functional results obtainable by early treatment. Safe anesthesia is achieved with intracranial pressure monitoring (Fig. 27–2).

Figure 27–2. Intracranial pressure is monitored continuously in patients with head injuries.

Despite the progress that has occurred in the treatment of major head injuries, one should not assume that minor head injuries do not have significant permanent sequelae. Even in patients in whom the duration of coma was less than 20 minutes, 80 per cent demonstrate some late symptoms such as headaches, memory difficulty, and problems with interpersonal relationships. Decreased attention span and concentration and judgment problems reflect some degree of organic brain damage. The patients, who frequently relate problems in work, school, and home, can benefit from intervention by a head injury rehabilitation center program or from proper guidance.

Cervical Spine Injuries

Injuries to the cervical spine often accompany those of the head and face. A significant cervical cord injury exists in one out of 300 accident victims, or one out of 14 occupants who are ejected from their cars (Babcock, 1976; Bucholz and associates, 1979; Huelke,

O'Day, and Mendelsohn, 1981). All patients (especially those who are unconscious) should be considered to have a spinal injury until it is proved otherwise. Patients who fail to move their extremities on command or sternal pressure, who have penetrating trauma to the neck, who complain of pain in the neck, or who describe disturbances in sensation or motor function must be assumed to have a cervical injury. The association of facial and cervical injuries has been documented in a large study in which 10 per cent of those with facial fractures had a cervical spine injury, and 18 per cent of those with cervical spine injuries had a maxillofacial injury (Gwyn and associates, 1971; Lewis and associates, 1985). The study also documented an association between fractures of the mandible and those of the upper cervical spine. Upper facial injuries were associated with cervical hyperextension injuries at all levels. Careful reviews of cervical injuries indicated that the most commonly missed lesions involved the base of the skull—C1/C2 and C6/C7. These areas are notoriously more difficult to visualize on radiographs and the failure to adequately demonstrate these areas allows the fractures to be missed. CT scans are more accurate than plain radiographs and may require less patient neck movement. Both cerebral and cervical spine injuries may occur secondary to whiplash without head contact or skull or facial fracture. The diagnostic principle to be emphasized is that if one is unable to visualize the whole cervical spine radiographically and confirm that the patient is asymptomatic, he must be treated as if he has a cervical fracture, by proper immobilization and limited movement of the head.

Anterior cervical cord compression produces a syndrome of motor paralysis and loss of pain and temperature sense below the level of the lesion, with preservation of dorsal column sensation (pain, touch, and vibration). *Posterior cord compression* affects dorsal column sensation. Acute central cord compression results in greater motor impairment of the upper limbs than of the lower, and is usually due to central hemorrhage and bruising. Many cervical cord injuries are incomplete and thus can be aggravated by improper diagnosis and treatment. There is evidence that the cycle of ischemia and vasoconstriction, mentioned in the cycle of cerebral injury progression, can also occur and aggravate the cervical cord lesion.

The treatment of maxillofacial injuries should be organized in several phases:

1. Emergency measures.
2. Early treatment.
3. Delayed treatment.

Emergency Treatment

There are three life-threatening facial emergencies:

1. Respiratory obstruction.
2. Hemorrhage.
3. Aspiration.

RESPIRATORY OBSTRUCTION

Establishment and control of the airway is a primary and important consideration in the clinical management of the acutely injured patient. Asphyxia is an ever-present threat in patients with injuries to the lower jaw, combined facial injuries, or laryngeal trauma. The mouth must be cleared of broken teeth, fractured dentures, foreign bodies, and clots that might be causing obstruction. Traction on the mandible or tongue pulls these structures away from the pharynx and allows removal or retrieval of objects displaced into that location (Fig. 27–3). In fractures of the mandible that are unstable, the jaw may be displaced posteriorly with the tongue falling against the posterior wall of the pharynx, obstructing respiration (Fig. 27–3). In these cases, it helps to place the patient in a prone or sitting position with the head down and forward if he can be turned or moved into that location without aggravating other injuries. Anterior traction on the tongue with a towel clip, suture, forceps, or fingers may avert asphyxia in patients who cannot be turned so that the tongue would be displaced forward by gravity.

