TYMPANOCENTESIS

Indications
Tympanocentesis is performed when any of the following are present:
• Otitis media in children who are seriously ill or have toxic signs or symptoms
• Unsatisfactory response to antimicrobial therapy
• Onset of otitis media in a patient who is receiving antimicrobial agents
• Presence or suspicion of suppurative complications
• Otitis media in the newborn, the very young infant, or the immunologically deficient patient, in each of whom an unusual organism may be suspected

Anesthetic Considerations
• The procedure can usually be performed without general anesthesia.
• In certain cases, premedication with a combination of a short-acting barbiturate and either morphine or meperidine, or even a general anesthetic, is advisable.
• For older children and adolescents, a small amount of phenol can be used on the tympanic membrane before the needle is inserted.
Procedure

- Aspiration can be carried out using an otoscope with a surgical head or with an otomicroscope. Adequate immobilization of the patient is essential when a general anesthetic is not used.

- The needle is inserted through the inferior portion of the tympanic membrane, using an 18-gauge spinal needle attached to a syringe or collection trap.

- The following method is recommended for tympanocentesis and aspiration of a middle-ear effusion for microbiologic assessment:
  - A culture of the external auditory canal can be obtained with a Calgiswab that is moistened with trypticase soy broth if an unusual middle-ear organism is suspected.
  - The external canal is filled with 70% ethyl alcohol for 1 minute (Figure 1–1). The alcohol is removed from the ear canal by aspiration when an unusual middle-ear organism is suspected.

Figure 1–1 Ethyl alcohol (70%) is instilled in the external canal for 1 minute.
Tympanocentesis is performed in the inferior portion of the tympanic membrane with an Alden-Senturia trap with a needle attached (Figure 1–2). Care is taken not to close the suction hole in the trap before entering the middle ear. A tuberculin syringe with an 18-gauge needle attached is an alternative.

- A myringotomy can be performed after tympanocentesis to provide more effective drainage.

**Postoperative Care**

- The middle-ear aspirate should be sent to the microbiology laboratory for Gram stain, culture, and antibiotic susceptibility studies.

- Even though the tympanocentesis defect is small, postoperative otorrhea may develop, the treatment of which is described in detail later in this chapter (see *Tympanostomy Tube Insertion*).

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Figure 1–2  Alcohol is removed from the ear canal by aspiration, and tympanocentesis is performed with an Alden-Senturia trap (Storz Instrument Co, St. Louis, MO) with a needle attached.
**MYRINGOTOMY**

**Indications**
Myringotomy is performed for the following indications:

- Presence or suspicion of suppurative complications of otitis media, such as facial paralysis or mastoiditis
- Relief of severe otalgia at the onset of the illness, or persistent signs and symptoms of acute middle-ear (mastoid) infection

Note that myringotomy is useful primarily to provide drainage of the middle ear and frequently the mastoid. As previously discussed, tympanocentesis with needle aspiration should precede the myringotomy when microbiologic assessment is indicated. Myringotomy as a *routine* adjunct to antimicrobial therapy is not required; however, the procedure is helpful for relief of otalgia. Furthermore, in selected cases, a tympanostomy tube may be indicated to provide adequate drainage, such as when a suppurative complication or chronic otitis media with effusion is present, or when the child has had recurrent otitis media in the recent past.

The use of a laser to perform the myringotomy is an experimental procedure, which awaits appropriate clinical trials comparing laser myringotomy (with or without insertion of a tympanostomy tube) with the standard knife myringotomy.

**Anesthetic Considerations**
- The anesthetic considerations and immobilization of the child are similar to those described for tympanocentesis.

**Procedure**
- A wide-field incision (Figure 1–3A) is made in the inferior portion of the pars tensa (instillation of 70% alcohol for 1 minute precedes the procedure if an unusual bacterial organism is suspected).
- A radial incision is made in the anterosuperior quadrant of the pars tensa (Figure 1–3B) if a tympanostomy tube is to be inserted (an incision in the anteroinferior quadrant is a reasonable alternative).

Figure 1–3  A, A wide-field incision is made in the inferior portion of the pars tensa. B, A radial incision is made in the anteroposterior (or anteroinferior) quadrant of the pars tensa.
• Middle-ear effusion is aspirated with a small Baron or Fraser aspirator (Figure 1–4A).

