Paparella: Volume III: Head and Neck

Section 2: Disorders of the Head and Neck

Part 4: The Pharynx

Chapter 22: Tonsillectomy and Adenoidectomy

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Historic Background

Evidence indicates that some form of tonsillar surgery was attempted as early as the year 3000 B.C. (Ritter, 1967). Celsus writing in *De Medicina* in 10 A.D. mentions crude tonsillar procedures that were used at the time. It apparently was common practice to use some form of tonsillar morcellation thereafter as treatment for diseased tonsils. According to MacBeth's 1950 review, the first tonsillectomy was described by Caque of Rheims in 1757. However, tonsillotomy remained the customary procedure, and only that portion of the tonsil protruding beyond the tonsillar pillars was removed. The first tonsillar guillotine or tonsillotome was incidentally described in 1827 by an American physician, P. S. Physick, who used the instrument primarily for removal of elongated uvulae. Subsequent primary enucleation, or tonsillectomy as it is now known, was then performed with satisfactory results.

Early in the 20th century, surgical removal of the tonsils became a popular method for treating various respiratory or systemic diseases. This popularity reached a peak in the early 1930s, after which a decline took place (MacBeth, 1950). In actuality, this change resulted from the availability of antibiotics and the current critical clinical and social assessments of the true need for tonsillar or adenoid surgery. Although enthusiasm for tonsillar surgery has varied during the past several decades, both tonsillectomy and adenoidectomy remain among the most prevalent surgical procedures performed.

During the recent past, estimates have indicated that between 1 and 2 million tonsillar or adenoid procedures, or both, were done yearly in the USA alone, particularly during the 1960s and 1970s (Faigel, 1966; Gibb, 1969; Wilke, 1974; Shaikh et al., 1976). This number has since decreased so that approximately 350,000 pediatric procedures were reported in the USA for 1983 (Bluestone, 1985), and the annual number may now be reaching a plateau.

Indications for Tonsillectomy and Adenoidectomy

There have been few changes in the indications for tonsillar or adenoid surgery during the past decade. Although this surgery is not technically difficult to perform, it is easily done badly owing to inappropriate patient selection and inadequate surgical technique. There can be intrinsic difficulties associated with the operation, and serious complications may ensue. In fact, past mortality associated with surgery has ranged from 0.5 to 1/10,000 to 1/100,000, primarily

because of hemorrhage or respiratory compromise. It is therefore imperative for the surgeon to use careful judgement and utmost care in the selection of patients for surgery, in doing the actual surgical procedure, and then in following patients during the period of postoperative convalescence.

In most patients, the decision to perform tonsillar or adenoid surgery is still based on a careful history and physical examination. As has been noted by numerous authors in the past, an unreliable history can indeed result in unsatisfactory surgical results. Unfortunately, symptoms have been exaggerated either by the patient or by the family to mislead the unwary physician into doing surgery best not done.

Actual indications for surgery are basically related to attempting to restore normal function of the nose or throat. Thus, nasal obstruction caused by enlarged adenoids is an indication for adenoidectomy. Conductive deafness associated with refractory serous or secretory otitis media resulting from adenoid obstruction of the eustachian tube orifices is likewise an indication for adenoid surgery. Similarly, tonsillar surgery is indicated in patients with *proven* recurrent tonsillar infections or obstruction of the oropharynx. Table 1 depicts various indications and contraindications for tonsillar or adenoid surgery. It is not intended to be all-inclusive, and it is only to be used to assist the clinician in forming justifiable rationale for accepting or rejecting a potential patient.

Table 1. Indication and Contraindications for Adenotonsillectomy

Definite Indications for Tonsillectomy

1. Recurrent episodes of acute or chronic tonsillitis
2. Tonsillitis resulting in febrile convulsions
3. Peritonsillar abscess
4. Diphtheria carrier
5. Tonsillar hypertrophy obstructing respiration or deglutition
6. Sleep apnea
7. Biopsy necessary to define possible malignancy

Definite Indications for Adenoidectomy

1. Recurrent middle ear disease secondary to eustachian tube obstruction
2. Adenoid hypertrophy obstructing respiration
3. Sinusitis or its complications secondary to adenoid obstruction of the sinus ostia

Equivocal or Relative Indications for Adenotonsillectomy

1. Recurrent sore throats
2. Recurrent otalgia
3. Recurrent or chronic rhinitis

4. Recurrent upper respiratory infections
5. Snoring or mouth breathing
6. Failure to thrive
7. Large tonsils or tonsillar debris
8. Cervical lymphadenopathy
9. Tuberculous adenitis
10. Systemic disease secondary to beta-hemolytic streptococcal infections (rheumatic fever, rheumatic heart disease, nephritis)

Relative Contraindications to Adenotonsillectomy

1. Cleft palate, frank or submucous
2. Presence of tonsils or adenoids

3. Acute infections (including tonsillitis, respiratory infections, and so on)
4. Poliomyelitis epidemic, or nonimmunized patient in endemic areas
5. Age less than 3 years

Definite Contraindications to Adenotonsillectomy

1. Blood dyscrasias - leukemias, purpuras, aplastic anemias, hemophilia
2. Uncontrolled systemic diseases - diabetes, heart disease, seizure disorders, and so on