Respiratory obstruction is most likely to occur with combined fractures of the maxilla, mandible, and nose, or in patients with massive hemorrhage or soft tissue swelling. Patients especially prone to difficulty are those with stupor or coma resulting from head injury. Consideration should be given to immediate intubation in these cases. Patients with laryngeal or tracheal injuries and significant facial burns benefit from intubation.

Respiratory obstruction may result in rapid demise. Only a short time exists between the onset of significant symptoms of respiratory

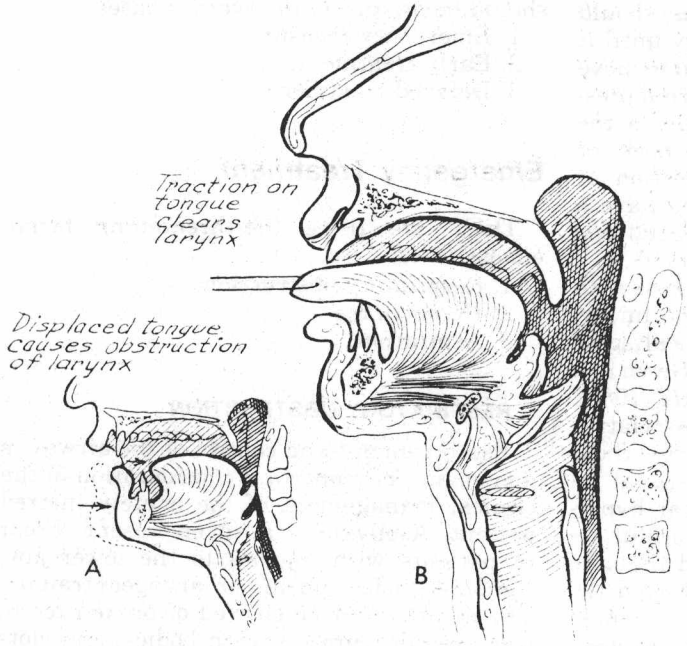


Figure 27–3. When the mandible is unsupported because of bilateral fractures (the body or subcondylar), respiratory obstruction can be produced by the mandible falling backward, allowing the tongue to lie against the posterior pharyngeal wall *(A)*. Holding the tongue or the anterior portion of the mandible forward with traction *(B)* clears the obstruction. If the patient can be turned to the prone position, the action of gravity displaces the tongue structures anteriorly.

obstruction (e.g., stridor, hoarseness, retraction, drooling, inability to swallow, restlessness, air hunger, cyanosis, tracheal tug, or retraction of supraclavicular, intercostal, or epigastreal areas) and total inability to breathe. An alert clinician anticipates an advancing respiratory obstruction and performs a prophylactic intubation before a crash or chaotic emergency intubation or tracheostomy becomes necessary. In extremely urgent cases, when oral or nasal intubation is not feasible, a cricothyroidotomy or coniotomy is the preferred treatment, incising transversely through the skin and cricothyroid ligament (conic ligament) between the thyroid and cricoid cartilages (Fig. 27–4). Cricothyroidotomy is the preferred emergency surgical treatment of airway obstruction. After the procedure, the coniotomy should be closed after conversion to tracheotomy; the latter avoids the damage that occurs when a coniotomy is used for long-standing intubation.

An emergency (low) tracheotomy may be performed in the following manner. The trachea is grasped between the fingers and the thumb. An incision is made through the skin in the midline between the thyroid cartilage and the sternal notch, and deepened into the trachea (vertically); the tracheal incision should be below the second tracheal ring. A cannula, catheter, or endotracheal tube or tracheostomy tube is inserted to keep the opening patent.