• When a wide-field inferiorly placed myringotomy is indicated, a larger aspirator is used (Figure 1–4B).

• If, during myringotomy, the effusion is too viscid to be aspirated through the anterosuperior radial myringotomy, a “counter incision” myringotomy can also be performed and the thick effusion aspirated through the inferiorly placed incision.

**Postoperative Care**

• The patient (or a family member) should be warned that otorrhea might become a problem.

• When otorrhea is profuse, external otitis may develop. Cotton should be placed in the external auditory canal, and ototopical antibiotic drops (with or without hydrocortisone) are usually helpful in preventing dermatitis and chronic suppurative otitis media that could result from bacterial organisms from the external canal entering and contaminating the middle ear through the myringotomy incision. The cotton should be changed at least once a day or whenever it becomes wet. Postoperative otorrhea is discussed in detail below (see Grommet-Type Tympanostomy Tube Insertion).

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**Figure 1–4**

*A*. A small Baron or Fraser aspirator is used for aspiration of middle-ear effusion.  
*B*. When a wide-field inferiorly placed myringotomy is indicated, a larger aspirator is used.
**GROMMET-TYPE TYMPANOSTOMY TUBE INSERTION**

Of the many types of tubes currently available, the biflanged Armstrong-type grommet tube is preferred for routine placement. Our studies have shown that it remains functional for approximately 12-18 months (range 6-24 months).<sup>5–7</sup>

**Indications**

The following are indications for the placement of a grommet-type tympanostomy tube:<sup>8</sup>

- **Chronic middle-ear effusion** that is relatively asymptomatic, does not respond to medical management, is not improving, and has persisted for at least 3 months when bilateral or 6 months when unilateral. Insertion at an earlier time would be reasonable when there is significant hearing loss (eg, >25 dB), speech or language delay, a severe retraction pocket, dis-equilibrium or vertigo, or when tinnitus is present.

- **Recurrent acute otitis media**, especially when antimicrobial prophylaxis fails to prevent frequent, severe, and long-lasting disease. Minimum frequency for considering tympanostomy tube insertion would be three or more episodes during the previous 6 months or four or more attacks during the previous year, with one being recent.

- **Recurrent otitis media with effusion** in which the duration of each episode does not meet the criteria for chronic disease, but the cumulative duration is considered to be excessive (eg, 6 to 12 months).

- When a **suppurative complication** is suspected or is present. Insertion of a tympanostomy tube at the time of tympanocentesis or myringotomy can provide more prolonged drainage and aeration of the middle-ear cleft.

- **Eustachian tube dysfunction**, even in the absence of middle-ear effusion, when the patient has persistent or recurrent signs and symptoms that are not relieved by medical treatment. Signs and symptoms would include tinnitus, hearing loss (usually fluctuating), and vertigo or dis-equilibrium. Also, tympanostomy tube placement may be required when there is a need for hyperbaric oxygen therapy.

- When **atelectasis of the middle ear** (with or without retraction pocket) is present, and is chronic and unresponsive to medical management.

- When a **tympanoplasty** (with or without a mastoidectomy) is performed and eustachian tube function is thought to be poor, such as when an acquired cholesteatoma is present in an infant or young child (see Chapter 4).

- Eustachian tube function testing is usually not feasible prior to surgery for cholesteatoma unless a tympanostomy tube is in place or a perforation is present. If a tube or perforation is present, the middle ear should not be infected.

- **Typanostomy tube insertion at the time of the cholesteatoma surgery** can help prevent postoperative atelectasis, retraction pocket, and recurrent cholesteatoma.
Anesthetic Considerations
- In children, the procedure is performed under general anesthesia.
- In some older cooperative teenagers, local infiltrative anesthesia (1% lidocaine with 1:100,000 epinephrine) can be used successfully (see Chapter 2, Figure 2–1 for injection sites), or a small amount of topical phenol can be applied to the myringotomy site, or both methods of local anesthesia can be used.