Tonsillectomy is indicated in those patients who experience recurrent episodes of incapacitating tonsillitis. Although we have previously indicated that these attacks should number three or more yearly, we would stress that surgery is justifiable for *any* patient with persistent or chronic recurrent infection that results in loss of significant amounts of school or work. Such patients often also require considerable expenditures of time and money in providing medical care. Surgery is also very much justified in patients who have had tonsillitis complicated by febrile convulsions. Tonsillectomy can also be justified in patients who have had peritonsillar abscesses, since recurrent tonsillar infections or abscesses frequently occur. Tonsillar surgery is classically indicated in patients who are found to be diphtheria carriers, since the tonsil functions as a nidus for seeding of infection. Obstruction of the pharynx by enlarged tonsils or adenoids is yet another indication for adenotonsillectomy, particularly for treating proven sleep apnea syndrome, obstructive pulmonary disease, and cor pulmonale. Finally, unilateral tonsillectomy for obtaining tissue for histologic study can always be supported when malignancy is suspected.

Obstruction of the eustachian tube orifices by adenoid tissues is an important indication for adenoidectomy. Thus, resultant middle ear effusions (serous, secretory, or suppurative) may be prevented by the elimination of tubal obstruction. Airway obstruction by enlarged adenoids has already been mentioned as a reason for adenoidectomy. Another indication is sinusitis secondary to adenoid obstruction of the posterior nasal choanae. An uncommon consequence of this may be extension of infection through the medial orbital wall to produce periorbital cellulitis or subperiosteal abscess.

There are differing clinical opinions about the justification for the relative indications for adenotonsillectomy, as indicated in Table 1. Subjective complaints, such as sore throats, recurrent earaches, and the like, require judicious evaluations before any decisions are reached as to the true usefulness of any surgery in effecting possible cures. On occasion, cervical adenopathy or abscess secondary to tonsillar infection has been a reason for doing tonsillar surgery, although cervical nodes alone are still disputed as a cause for such surgery. In the past, tuberculosis adenitis has been attributed to the tonsillar infections to justify tonsillectomy, but it is an uncommon problem in North America at the present time. There has been much debate on the role of the tonsils and adenoids in allergy or infections caused by beta-hemolytic streptococci. It is enough to say that most critical evaluations have found only equivocal postoperative results in such patients improving following adenotonsillectomy. One notable exception is the study by Veltri and associates (1972), in which a lessened incidence of pathogenic oral bacterial flora was found after surgery. Lastly, there have been a number of dental reports indicating that large tonsils or adenoids can adversely affect occlusion. This is typified by McNamara's 1981 publication. In actuality, the true incidence of this occurrence is still unclear, and previous studies may represent individual bias or anecdotal experience. Certain procedures in laboratory studies, such as those of Harvold and co-workers (1981) in a primate model, abnormally obstruct the oral cavity and may not be applicable clinically.

Among relative contraindications to adenotonsillectomy, overt or submucosal cleft palate is an important reason for deferring surgery, since both the tonsils and the adenoids provide tissue bulk in the pharynx and are an autogenous means for effecting "normal" voice or velopharyngeal closure. In these patients, medical management is generally preferred for treating inflammation or infection, whereas conservative lateral adenoidectomy may be required on occasion or tympanostomy tubes alone may be used to treat persistent middle ear effusions. A provocative study by Pickrell and associates (1976) indicated that tonsillar or adenoid surgery may *not* be a significant cause of velopharyngeal incompetence in the patient with cleft palate. However, critical judgment should still be employed in these patients *before* initiating any pharyngeal surgery.

Acute infection at the time of planned tonsillar surgery (including tonsillitis, upper respiratory infections, and the like) are definite contraindications to surgery. Anaesthesia becomes hazardous, and the patient is at definite risk of cardiopulmonary compromise. Moreover, local tissues become hyperemic in the presence of infection and make control of operative bleeding difficult. An exception is the peritonsillar abscess, since tonsillectomy may be necessary to drain the abscess bed effectively. Although operative morbidity under these circumstances can be negligible, the surgeon must still use discretion in selecting patients for such surgery.

Prior to the common use of the Sabin and Salk poliomyelitis vaccines, the summer months were considered the "polio season", during which time tonsillar and adenoid surgery was contraindicated. It was believed that droplets of the poliovirus could proliferate within the tonsils and pass into regional nerve sheaths following surgical disruption of protective epithelial linings. Infection could then pass along the nerves to the brain stem to produce a lethal bulbar polio. Enders (1949) was able to isolate poliovirus form the tonsil but also demonstrated that viral

proliferation failed to occur within its substance. Other work has corroborated these findings on a clinical basis, although the association of epidemic polio to tonsillar surgery has only a historical interest at the present time.

Patients younger than 3 years of age are usually not considered to be proper candidates for adenotonsillectomy, since blood loss in the very small or young patient may significantly alter circulating blood volume. When clinically indicated in the very young patient, however, selective adenoidectomy or tonsillectomy can be justified.

Absolute contraindications to adenotonsillectomy include uncontrolled systemic diseases and blood dyscrasias. In certain instances, control of these problems may be achieved so that surgery can be safely performed. Great caution is still required in selecting these patients for surgery, since significant morbidity can otherwise ensue.