Elective Tracheotomy

Early tracheotomy is an advantage in patients with panfacial fractures and in those with head or chest injuries when they are

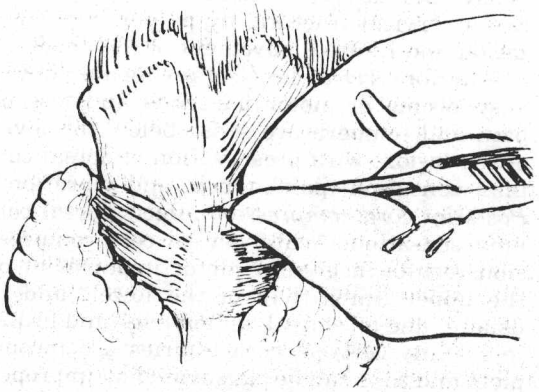


Figure 27–4. Coniotomy. The cricothyroid membrane, following a skin incision, is incised transversely. The direction of the cricothyroid membrane fibers favors opening of the wound to provide an airway, especially with the head extended. The knife should be grasped firmly to prevent the inadvertent entrance of the knife into the esophagus and development of an acute tracheoesophageal fistula.

unlikely to be awake or be able to manage the airway within a brief period (one week). The tracheotomy facilitates placing the patient in intermaxillary fixation and clears the oral or nasal area of obstructing tubes. Patients in whom the floor of the mouth, tongue, and hypopharynx are becoming increasingly edematous, and who require intermaxillary fixation, should also be considered for tracheotomy. Patients who have an adequate airway but are maintaining it only by sheer effort will be more comfortable (and the surgeon will be more secure) if an airway is established by intubation or tracheotomy. The tracheotomy provides a route by which a general anesthetic may be administered and one that does not interfere with the reduction of fractures in the facial area.

Indications for Tracheotomy. These include:

1. Unrelieved obstruction of the airway in the region of the larynx or the hypopharynx.
2. The probability that edema might result in serious decrease in size of the airway above the larynx.
3. Intracranial or chest injury with difficulty in maintaining adequate ventilation by normal reflex activity or endotracheal intubation.
4. Chest or high spinal cord injuries with loss of normal cough reflexes to clear the bronchial tree of fluids, blood, or secretions.
5. The possibility of prolonged postoperative airway problems.
6. The need for intermaxillary fixation in comatose patients or those with chest injuries.
7. Panfacial fractures.
8. Severe facial burns.
9. Concern about a difficult reintubation.

Techniques of Tracheotomy. The *coniotomy* procedure is useful in extreme emergencies when time is of the essence. Coniotomy is performed by making an incision (or passing a large-bore needle or two) through the cricothyroid membranes (conus elasticus). Although not recommended as a routine procedure, coniotomy may be employed as a lifesaving measure (see Fig. 27–4). The cricothyroid membrane lies superficially and the overlying tissues are relatively avascular except for the anterior jugular veins that are close to the operative incision.

When there is sufficient time to carry out an elective procedure, or when a semiurgent situation exists under satisfactory conditions, the low tracheotomy is the operation of choice. The *low tracheotomy* is made below the thyroid isthmus. The opening is generally in the second and third, or preferably in the third and fourth, tracheal rings.

The patient should be placed in the dorsal recumbent position (Fig. 27–5). The shoulders should be elevated by a sheet and the head extended if this position is permitted by the absence of cervical injury (Fig. 27–5). The neck is extended (if there are no cervical fractures) as much as feasible in order to bring the trachea into the best relationship for exposure and incision. Positioning is especially important when the neck is short or thick, or when the patient has heavy neck musculature.

Tracheotomy may be performed relatively easily, under a local anesthetic or with a general anesthetic when an endotracheal tube is in place. If a local anesthetic is to be used, the skin is infiltrated, as well as the deep structures down to the tracheal level. When the trachea is entered, the endotracheal tube is retracted to the superior level of the tracheal opening, and the tracheostomy tube can be immediately inserted and the inner trochar removed. The endotracheal tube is still in place in the event of emergency. The anesthetic connections can be applied to the tracheotomy cannula and the general anesthetic continued if indicated.

The *elective tracheotomy* operation (Fig. 27–6) is performed through a 4 cm transverse incision approximately 2 to 3 cm above the suprasternal notch (Fig. 27–6*A*). The incision is planned to be directly over the tracheal opening. The incision line should fall exactly within skin creases. Hypertrophy of the scar has been noticed in the exact area of an incision that has strayed from the relaxed lines of skin tension (Rubin, 1948). Location

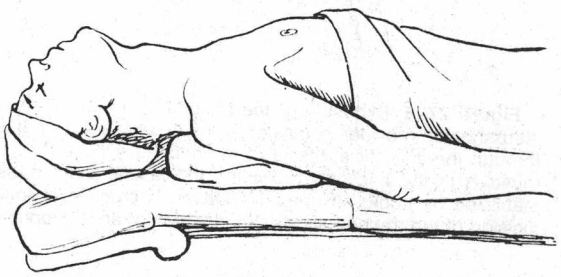


Figure 27–5. The tracheotomy is most easily performed with the patient in the dorsal recumbent position, the head and shoulders being placed on a roll to extend the neck.