Procedure
- A myringotomy is performed as previously described, in the anterosuperior or anteroinferior quadrant of the pars tensa. A radial incision is made that is small enough to prevent premature extrusion but is long enough to permit the tube to be easily inserted.
- If the indication for tube placement is a suppurative complication (ie, mastoiditis), a wide-field myringotomy (see Figure 1–3A) should also be performed in the inferior portion of the tympanic membrane to provide adequate drainage. The tympanostomy tube is inserted through a second incision in the anterosuperior (or anteroinferior) quadrant.
- Middle-ear effusion, if present, is aspirated.
  - When purulent or mucopurulent fluid is aspirated, a culture of the middle-ear effusion is recommended using a Quik-Cath (Baxter Healthcare Corporation, Deerfield, IL) attached to an Alden-Senturia trap.
  - If the middle-ear effusion is too mucoid to be effectively aspirated through the myringotomy incision, a counter incision should be made in the inferior portion of the tympanic membrane, which is large enough for the viscous effusion to be aspirated with a large-bore suction aspirator. Instillation of saline through the myringotomy has also been advocated to enhance the suctioning of extremely viscous middle-ear effusions.
- The tympanostomy tube is inserted using alligator forceps (Figure 1–5); the Armstrong-type grommet tube is preferred.

Figure 1–5 An alligator forceps is used to insert the tympanostomy tube into the previously performed myringotomy in the anterosuperior quadrant of the pars tensa.
• Forceps with a serrated (not smooth) edge are recommended to permit better control of tube position and angulation during insertion.

• The tube is placed in either the anterosuperior or anteroinferior quadrant (Figure 1–6); there is no consensus regarding the safest and most effective position for tube placement. Placement in the anterosuperior may be associated with a longer duration, however, if a chronic perforation occurs following extrusion, repair of the tympanic is somewhat more difficult than when the perforation develops in the anteroinferior quadrant. Nevertheless, these perforations, irrespective of site, can be successfully repaired in most children (see Chapter 3).
When the external auditory canal is small, such as in young infants, a smaller-bore grommet tube may be more feasible than the traditional tube. However, in these infants, as well as those children who have stenosis of the ear canal (eg, Down syndrome), the tympanostomy tube will have to be inserted into the ear canal prior to insertion of speculum, since the grommet will not usually pass through smaller specula (Figure 1–7). If a longer period of ventilation is desired, however, a T-tube can generally be passed through a small speculum.

- Ototopical drops (preferably non-ototoxic, eg ofloxacin) are instilled into the external auditory canal when a middle-ear effusion is aspirated, and instillation is continued if otorrhea occurs. Saline irrigation of the middle ear (when middle-ear effusion is present) at the time of tympanostomy tube insertion has been reported to be effective in preventing postoperative otorrhea.9

Postoperative Care

- Otorrhea that occurs after surgery is usually treated effectively with an ototopical medication, such as ofloxacin.10 Culture and susceptibility testing of the effusion at the time of tympanostomy tube placement can be helpful in selecting oral antimicrobial agents.

- The need to protect the ears when the child with tympanostomy tubes is bathing or swimming is controversial. This author prefers routine use of earplugs, but others advise earplugs only when swimming deep under water or if the child complains of ear pain upon head submersion (see Chapter 35).

- Patients are re-examined approximately 2 weeks after insertion of the tube, at which time an audiogram is obtained to determine if, indeed, the hearing is normal when the tympanostomy tubes are in place and patent. If the hearing is normal and the tympanostomy tubes are functioning, the child can be re-examined in 6–12 months and then every

Figure 1–7  A. When the external canal is too small or is stenotic, the grommet, attached to the alligator forceps, is inserted into the canal prior to the speculum, since the speculum is too small to pass the grommet. B. Once the grommet is in the canal, it can then be inserted into the myringotomy incision.
6 months until spontaneous extrusion occurs. Ideally, periodic examination of the child by the surgeon is advised, but this recommendation is not always followed in this cost-conscious era. 11

- Rosenfeld and Isaacson12 (and this author concurs) suggest that children be referred back to the otolaryngologist every 4-6 months after insertion, 6-12 months after the tubes extrude, whenever recurrent or chronic otorrhea occurs, when the tube becomes occluded, and when a chronic perforation develops after the tube extrudes. They strongly recommend referral for a postoperative audiogram, whenever the tube can not be visualized, bloody otorrhea occurs or when otorrhea is not controlled by antibiotics, the hearing worsens, persistent otalgia occurs, granulation is present, or when the tube is retained longer than 2 years.