There is *no* justification for performing tonsillectomy or adenoidectomy only because the tonsils or adenoids are "present". In fact, it is mismanagement to remove either tissue without definite clinical indications. Unfortunately, it must *still* be repeatedly stressed that either procedure should not be taken lightly by any surgeon, since complications can be significant and may result in a severely compromised patient.

Surgery of the Tonsils and Adenoids

The general aim of adenotonsillectomy is the removal of tissue with minimum blood loss and minimal trauma to adjacent tissues. Adenoidectomy is usually performed with either curette or an adenotome. A guillotine type of tonsillotome is useful when performing tonsillectomy in children, although various dissection techniques may be more common at the present time. On occasion, cryosurgical tonsillectomies have been performed successfully in selected patients, whereas electrocoagulation of tonsils has been employed in other patients. In addition, the CO_2 laser has also been used for tonsillar or adenoid surgery. However, regardless of the method used, the skill or experience of the surgeon will determine the actual technical success of the procedure.

Under most circumstances, adenoidectomy is usually performed at the same time as tonsillectomy, although the adenoid tissues have usually atrophied in adults so that only tonsillectomy is required (if clinically indicated). As previously noted, certain patients will require only adenoidectomy or tonsillectomy. This is particularly so in very young patients in whom even minimal blood loss results in significant whole body fluid depletions (Ogden, 1961). Separate procedures should also be done if excessive bleeding is encountered during surgery or if unexpected problems develop that require the rapid termination of surgery (Ritter, 1967).

Preparations for Surgery

Adenotonsillectomy is usually considered to be minor surgery, but it cannot be overemphasized that any procedure requiring general (or even local) anesthesia is not necessarily minor (Ogden, 1961). Special preparations prior to surgery are required so that the patient and

the family will be well prepared to cope with the forthcoming procedures and to better understand the anticipated surgical results or their possible complications. In those patients with special pre-existing medical problems (such as seizure disorders, heart disease, and the like), preparation ensures that clinical stability will most likely ensue. Thus, the prophylactic use of antibiotics preoperatively may be necessary to prevent transitory bacteremia from occurring during of after surgery to possibly seed infection in distant sites. Preparation should also include screening patients for allergies in order to minimize the chance occurrence of an allergic reaction from the medications used (Hill, 1960). A careful history is still the best means for determining possible bleeding disorders and should include notation of any bleeding tendencies within the patient's family as well as define the patient's response to minor cuts and tendency for bruising (Hutchinson et al, 1987).

Although ambulatory surgery has become quite popular to minimize hospital costs, sufficient time should still be allowed for patients to become better acquainted with hospital routines. Reassurance is especially important for children, since the poorly prepared child can experience a number of emotional problems for some time following surgery, which can include nightmares, enuresis, and fear of strangers.

Following hospital admission, all patients must have appropriate histories and physical examinations entered on the permanent hospital record. Hemograms (leukocyte counts and hematocrits) and urinalysis are performed prior to surgery. Platelet counts and prothrombin and partial thromboplastin times are still excellent screening tests for most bleeding and clotting diatheses, in addition to personal and family histories. Special clotting studies should be obtained as needed. Great significance was formerly attached to bleeding and clotting times, but they tend to be abnormal only in major clotting disorders, and a normal value may possibly mislead the unwary clinician. Other laboratory studies (blood urea nitrogen, blood glucose, electrolyte determinations, and the like), as well as chest x-ray films, can be obtained as needed. Wilkinson and co-workers (1981) found electrocardiographic abnormalities demonstrating right-sided heart strain in some children with enlarged tonsils and adenoids and unrecognized hypertension, even though the *only* clinical symptom was snoring!

Preoperatively, all patients should fast for at least 12 hours to prevent regurgitation of stomach contents (and aspiration) at the time of surgery. However, inordinate fasting without parenteral fluid replacement can produce significant dehydration, which can then be further worsened by blood loss during surgery. Thus, parenteral fluids are recommended for some patients preoperatively and *all* patients perioperatively and immediately following surgery.

Mild laxatives can be given to patients the night before surgery, and baths or showers may be taken as needed. A sedative at bedtime the night before surgery may also help to lessen possible anxiety and allow the patient to have a good night's sleep.

During the morning of surgery, preoperative medications are given as needed and can include a sedative (such as secobarbital), a narcotic (meperidine, morphine, and so on), or tranquilizers (promethazine, hydroxyzine, and so on). Drying agents, such as atropine or

scopolamine, are also useful. Narcoleptic agents, including fentanyl citrate or droperidol, may be given in place of a narcotic and tranquilizer. There are many valid methods for using preoperative medications.

Anesthesia

General anesthesia is the anesthetic method of choice for children or uncooperative patients undergoing tonsillar or adenoid surgery, whereas local anesthesia supplemented by incremental doses of intravenous narcotics or tranquilizers is useful in cooperative adults. In the past, there has been considerable discussion in the literature concerning the merits of endotracheal versus insufflation anesthesia. Endotracheal anesthesia provides better control of the patient's airway and allows the anesthetist to assist spontaneous respirations when required. The endotracheal tube also prevents aspiration of blood or debris during the surgical procedure and allows ready suctioning of secretions from the pharynx as needed. A wide choice of anesthetics is available, and patients can also be managed in lighter planes of anesthesia to allow for more rapid recovery. The drop or insufflation anesthetics - typified by ether - require deeper levels of anesthesia but fail to provide immediate control over the patient's airway. Since the insufflation anesthetics also carry the great risk associated with volatility, they are uncommonly used in the USA at the present time. However, either method can be sufficient for safe adenotonsillectomy when properly administered.