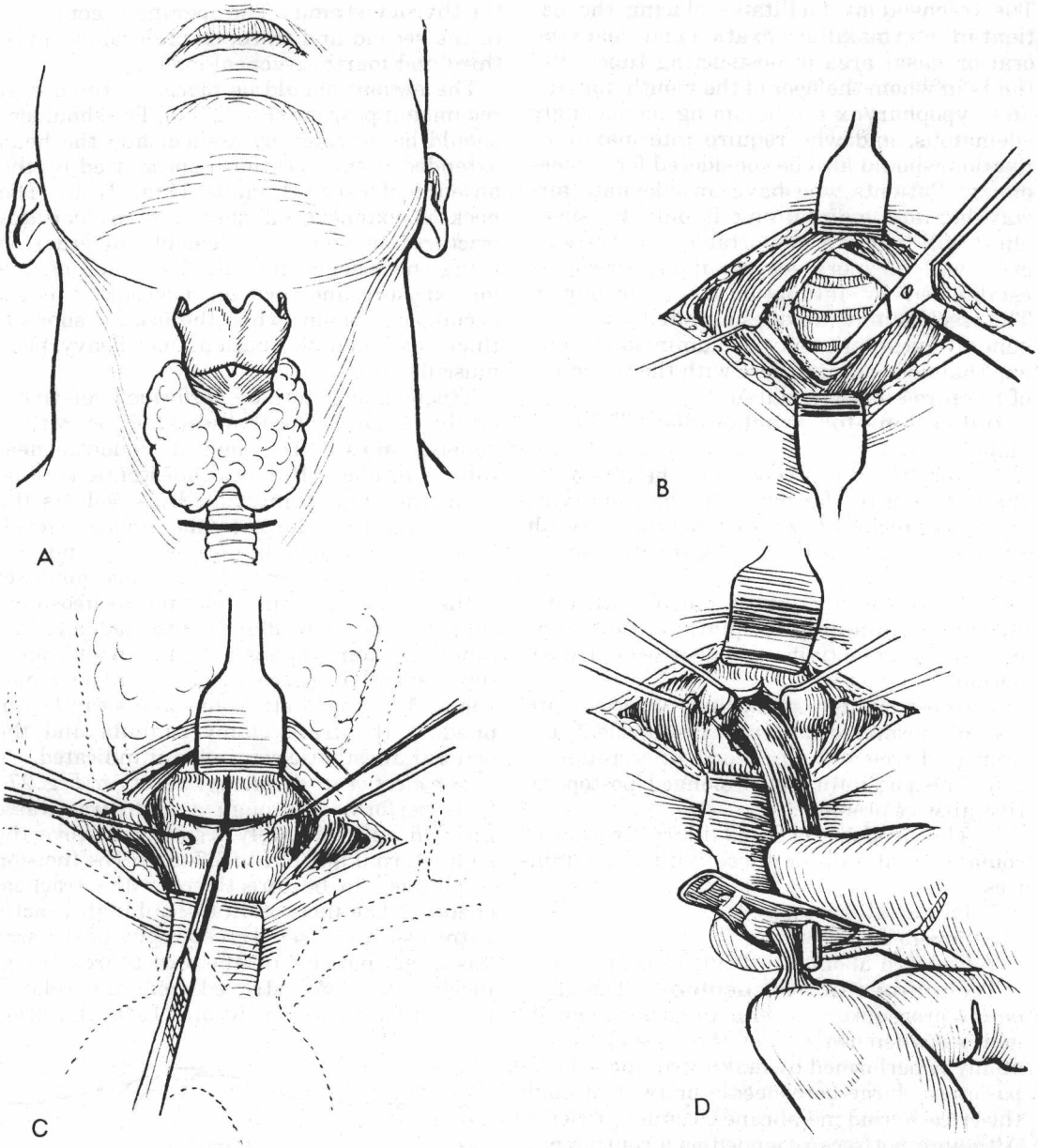
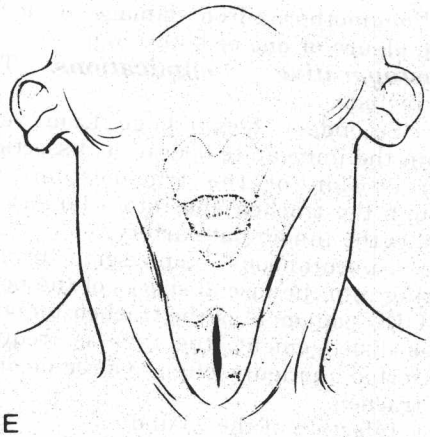