**Postoperative Complications and Sequelae**

- Because episodes of acute otorrhea are common during the life of indwelling and patent tympanostomy tubes, early treatment of these infections with an ototopical agent, with or without a systemic antimicrobial agent (depending upon the severity of the otitis media and the underlying upper respiratory tract infection), appears to not only decrease the duration and severity of the infection but also to prevent progression to the chronic stage, i.e., chronic suppurative otitis media.13

- Premature extrusion of the tympanostomy tube occasionally occurs, and if it does so prior to 6 months, this author usually recommends re-insertion, since prevention of recurrent disease will most likely require 12 or more months with the tube in place. Spontaneous extrusion in the immediate postoperative period may be due to the presence of acute otitis media, with otorrhea, at the time of tube placement. To avoid this complication, place the patient on prophylactic antibiotics (e.g., amoxicillin, 20 mg/kg/day) until the day of the procedure. In addition, if acute otitis media is present when the tubes are inserted, vigorously treat the acute infection with either oral antibiotics, ototopical agents, or both, which can be culture-directed following the results of the Gram stain and culture and susceptibility studies of the middle-ear aspirate obtained at the time of the myringotomy and tube placement.

- On rare occasions, the tympanostomy tube may fall into the middle ear, either at the time of placement, or at any time during the postoperative period.
  
  - When this occurs during the procedure, instillation of saline through the myringotomy incision will float the tube to the level of the ear drum and then suctioning at the site of myringotomy incision will bring the tube into view, at which time the tube can be either properly repositioned or extracted and re-inserted.
  
  - If the tympanostomy tube is found to be behind the tympanic membrane during the postoperative period and the child requires re-insertion of the tube, then the procedure described above can be performed. However, if the tympanic membrane has healed with the tympanostomy tube in the middle ear, but the child does not have an indication for re-insertion of tympanostomy tubes, then inform the
parents that the tube is biocompatible, should not be associated with a foreign body reaction, and will not cause otitis media. Thus it can remain indefinitely in the middle ear, since the child will otherwise require a general anesthetic in order to retrieve the tube.

- Following spontaneous extrusion (or removal) of tympanostomy tubes, a permanent perforation can occur. When grommet-type tubes are used, the perforation rate is between 0.5 and 1%, but when permanent tubes are used the rate can be as high as 40%.14,15 These perforations can usually be prevented when tubes are surgically removed if a myringoplasty is performed at the time of removal (see below), however, if a chronic perforation is found after spontaneous extrusion, a myringoplasty or tympanoplasty may be indicated (see Chapter 3).

- Other common sequelae of tympanostomy tubes are myringosclerosis, and localized atrophy of the tympanic membrane resulting in a dimeric membrane that can develop into a retraction pocket if the child continues to have chronic eustachian tube dysfunction. The presence and extent of myringosclerosis increases with increasing number of tube insertions, but does not commonly cause hearing loss, ie, it is a cosmetic problem but not a functional one. The presence of a chronic retraction pocket, however, is more problematic since an iatrogenic cholesteatoma can occur. Thus, management of these defects is indicated and may include re-insertion of a tympanostomy tube at another site, tympanoplasty, or both, depending upon the site, extent, and the presence or absence of adhesive otitis media. If the portion of tympanic membrane involved in the retraction pocket returns to the normal position following tympanostomy tube placement, then tympanoplastic repair of the defect may be avoided (see Chapter 3).

- Even though a relatively uncommon occurrence, a cholesteatoma can develop at the site of the tympanostomy tube placement (either as result of a retraction pocket, or following invagination of epithelium around the tube, or at the margin of a chronic perforation that occurs after the tube extrudes), especially if the child is not frequently observed during the postoperative period.13

**PERMANENT TYMPANOSTOMY TUBE INSERTION**

When ventilation of the middle ear is desirable for a period of time longer than 12-18 months, a permanent tube may be more appropriate than a grommet tympanostomy tube. The incidence of chronic perforation following permanent tube extrusion or removal, however, is higher than that of short-acting grommet tubes. Therefore, this author rarely recommends permanent tympanostomy tubes for infants and young children.