Majer and Bischko (1973) have reported some success in the past with the use of acupuncture as anesthesia for tonsillectomy. Unfortunately, a topical anesthetic spray was used in some of the patients treated in this way to detract from the validity of the technique. Although further support for this method has been provided by Leicher (1975), acupuncture as anesthesia for pharyngeal surgery should still be regarded with great reservation.

Positioning of the Patient

When general anesthesia is employed for surgery, the patient is placed supine on the operating table. A Blair type of head drape can then be used, particularly to protect the patient's eyes, and sterile drapes are placed over the patient's chest. The actual surgery is not sterile, but it should be performed with sterile instruments and ancillary equipment to prevent needless exogenous contamination or infection.

Adequate illumination for surgery can be achieved with reflected light or a Lempert head lamp. Most surgeons tend to use the head lamp to facilitate illumination of the operative field.

The surgeon can stand at the patient's head or to the side directly facing the patient's oral cavity. The mouth can be opened with a Jenning's gag, and an assistant then employs a sterile metal depressor to control the position of the tongue. When the patient is placed in the Rose position, the head is extended so that the surgeon can either stand or sit at the head of the patient. In this latter position, the Davis-Crowe mouth gag or its modifications can be used, so that the gag blade is placed over the middle of the tongue. A vertical groove in the middle of the gag

allows temporary fixation of the endotracheal tube in the position desired by the surgeon. The patient's head is partially extended, and the end of the gag is hooked over a sterile supporting (Mayo) stand, which is positioned over the patient's chest. If the patient's head is left in a dependent position, the surgeon can more readily remove pharyngeal blood or secretions and can directly visualize the pharynx at all times. If the surgeon chooses to stand at the patient's side, better visualization of the nasopharynx may be had. However, an assistant is required to retract the tongue out of the field, and it can also be more difficult to adequately control any secretions or debris.

Technique of Adenoidectomy

Prior to beginning surgery after the patient is properly anesthetized and positioned, careful palpation of the teeth and pharynx should be performed by the surgeon. This defines the integrity of the teeth, protects against inadvertent dislodgement or loss of loose teeth, and allows the surgeon to note any subtle anatomic anomaly. Aneurysmal dilatation of major vessels rarely occurs but may result in disaster if one of these vessels is unwittingly incised. Cleft of the uvula may be associated with a submucosal or over cleft of the palate that requires surgical conservativism (ie lateral adenoidectomy alone) in order to prevent velopharyngeal incompetence.

The soft palate can be retracted either with a metal palatal retractor or by insertion of small French rubber catheters through the nostrils. These catheters are brought through the mouth, and the ends are cinched for retraction. The nasopharynx can then be inspected directly or by mirror.

A LaForce adenotome can be used in performing the adenoid dissection. It is introduced into the nasopharynx so that its basket engages the central adenoid mass. Adenoidectomy is performed by pressing the instrument firmly against the base of the sphenoid bone or posterior nasopharyngeal wall and rotating it downward with closure of the blade. Curettes are then passed laterally along the walls of the nasopharynx to remove the lateral adenoid tissues. Bleeding is controlled by aspiration or pressure changes, using gauze sponges.

Adenoidectomy can also be performed by curettage alone, but this requires care. Overextension of the neck may push the adenoid mass forward and bring the deep structures of the posterior pharyngeal wall within reach. Thus, careless curettage may inadvertently excise muscle, cartilage, or bone and leave traumatized adenoids in place.

Adequate adenoidectomy requires the removal of both central and lateral adenoid tissues, particularly those around the eustachian tube orifices or in Rosenmüller's fossae. Removal can be confirmed by direct inspection or by palpation of the nasopharynx. Persistent tissues can be removed with biting forceps or by blunt scraping of the nasopharynx with sterile gauze wrapped around the surgeon's gloved finger.

Pressure hemostasis usually suffices to control bleeding, since vessels normally retract within underlying soft tissues. On occasion, insertion of a nasopharyngeal pack may be required

for control of persistent bleeding. The pack strings must then be brought across the nose and tied securely around an extranasal gauze bolus. This minimizes change slippage of the pack (which may cause possible airway obstruction). The pack is usually left in place for 12 to 24 hours.

Technique of Tonsillectomy

Dissection and Snare Method

Preparation for tonsillectomy is similar to that described for adenoidectomy. The surgeon can position himself or herself at the patient's side or head, as previously noted. The Jenning's or Davis gag is again employed for exposure.