Figure 27–6. Exposure of the trachea for tracheotomy. *A*, A 5 cm incision approximately 2 fingerbreadths above the sternal notch provides excellent exposure and a scar that is in the relaxed lines of skin tension. The incision is deepened through the superficial fascia of the neck to expose the strap muscles. *B*, Dissection is performed separating the strap muscles in the midline by dividing the fascia. Blunt dissection with scissors exposes the trachea. *C*, The trachea is stabilized by hooks to prevent rotation. A cruciate or longitudinal incision is made. *D*, Retraction of the edges of the incision of the trachea allows the insertion of an appropriately sized and pretested cuffed tracheostomy tube.



E

Figure 27–6 *Continued E.* The tracheal opening is made through the third and fourth tracheal rings, and the incision is separated for the insertion of the tube.

of the skin incision directly over the tracheal opening avoids irritation of the skin, dislodgement of the tube, or tension on the skin.

The incision should be made through the skin and subcutaneous tissue to the level of the superficial fascia of the neck. Small bleeding vessels should be clamped and electrocoagulated. Larger veins, such as the anterior jugular, if transected, should be ligated with silk sutures. An incision is made vertically in the fascia between the strap muscles exactly in the midline of the neck (Fig. 27–6*B*). The isthmus of the thyroid should be located after separation of the strap muscles of the neck. If it cannot be conveniently retracted, the isthmus should be incised in a vertical direction after ligation with suture ligatures. The deep fascia overlying the trachea is apparent and the glistening cartilages are easily identified. Both the lower portion of the larynx and the cricoid cartilage below the larynx should be palpated. A sharp hook is then placed in each side of the trachea and the trachea is raised into a position for incision. The anesthesiologist, if present, should be warned before an incision is made in the trachea. The balloon on the cuff of an endotracheal tube should be deflated at this time. Rotation of the trachea before the incision is made should be avoided. The tracheal incision was formerly made in a cruciate manner (Fig. 27–6*C*) between the third and fourth tracheal rings. It is the author's preference to make this in a vertical manner (Fig. 27–6*E*), spreading the edges and inserting the endotracheal tube. No cartilage is removed.

Some surgeons prefer to place a suture in the sides of the tracheal incision and to bring these sutures out through the skin. The purpose of this precaution is to allow easy and direct retraction of the trachea if inadvertent decannulation occurs. These sutures can be trimmed in the early postoperative period.

After the tracheal incision has been made, a tracheostomy tube of adequate diameter and length, with the trochar in place, which has been previously tested for cuff integrity, is inserted into the trachea under direct vision (Fig. 27–6*D*). Tracheostomy tubes have been inadvertently placed in the fascial spaces of the neck and alongside or in front of the trachea. If the tracheostomy tube is too long, it may irritate the carina or ventilate only one lung by intubation of one of the main stem bronchi. If the tube is too firm or curved too acutely, it can erode the surface of the trachea and cause necrosis of the tracheal wall, resulting in a fistula. The esophagus or a major blood vessel may be involved. Soft, low pressure (cuff) tracheostomy tubes are preferred. Semiflexible silicone material seems to cause less irritation and the tubes are less likely to result in complications than are metal tubes. After the tracheostomy tube has been inserted, the edges of the skin incision are closed with several interrupted sutures and the tube may be secured to the cervical skin both by means of sutures and by a tie through the edges of the cuff on the tracheostomy tube. These two measures prevent dislodgement. Fabric tape is tied around the neck at the close of the procedure. The fixation must be sufficiently secure so that the tube cannot be dislodged from the trachea when the patient coughs or moves the neck. Blood and secretions are carefully aspirated from the trachea through the tube periodically.