Candidates for permanent tympanostomy tube insertion include older children and adolescents who have had several (three or more) recent insertions of grommet-type tubes. In this situation, placement of permanent tubes may reduce the need for frequent future operations. In general, a permanent tympanostomy tube is recommended when a permanent (chronic) perforation is desirable. This author uses one of two types: the Per-Lee tube (Xomed-Treace Inc, Jacksonville, FL)16 or the Richards T-Tube (Smith-Nephew Inc, Bartlett, TN).15
Indications
The following are indications for placement of a permanent tympanostomy tube:

- Otitis media or atelectasis of the middle ear is determined to be permanent (ie, caused by eustachian tube dysfunction) and not likely to improve with advancing age
- For conditions such as congenital or acquired eustachian tube stenosis, fracture through the eustachian tube following skull-base surgery, or benign or malignant neoplasms
- These conditions are relatively rare but can lead to chronic and potentially life-long eustachian tube dysfunction.

Anesthetic Considerations
- Aspects of anesthesia are similar to those described for myringotomy and placement of grommet-type tympanostomy tubes.

Procedure
(see also Myringotomy and Grommet-Type Tympanostomy Tube Insertion procedures)
- When a Per-Lee tube is to be used, an incision is made with a myringotomy knife immediately anterior to the body of the malleus (Figure 1–8).

Figure 1–8 An incision is made anterior to the body of the malleus.
• A Per-Lee tube is preferred:
  • The tube should be shortened and a wide flange cut to fit posterior to the malleus. The wide flange is posterior behind the malleus, and a shorter anterior flange is cut to fit behind the anterior quadrant of the tympanic membrane (Figure 1–9).
  • The tube is inserted using alligator forceps. Compression of flanges with alligator or cup forceps aids in insertion of the tube (Figure 1–10).
  • The tube is in place. Note the posterior flange behind the malleus (Figure 1–11).

Figure 1–9  A Per-Lee tube is shortened.
Figure 1–10  The tube is inserted using an alligator forceps.  Figure 1–11  The tube in place.
A Richards T-tube may also be used:

- The tube shaft is trimmed (Figure 1–12) to prevent contact with the ear canal, but should be kept long enough to prevent the tube from falling into the middle ear.
- A myringotomy incision is made in the anteroinferior quadrant of the tympanic membrane.

**Figure 1–12** The Richards T-tube is cut short (similar to Figure 1–9) and grasped by the tips of the alligator forceps so that the two flanges are folded backwards inside the forceps.
Both flanges of the T-tube are pressed by the forceps (see Figure 1–12), inserted through the myringotomy incision (Figure 1–13A), and allowed to spring out behind the tympanic membrane (Figure 1–13B). Alternatively, the tube can be grasped with the flanges pressed forward, rather than back against the tube shaft.

A properly placed tube permits a clear view of the middle-ear mucosa through the tube lumen. When one or both flanges are not in an ideal position, they can be repositioned with an otologic pick.

The shaft should be positioned so that the lumen can be easily seen, which enhances postoperative follow-up. The tube may easily become blocked if it is placed against the canal wall.

Postoperative Care

- Postoperative care is similar to that described for myringotomy and grommet-type tympanostomy tube insertion.
- When ototopical medication is prescribed, the patient should use sufficient amounts to fill the ear canal in order that the drops penetrate the tube, since these two types of permanent tympanostomy tubes are longer than the grommet types.

Figure 1–13  A. The T-tube is inserted with the forceps through the myringotomy incision far enough that the two flanges are behind the tympanic membrane. B. The forceps releases the tube and is withdrawn so that the flanges spring out behind the eardrum.
REMOVAL OF TYPANOSTOMY TUBES AND MYRINGOPLASTY

Tympanostomy tubes can be removed as an office procedure without the aid of either local or general anesthesia, especially when the tube is partially extruded or if there is chronic infection involving the tympanic membrane. In children, however, tympanostomy tubes are usually removed under general anesthesia in the operating room since the procedure is painful and the rim of the perforation can be denuded of epithelium. This also allows the defect to be closed (ie, myringoplasty) following removal of the tube. This method, although not tested in a clinical trial, appears to result in a higher rate of closure of the perforation than when the tube is removed with no attempt to close the defect.