One tonsil is grasped with a vulsellum or Allis clamp and is retracted medially to place the tonsillar pillars on a stretch. A No. 12 or sickle knife is best used to incise the overlying pillar mucosa. This cut begins at the plica triangularis and extends to the supratonsillar fossa and posterior pillar. The tonsillar capsule is easily split so that when the tonsil is retraced medially, the mucosal incision will gape. The clamp can then be adjusted to grasp the tonsillar capsule firmly. The upper tonsillar pole can be freed by blunt dissection, using hemostat, blunt-tipped scissors, or a Hurd dissector. Since the tonsillar capsule is usually in loose contact with the constrictor muscle posteriorly, fine and blunt dissection should readily allow enucleation of the tonsil from the fossa. However, this may be difficult if previous scarring has occurred. Care has to be taken during dissection to preserve the tonsillar pillars and the constrictor muscle and to avoid inadvertent perforation through the tonsillar capsule. When the dissection has reached the inferior pole of the tonsil, a snare (such as the Tydings snare) is passed around the tonsil. The tonsil is then amputated by closing the snare loop. The adjacent lingual tonsil can also be removed as needed, using either scissors or snare. The other palatine tonsil is then similarly removed.

Suction should be used throughout the operation to keep the surgical field clear of blood. Bleeding can usually be controlled by pressure hemostasis with small sponges. This allows any vessels cut to retract within the underlying soft tissues. On occasion, excessive sponging or suction can disrupt retracted vessels or remove tissue factors necessary for clotting, such as thrombokinase (Shambaugh, 1945). Profuse bleeding requires electrocoagulation of vessels or their ligation with a slipknot or fixation sutures. Plain or chromic sutures are preferred, although cotton has been used in the UK without incident. Infrequently, a suture ligation may penetrate a major vessel, especially at the inferior pole of the tonsillar fossa, and this can produce delayed hemorrhage when the suture dissolves. This occurrence may be heralded by bleeding on placement of the ligature, which is then controlled following closure of the suture. The proper initial management of this hemorrhage requires removal of the suture and placement of a finer suture in the more superficial tissues of the wound. However, severe bleeding from the fossa may require apposition of both anterior and posterior tonsillar pillars with interrupted mattress sutures. This method usually succeeds in controlling bleeding without further incident, although rarely ligation of the external carotid artery may also be required.

Other methods used to control operative bleeding have included topical astringents, such as silver nitrate and tannic acid, and diluted epinephrine solutions. Topical cellulose sponges that expand within the tonsillar fossae have also been advocated for pressure control of hemorrhage. Parenteral medications have been suggested in the past as an alternate means for controlling wound hemorrhage; such preparations include estrogen solutions, epinephrine derivatives, and inhibitors of fibrinolysis (such as epsilon-aminocaproic acid and para-aminobenzoic acid). However, no objective study has yet shown that these medications do indeed prevent bleeding in the normal tonsillectomy patient. Under most circumstances, adequate hemostasis is the result of careful surgical dissection and the direct control of bleeding vessels.

Tonsil Guillotine (Sluder) Technique

The tonsillotome or tonsil guillotine is useful in performing tonsillectomy *if* the tonsil can be everted through the opening of the instrument. The technique is more commonly employed in children in whom there has been little tonsillar fossa scarring and in whom the tonsillar capsule is in loose contact with the constrictor muscles posteriorly. Yuan and colleagues (1984) in Shanghai have indicated that guillotine tonsillectomy is useful in *all* patients for performing a rapid procedure with minimal blood loss.

The actual technique of using the tonsillotome involves displacing the tonsil forward by digital manipulation over the alveolar eminence of the mandible. The tonsil is inserted through the fenestra of the instrument, and the guillotine blade is closed to amputate the tonsil and its intact capsule from the fossa. Lymphoid tissue is left in the region of the plica triangularis and must also be removed to prevent it from becoming hypertrophic postoperatively. Additionally, an inadequate procedure may result in tearing of the tonsillar pillars or incompletely removing the tonsils so that a later revision procedure may be required.

The Sluder instrument has a horizontally advanced blade that requires the surgeon to advance the blade with the thumb, whereas the Ballenger-Sluder device incorporates a scissors handle for manipulation of the blade.

Tonsillectomy with Local Anesthesia

As previously discussed, local anesthetics can be very useful in the surgical removal of an adult's tonsil and may even be satisfactory in a cooperative adolescent under selected circumstances. The operative technique is similar to that described for dissection tonsillectomy, but it employs local anesthesia. Parenteral analgesics (diazepam or meperidine) can also be given as needed for controlled sedation.

The patient is placed in a modified upright position and is draped for surgery. The oral cavity is then partially anesthetized with a topical anesthetic solution, such as 4 to 5 per cent cocaine, 4 per cent tetracaine, or dyclonine hydrochloride. The tonsil pillars are next infiltrated with 5 to 7 mL of anesthetic solution (1 to 2 per cent lidocaine with 1:100.000 epinephrine solution). A curved tonsillar needle is then introduced into the plica semilunaris behind the apex

of the tonsil and is used to infiltrate the posterior tonsillar fossa with the anesthetic solution. This latter maneuver is the key to a successful procedure, since adequate anesthetic infiltration allows a rapid and painless tonsillectomy with minimal bleeding.

Cryogenic Tonsillectomy

Cryosurgical techniques have been employed in selected patients requiring tonsillectomy. Cryonecrosis of the tonsils results from rapid deep freezing and subsequent slow thawing of the treated tissues. Local anesthetics may be used, although the cryosurgical technique tends to anesthetize regional nerves sufficiently to make the procedure relatively painless.