After insertion of the tracheostomy tube, the wound should not be allowed to close too tightly, otherwise trapped air may pass along the fascial spaces of the face and neck, resulting in troublesome subcutaneous emphysema. The wound is sutured loosely, leaving it funnel shaped outwardly so that the air cannot be trapped in the subcutaneous tissue and fascial spaces.

Postoperative care of tracheostomy patients requires diligence. It is distressing to see patients who have retained secretions with tracheostomy tubes partially plugged by mucus and crust, and an infected tracheotomy

wound with macerated skin surrounding it, or patients unable to make their wants known or to communicate. All these conditions can be avoided by proper care.

The tracheostomy tube should be aspirated frequently with a sterile disposable catheter, using a glove. The nature of tracheal secretions should be monitored and appropriate cultures taken if indicated. The tracheotomy wound itself should be cleansed with hydrogen peroxide on cotton-tipped applicators, and a lubricating antibiotic ointment may be applied as necessary. The wound may be protected with a gauze dressing to keep it dry and clean until healing has occurred. Since a tracheotomized patient is unable to speak, a pad of paper and a pencil at the bedside are helpful in maintaining communication and providing a sense of security. Oxygen should be humidified and delivered through a cuff or tent over the tracheostomy stoma. The humidification is necessary to prevent excessive drying of the respiratory mucosa. Humidification moistens the gases passing into the bronchi and facilitates the removal of secretions that would otherwise become dry and inspissated. Particular attention should be paid to the task of intermittently deflating the balloon of the cuff of the tracheostomy tube. If the tube has more than one balloon, they should be inflated alternately. Such care prevents continuous mucosal pressure and the development of tracheal necrosis, erosion, and fistula.

Complications of Tracheotomy. As with all seemingly simple operative procedures, complications (Meade, 1961; Cambell, 1962) may follow, but these are mostly avoidable.

Operative Complications. These may include:

1. Severe hemorrhage from vessels of the neck, which may be difficult to control if exposure, lighting, and assistants are inadequate. If too low an exposure is attempted, the large vessels in the chest may be damaged. Hemorrhage from the innominate artery or thyroid arteries may occur from inappropriate dissection.

2. Inadvertent damage to the larynx or cricoid cartilage from inappropriately placed incisions.

3. Cutting through the back wall of the trachea, producing a tracheoesophageal fistula. Inadequate exposure is the cause of this complication, which most often occurs in children.

4. Pneumothorax from damage to the apex of the pleura or one or both lungs.

Postoperative Complications. These may include:

1. Secondary hemorrhage from vessels within the immediate operative dissection or from erosion of the tracheostomy tube through the trachea and into a large vessel, such as the innominate artery.

2. Subcutaneous emphysema from air leaking into the fascial spaces of the neck.

3. Dislodgement of the tracheostomy tube. After dislodgement, the tube is frequently reinserted hurriedly, often in a region outside the trachea.

4. Infection of the wound.

5. Erosion of the trachea with tracheomalacia and stenosis.

6. Tracheoesophageal fistula.

7. Aerophagia, which may result in distressing abdominal distention, gastrointestinal atony, paralytic ileus, and death.

8. Recurrent respiratory obstruction from blood, mucus, and purulent materials in the tube.

9. Ulcerative tracheobronchitis.

10. Retained tracheobronchial secretions with lung abscess.

Late Complications. These may include:

1. Unsightly scar formation.

2. Adherence of the scar to the trachea (routine following decannulation of a tracheostomy that has been present for some time).

3. Injury to the trachea or tracheal cartilage with tracheomalacia, tracheal atresia, or stenosis. Collapse of the trachea may occur from inadequate support, or the tracheal opening may be narrowed by scarring or granulation tissue. A bronchoscopy is necessary to establish this diagnosis.