Case Selection
Our studies of tympanostomy tubes indicate that the Armstrong-type tube usually lasts about 12 to 18 months, with the range being 6 to 24 months. Tubes that remain in place longer than that period may require removal on an individualized basis depending on several factors, such as the following:

- Age of the child
- Amount of time that the tube has remained in place
- Unilateral versus bilateral tubes
- Status of the contralateral ear when that tympanic membrane is intact
- Eustachian tube function
- Presence or absence of recurrent or chronic otorrhea (and frequency, severity, and duration of otorrhea)
- Patency of the tube
- Season of the year

The age of the child is one of the most important factors, because most epidemiological studies of otitis media show that the disease peaks in infancy and declines rapidly after about 6 years of age. In addition, the structure and function of the eustachian tube as well as the child’s immunity are usually more mature after 6 years of age. Therefore, removal of tubes in children 6 years of age and older is more desirable than in younger children. However, removal of the tube in select younger children may be beneficial, for example, in cases of unilateral recurrent otorrhea through a tube (apparently owing to reflux of nasopharyngeal secretions into the middle ear) that is not medically controlled. Tube removal may also be beneficial when the contralateral tympanic membrane is intact (no tube is present) and that ear has been free of middle-ear disease for 1 year or more.

Indications
- Presence of a retained unilateral tympanostomy tube in children who are 6 years of age or older, when the contralateral tympanic membrane is intact and the middle ear has been free of disease for 1 year or more
- Select children younger than 6 years of age, depending on the factors listed above
• Presence of retained bilateral tympanostomy tubes in children in whom eustachian tube function is now considered within normal limits owing to either growth and development, nonsurgical management (eg, allergy control or treatment), or surgery (eg, adenoidectomy, repair of cleft palate)

• Presence of frequently recurrent otorrhea through a tympanostomy tube that is not prevented by antimicrobial prophylaxis

• Important factors in decision-making are frequency, severity, and duration of the episodes; age of the patient; and duration that the tube has been in place.

• Following chronic otorrhea, especially when the criteria described in the first two points are met

• When the tympanostomy tube is imbedded in granulation tissue, which is unresponsive to medical treatment

Anesthetic Considerations
• In children, general anesthesia is usually required. For select children, especially teenagers, no anesthesia is needed.

Procedure
• The myringotomy tube is gently removed using an alligator forceps (Figure 1–14).

• Epithelium from the rim of the perforation is removed using a right-angled pick, or using a gently curved pick to split the layers of tympanic membrane and a cup forceps to remove the tissue (Figure 1–15).
• A circular portion of Steri-Strip is cut and placed over the perforation (Figure 1–16). The operative site must be free of any bleeding prior to placement of the patch; application of epinephrine via Gelfoam for 5 minutes is adequate.

• An antibiotic ointment (eg, polymyxin B sulfate, zinc bacitracin, neomycin sulfate) is instilled into the external auditory canal using a syringe and a plastic needle tip (Figure 1–17).

Figure 1–16 A circular portion of Steri-Strip (Medical-Surgical Division/3M, St. Paul, MN) is cut and placed over the perforation.

Figure 1–17 Instillation of an antibiotic ointment into the external auditory canal using a syringe and a plastic needle tip (Quik-Cath, Baxter Healthcare Corporation, Deerfield, IL).
Postoperative Care

- The patient is re-examined after 4 to 6 weeks. At that time, the Steri-Strip patch has usually come off the tympanic membrane and the perforation is healed. If the patch is not displaced, an ototopical agent is instilled for several days and the child is re-examined.
- Confirmation of closure of the tympanic membrane can be achieved using pneumatic otoscopy, or more precisely, with the aid of the otomicroscope and a Bruening otoscope with a nonmagnifying lens. A microscopic defect, however, may still be present despite seemingly good tympanic mobility as observed during pneumatic otoscopy. Tympanometry is the most sensitive method to confirm that the tympanic membrane is intact.

REFERENCES