Both fluorocarbon aerosols (Freon) and liquid nitrogen have been used as the cooling agent in cryogenic tonsillectomy. Hill (1966) employed liquid nitrogen at -196 C under a pressure of 22 lb/sq in. An insulated withdrawal tube was used, and a vacuum brought the liquid to an operative probe. Two applications of the probe to a tonsil, lasting 3 to 4 minutes each, were required to produce complete freezing of the tonsil. As described by Cahan and Montesa-Cruz (1965), the procedure is considered to be complete when the tonsil and 2 to 3 mm of the adjacent mucosa are covered by frost.

Delayed necrosis of the tonsil occurs within hours and is usually complete within several days. The necrotic tissues subsequently slough away to leave a clean granulating base. This technique has not been associated with any significant bleeding, since intracapillary thrombosis occurs during the freezing process. On occasion, there may be some postoperative pain, but usually this can be relieved by supportive medications.

Rabkin (1968) found that his technique of tissue freezing failed to remove all tonsillar tissue, but he believed that the persistent tissue was more resistant to infection. He also suggested that the procedure should not be done in patients with markedly enlarged tonsils (especially children), since edema of the treated tissues after freezing could possibly result in airway obstruction.

Electrosterilization of the Tonsils

A different approach to surgical manipulation of the tonsils has been described by Hollander (1952, 1965). Under topical anesthesia, the tonsils are treated with an electrocoagulation or desiccation needle. The needle is used to puncture the tonsil, and surgical diathermy (250 ma) is applied for 1 minute. This results in contraction of the tonsil mass and produces later fibrosis of the tonsil. Hollander has suggested that the technique somehow alters the cellular elements of the tonsils and serves to prevent recurrent tonsillar infection.

Laser Tonsillectomy

The laser beam has become quite useful in surgery during the past decade. As described by Hobeika and Rockwell (1972), the laser creates an intense coherent electromagnetic radiation

beam that is frequency specific. Since the beam is composed of nearly parallel waves, it can be point-focused by a lens to a specific site. This produces a highly localized thermal reaction that can be modified by the absorption capability of the target area at the frequency of the beam. Both pulsed and continuous lasers exist, although the latter (including argon, CO2, and yttrium aluminium garnet) have greater clinical applicability. Complete flexibility in directing the laser beam can be achieved by using a coordinated series of movable mirrors. Thus, by selecting the appropriate beam power, exposure time, and focus angle, precise tissue destruction can be achieved, producing excellent hemostasis and no damage to underlying tissues. As indicated by Strong and associates (1973), the laser has definite limitations. The target lesion must be clearly visible at all times to prevent unwitting destruction of adjacent tissues. This is particularly significant when blood or secretions obscure the operative field and alter the laser effect. At the present time, there is still limited need for using the laser to remove adenoid tissues or for performing tonsillar surgery. However, its primary use may involve patients with bleeding disorders, especially to minimize blood loss.

Postoperative Care

Immediately following tonsillar or adenoid surgery under general anesthesia, the patient should be taken to a properly supervised recovery room and placed on the side in a modified Trendelenburg position. This allows the easy removal of secretions from the mouth or pharynx, although care must be taken not to injure the tonsillar fossae with any suction apparatus. The use of the blunt (disposable) Yankauer aspirator is best, since standard rubber or plastic suction tubes can traumatize the throat and inadvertently start postoperative hemorrhage.

Once the patient is alert, intake of oral fluids should be encouraged. Oral hygiene can be maintained with diluted saline or peroxide solutions. Ice collars seem to provide temporary relief of neck discomfort, and mild analgesics or sedatives can be used as needed. Since salicylates can cause bleeding in some patients, acetaminophen or codeine elixirs are preferable. The actual need for analgesics tends to be less in children, whereas pain can be quite significant in older patients.

In the immediate postoperative period, patients must rest as much as possible and liquids should be encouraged to prevent dehydration. Diet and activity can then be adjusted as tolerated. Except when complications occur, most patients can usually return home within 24 hours following surgery. Although there is now an emphasis on sending patients home promptly after surgery (ie when they wake up from anesthesia and their vital signs have stabilized), most patients are best supervised overnight in hospitals.

In general, normal activities are commonly resumed by patients within a 2-week period. Actual medical follow-up is best at 1-week and 1-month intervals following surgery, after which the patient is seen as needed.

Diet and activity sheets are useful for the patient or his family to have. Diet prohibitions during the postoperative period include those foods with significant roughage that might injure the pharynx or induce bleeding. This period of food restriction can vary but is approximately 3

weeks (until the pharynx heals), after which normal diets can be resumed. Smoking should also be prohibited in adults, since this can cause secondary inflammation and prolong healing.

Within 24 hours after tonsillectomy and adenoidectomy, the surgical wounds are usually covered with a granulation membrane. The peripheral mucosa then gradually covers the granulating wounds so that healing is usually completed within 3 weeks of surgery. On occasion, the membrane lining the raw pharyngeal surfaces may separate by the end of the first postoperative week to produce some temporary bleeding. This usually can be controlled by supportive measures, although occasional surgical intervention may be required (as discussed in the following section).

Complications of Adenotonsillectomy

Anesthesia

Among the most serious complications to be associated with tonsillar or adenoid surgery are those attributable to the anesthesia. Even under closely supervised conditions, anesthesia can produce operative mortality secondary to respiratory compromise or cardiac arrest. Beecher and Todd (1954) found that the overall death rate from general anesthesia was approximately 1:1560, but 20 per cent of the deaths occurred in children.