4. Persistent tracheocutaneous fistula after long-standing tracheostomy.

CONTROL OF SEVERE HEMORRHAGE IN FACIAL WOUNDS

Lacerations and crush injuries of the facial region may result in significant hemorrhage that may be life threatening. Methods of control include local pressure, dressings, the application of fine clamps, ligation, or packing. Hemostatic materials and nasal tamponade to pack the nasal cavity and sinuses may be required (Fig. 27–7). Such packs may be gradually removed over a two to three day period or may be removed as soon as the

patient's general condition improves and the hemorrhage has abated. Approximation of wound edges with a few sutures or reduction of the fracture often diminishes hemorrhage. Careful final suturing can be accomplished later when adequate exposure and time permit a precise repair. Secondary bleeding is occasionally observed in facial injuries but usually responds to the methods described for acute bleeding. Since hemorrhage may be rapid and exsanguinating, evaluation of the effective circulating blood volume with replacement therapy is indicated if blood loss has been significant. It is not uncommon for patients to swallow several hundred milliliters of blood from severe nasal, oral, or pharyngeal bleeding. Alternatively, significant quantities of blood can be aspirated into the pulmonary tracheobronchial system. Patients seem to be swallowing frequently and epigastric distention may be noted; significant hemorrhage may be disguised and unrecognized because of the persistent swallowing of blood.

There are three techniques for control of closed hemorrhage from the nasopharyngeal region, which is usually due to lacerations of arteries or veins in fractured sinus cavities of the face. The internal maxillary artery is commonly the source of bleeding.

Anteroposterior Nasal Packing (Fig. 27–7). Efficient anteroposterior nasal packing can be achieved with two 30 to 50 ml balloon Foley catheters. One is inserted through each nostril, inflated in the pharynx, and pulled to occlude the posterior nasopharyngeal opening on each side. This maneuver provides a posterior obturator. Several packs of oxytetracycline (Terramycin) ointment–soaked Vaseline gauze are carefully packed into the recesses of each nasal cavity. Care must be taken to avoid entering the orbit or anterior cranial fossa in cases of severe comminuted fractures. The packing provides compression, which can be supplemented by tying or securing the ends of the Foley catheters over the columella. Necrosis of the columella must be avoided by intermittently relaxing this pressure (Fig. 27–7*C*). A period of several hours of pressure is usually sufficient to stop the bleeding. The columella pressure can then be relaxed; the packing is removed after 24 to 48 hours. If a cerebrospinal fluid leak is present, most surgeons prefer that the packing be removed as early as possible in order to limit the possibility of an infection ascending into the meningeal area.

External Compression Dressing. This dressing (with a Barton circumferential bandage) may reduce bleeding. In practice, this dressing is rarely necessary.

Selective Arterial Ligation. Selective arterial ligation or embolization (done under radiographic control) is reserved for those few patients who continue to hemorrhage despite the above measures, including reduction of the maxillary fracture and placement of the intermaxillary fixation. Frequently, the placement of the maxilla in intermaxillary fixation limits the hemorrhage. Selective arterial ligation may include the internal maxillary or ethmoidal arteries. In severe cases, the bilateral external carotid and superficial temporal arteries are ligated.

Massive uncontrolled hemorrhage secondary to closed maxillofacial trauma occasionally occurs, and one must be prepared to administer multiple transfusions and to monitor the state of the coagulation factors hourly, correcting any abnormalities. Coagulation factor abnormalities are frequently observed in patients with combined cerebral and maxillofacial injuries on an almost immediate basis.

ASPIRATION

Pulmonary aspiration of oral secretions, gastric contents, or blood frequently accompanies maxillofacial trauma, especially if there is a concomitant cerebral injury. Noisy respirations, low arterial oxygen content, and a decrease in compliance are rapidly seen. A chest radiograph usually shows an infiltrate. Appropriate cleansing by aspiration of the tracheobronchial tree is indicated. Tracheal lavage and steroids are advocated by some but probably are not more effective than aspiration and positive pressure ventilation.

Planning of Treatment

Because of the complexity of the face, a team approach to the management of severe facial injuries has become popular in many centers in which specialists in various disciplines compete for cases. Plastic surgeons, otolaryngologists, oral surgeons, ophthalmologists, neurosurgeons, general surgeons, and critical care specialists constitute the team. It is preferable, however, for a single individual with broad training to be primarily responsible for the facial injury and to coordinate consultations and operative activities of