Cardiorespiratory arrest will occur as a result of excessive sedation from either inappropriate preoperative medications or operative anesthesia that is given without adequate ventilation. Respiratory compromise can also result from pharyngeal obstruction by the posterior portion of the tongue as well as from inadequate control of secretions.

Endotracheal intubation has certain risks associated with laryngeal trauma, laryngospasm, and laryngeal edema. In contrast, insufflation anesthesia presents hazards associated with inadequate control of the airway as well as flammability. As noted previously, safety in anesthesia depends on the experience of the anesthetist as well as the care taken to protect the airway.

Local anesthetics have their own hazards. Even weak anesthetic solutions may produce allergic or idiosyncratic reactions, and patient responses may be unpredictable. Inadvertent injections of the solutions into major vessels deep to the tonsillar fossae can also cause anaphylaxis and frank cardiac arrest.

Preventive measures are of first concern in avoiding any toxic reactions to the planned anesthesia. When using local anesthetics, dilute solutions should be given in the smallest possible amounts. If cardiorespiratory arrest *does* occur, prompt action will be life-saving. Immediate control of ventilation is required, including endotracheal intubation (if not previously done). Both closed chest and open cardiac massage techniques should be used when required. Appropriate cardiac stimulants are required, as are those electrolytes and fluids needed to control emergent acidosis.

Hemorrhage

The overall incidence of bleeding from tonsillar or adenoid surgery has been estimated to be less than 1 per cent of cases. Breson and Diepeveen (1969) found that immediate bleeding, or bleeding occurring within the first 24 hours after surgery, occurred in 1.4 per cent of their series of 10.000 patients, whereas delayed bleeding occurred in 3.2 per cent of these patients. However, of those patients with significant bleeding, approximately half required further surgical management.

During the postoperative period, pulse and blood pressure determinations are usually sufficient in defining blood loss clinically, in addition to serial hematocrits. Radioisotope dilutional studies are the most accurate means for determining actual blood volume. Loss of 10 per cent of blood volume can alter pulse and pressure, whereas shock may result from loss of 20 per cent of blood volume. Blood loss can be even more significant, since Holden and Maker (1965) found that many children in the past were inadequately hydrated prior to surgery, and Faigel (1966) found that 18 per cent of the patients in his series commonly lost 10 per cent of blood volume during surgery.

The management of immediate postoperative (or operative) bleeding has been discussed previously, so that the present discussion will focus on the management of delayed post-tonsillectomy hemorrhage. Such bleeding usually occurs during the fifth through the tenth postoperative days and is commonly associated with premature separation of the granulation membrane that forms over the pharyngeal surfaces. This may be precipitated by intercurrent infection or dietary indiscretions that traumatize the healing pharynx.

Delayed bleeding usually originates from small surface vessels that somehow have reopened. This produces a clot that prevents normal vessel retraction and subsequent healing. Initial management requires evacuation of the clot to control bleeding. Topical medications, such as caustic or astringent solutions, may suffice to effect hemostasis. However, surgical intervention may be required to stop bleeding. In a cooperative patient, local or topical anesthesia may be sufficient to allow direct control of bleeding or placement of a fixation ligature. If this fails or if the patient is unable to tolerate care in an awake state, general anesthesia will be required to control the airway and allow the surgeon to work without distraction. The operative wound can then be electrocoagulated or the tonsillar pillars approximated with mattress sutures. A postnasal pack may also be required to stop any nasopharyngeal bleeding. On occasion, significant blood loss may occur and require transfusions with whole blood or packed cells.

Previous mention was made of delayed hemorrhage resulting from inadvertent placement of a suture through a major vessel. Delayed bleeding occurs when the suture dissolves, and it can be profuse. Treatment requires prompt recognition and management. If direct control of the bleeding fails, emergency ligation of the external carotid artery and its branching vessels in the neck may be required. When patients experience recurrent bleeding from the tonsillar fossae without a cause being defined, selective angiography may expedite identification of the involved vessels and allow proper placement of ligatures.

Postoperative Pain

Pain following tonsillar or adenoid surgery tends to be less in the very young patient and increases in severity with age. Pain may involve either the throat or the ears (from referred otalgia). The mechanism of pain has been attributed to irritation of sensory nerve endings as well as to spasm of the pharyngeal muscles. Management usually consists of supportive measures, with analgesics adjusted as required. Talbot found that early chewing of solid food by his patients lessened muscle spasms and effectively alleviated postoperative pain. Ritter (1967) suggested that swallowing might be facilitated by giving analgesics prior to meals. Other measures used to prevent pain have included local injections of antibiotic-steroid-analgesic combination drugs, but these have had questionable success. One study by Hope and co-workers (1954) suggested that throat irradiation postoperatively might be useful in preventing pain. The rationale behind this study was that radiation minimizes pain in cancer patients with metastatic disease. However, other studies have produced no definitive results. Somers (1951) attempted to use intravenous procaine to prevent posttonsillectomy pain. The drug was believed to concentrate in traumatized tissues around terminal nerve endings and to exert a positive central nervous system effect. Needless to say, the results were disastrous, and patients experienced significant toxic reactions.

Infections

Localized subacute inflammations of the pharyngeal wall or tonsillar fossae are not uncommon following adenoid or tonsillar surgery and usually respond to topical therapies such as diluted peroxide or saline lavages. Occasionally, significant infections will occur, particularly in the dehydrated patient, and they require antibiotics for control (with cultures taken to define the organisms present). More complicated pharyngitis has produced suppurative otitis as well as localized abscesses. Lung infections have resulted from both atelectasis and the aspiration of loose teeth, blood, tissue fragments, and the like. Distant sites seeded by infection have included the heart, brain, and major viscera, and such infections tend to occur in those patients with known cardiac valvular or septal disease.

Operative Trauma

Careless dissection during adenotonsillectomy has wrought havoc on the pharyngeal tissues. Injury to the tonsillar pillars, soft palate, uvula, and pharyngeal walls has been reported. Nerve and vessel injuries have occurred. Among the more striking injuries described has been amputation of the anterior portion of a child's tongue. Internal carotid artery thrombosis has been reported following blunt trauma to the throat and can conceivably follow tonsillar surgery. As a result of tissue necrosis, rerouting of the salivary ducts into the tonsillar fossae has occurred to produce ectopic salivation. Velopharyngeal incompetence has resulted from adenotonsillectomy, primarily in patients with unrecognized palatal clefts. Excessive scarring following surgery has also produced nasopharyngeal stenosis that later required surgical repair.

Miscellaneous Complications

Delayed healing attributed to unrecognized diabetes mellitus has followed tonsillectomy, although, interestingly, Kitaigorodsky (1984) *did* find stabilization of known diabetes in children after surgery. Postoperative acidosis can result from surgery but more commonly follows the inability to eat as a result of pharyngeal pain. In contrast, clinical hypoglycemia has also been described and can complicate excessive presurgical fasting.

Loss of tissue and instruments has been reported following tonsillar surgery. These losses have included surgical needles, sponges, and entire tonsils, as well as loose or broken teeth. Markowicz and Shanon (1959) described a case in which a tonsillar snare was lost in the esophagus, producing dysphagia and mediastinal pain. Nasopharyngeal or tonsillar packs have caused infection and airway obstruction as well as pressure effects on regional nerves.

Among unusual complications following tonsillar surgery has been subcutaneous emphysema caused by air dissecting through the tonsillar fossae to the facial soft tissues. Fatal air embolism has also occurred as a result of air being sucked into open pharyngeal veins. Also uncommon has been infection of the deep cervical muscles causing atlantoaxial subluxation.

More recently, Feinberg and Shabino (1985) reported that certain patients can experience acute pulmonary edema following tonsillar surgery and suggested that compensated increases in inspiratory and expiratory pressures immediately after surgery will be adversely affected by the removal of any tissue obstructing the airway. Thus, an abrupt decrease in airway pressure produces a sudden increase in systemic venous pressure produces a sudden increase in systemic venous return, with pulmonary edema resulting from the increased pulmonary pressure.

According to the older literature, the thymus was believed to be a cause of operative mortality. Although the reasons were unclear, the thymus was somehow thought to cause respiratory obstruction and sudden death. However, there has never been any objective evidence presented to substantiate this assumption.

Persistence of Tonsils or Adenoids

Incomplete tonsillectomy or adenoidectomy may result in persistence of tissues that later become infected or inflamed. Following properly performed surgery, the tonsils will not "regrow". Superficial lymphoid nodules can be seen in the tonsillar fossae after surgery, but they usually originate from the lingual tonsil through compensatory hypertrophy. A true "tonsillar tag" can also be partly covered by scar tissue, which then obstructs the crypts present. This may later become a clinical problem if secondary infections occur.

Adenoid tissues can persist following surgery because of the lack of delineating capsule to facilitate their complete removal. Consequently, symptoms recur if this tissue enlarges - especially when generalized lymphoid responses result from other factors (such as possible allergy or certain infections).

If patients become clinically symptomatic, secondary adenoidectomy or tonsillectomy may be required. Indications for secondary surgery are similar to those for primary surgery. On rare occasions in the past, irradiation of persistent pharyngeal lymphoid tissue has been justified. However, this treatment is not without significant hazard, particularly since malignant degeneration of the irradiated tissues can occur over time. It is enough to say that meticulous surgical care is necessary for the removal of any persistent adenoid or tonsillar tissues, and discretion governs the use of any radiation in therapy.

Tonsillectomy and Late-Occurring Malignancy

Vianna and colleagues (1971) described a retrospective study of patients with Hodgkin's disease and suggested that tonsillectomy was a predisposing factor because it removed a "protective barrier" from the throat. Bross and co-workers (1971) also found an increased incidence of prior tonsillectomies in some patients who later developed Hodgkin's disease and thyroid malignancy. Later, Cuneo (1972) reported an increased prevalence of myeloid leukemias in patients who had undergone prior tonsillectomies. Unfortunately, such reports have caused considerable unwarranted confusion in patients and their families when tonsillar or adenoid surgery has been needed. In fact, papers by Ruuskanen and co-workers (1971), Cassimos and colleagues (1973), Teillet and co-workers (1973), and Matzker and Klasen (1975) failed to corroborate any incidence of tonsillectomy being associated with subsequent malignancy. As we have previously written, whether or not immune incompetence with malignant changes does occur in certain patients following tonsillar or adenoid surgery *remains* a problem for further speculation, study, and finally definition.