

Drainage or paracentesis

Drenaż czy paracenteza

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ABSTRACT:

Tympanostomy tube insertion and tympanic membrane incision are two the most frequently performed surgical procedures in otolaryngology, especially in children. The tympanic membrane incision - paracentesis, or myringotomy – is an incision of the tympanic membrane for diagnostic purposes or to allow drainage of pathological secretion from the tympanic cavity. Tympanostomy tube insertion involves incision made in the tympanic membrane and insertion of a ventilation tube (various types and for various periods of time) to improve hearing and aeration of the tympanic cavity. Procedures are performed through the ear canal (transcanal approach), under local or general anesthesia. Complications may occur in some cases of paracentesis and tympanostomy tube insertion.

KEYWORDS:

middle ear, paracentesis, ventilation tube, otitis media, ear effusion, complications

STRESZCZENIE:

Drenaż wentylacyjny ucha środkowego i nacięcie błony bębenkowej to dwie najczęściej wykonywane procedury zabiegowe w otolaryngologii, zwłaszcza dziecięcej. Paracenteza, inaczej myringotomia – polega na nacięciu błony bębenkowej albo w celu ewakuacji wydzieliny patologicznej z jamy bębenkowej, albo w celach diagnostycznych. Drenaż wentylacyjny ucha środkowego polega na założeniu drenu wentylacyjnego w nacięcie błony bębenkowej (różnego typu dreny zakładane są na różny czas) w celu poprawy słuchu oraz upowietrzenia jamy bębenkowej. Zabiegi te są wykonywane przez przewód słuchowy zewnętrzny w znieczuleniu miejscowym lub ogólnym. W części przypadków paracentezy i drenażu występują powikłania.

SŁOWA KLUCZOWE:

ucho środkowe, nacięcie błony bębenkowej, dren wentylacyjny, zapalenie ucha środkowego, wysięk w uchu, powikłania

DEFINITIONS

Tympanic membrane incision and tympanostomy tube insertion are surgical procedures usually performed in patients with acute bacterial otitis and/or chronic otitis media with effusion. Acute otitis media (AOM) is characterized by an acute onset of symptoms, presence of middle ear effusion and symptoms of acute otitis media. Otitis media with effusion (OME) is a chronic inflammatory process of the middle ear, in the presence of an intact tympanic membrane, with the middle ear space filled with serous/mucous fluid and with no evidence of clinical or otoscopic signs of acute inflammation. The difference between AOM and OME is the presence of signs of inflammation of the middle ear – Ear pain ache and fever. Fluid occurs in both types of otitis media [1].

The tympanic membrane incision, or paracentesis, or myringotomy - is a laryngological procedure performed to remove pathological secretion from the tympanic cavity or used for diagnostic purposes and microbiological testing. The tympanic membrane incision is performed under local anesthesia in adults or co-operative children, and also under short-term general anesthesia, usually in children, but also in adults unable to cooperate [2]. Paracentesis was first described by Sir Ashley Cooper in 1802 [3]. It was widely used and extremely effective in the 1940s of the last century, in the pre-antibiotic era, because it often prevented the occurrence of complications of otitis media (OM). Currently, in the era of antibiotic treatment, it is reserved for selected clinical cases and situations.

The tympanic membrane incision is made with a special knife or, less often, with a laser, and usually performed under surgi-

cal microscope medium magnification, involving both lower quadrants (anteroinferior and posteroinferior quadrant). The incision should be wide to facilitate the flow of fluid to the external auditory canal and to aerate the middle ear, which allows drainage of secretion through the Eustachian tube into the nasopharynx. In case of the presence of retained secretion, suction removes fluid out of the middle ear (by metal aspirator tube). The procedure usually takes a few minutes. The incision of the tympanic membrane typically heals and epithelializes within a few hours or more.

Tympanopuncture is a puncture of the tympanic membrane and aspiration of the tympanic cavity contents with a needle in order to collect material for laboratory testing, most commonly for bacteriological tests. Material obtained from the nasopharyngeal cavity, although easier to collect, correlates poorly with the bacteriological results obtained during tympanopuncture [2]. This procedure is also used to provide a route for administration of intratympanic medications.

INDICATIONS FOR PARACENTESIS

Indications for paracentesis are limited to patients with severe ear pain and/or ear complications with the presence of pus. Due to the increasing incidence of acute and chronic otitis media with effusion, procedure is also applied in those cases. Sometimes it is performed at the same time with the ventilation tube insertion into the tympanic membrane. It is performed also in cases, when targeted antibiotic treatment is not successful or in cases of otological complications.

Paracentesis is carried out as a sudden procedure in cases of purulent complications (such as acute mastoiditis, labyrinthitis, facial nerve paralysis) and intracranial complications (such as meningitis). Tympanopuncture often precedes the paracentesis, in order to take the material for microbiological examination, especially in cases of severe acute OM, or when there is worsening of health condition as a result of ineffective antibiotic treatment, when acute OM develops during antibiotic treatment recommended for inflammation of another organ, when acute OM occurs during neonatal period, and when acute OM accompanies immune disorders. Even after 10-14 days of antibiotic therapy in acute OM, when fluid still remains in the middle ear and clinical signs of inflammation are present, paracentesis should be performed.

Also in the case of AOM with symptoms of irritation of the inner ear (dizziness, nausea, vomiting, nystagmus) paracentesis should be carried out. Paracentesis should be considered also in suspicion of AOM or its weakly otosclerotic symp-

toms in infants and young children with persistent diarrhea with fever and after exclusion of diseases other than AOM.

At the initial stage of mastoiditis, when changes do not involve bone tissue, only a large incision of the tympanic membrane can be made and intravenous antibiotic therapy should be administered. In this case, incision of the tympanic membrane allows to obtain a discharge to perform a microbiological culture. If the symptoms of mastoiditis do not subside within 48 hours, surgical treatment and wide opening of the mastoid cells with removal of secretion and granuloma is indicated. In cases of acute mastoiditis in the course of acute OM, 95.8% of patients underwent myringotomy/ventilation tube insertion and recovery was achieved [5]. In otogenic meningitis and in all intracranial complications, ventilation tube insertion is recommended.

In case of labyrinthitis in the course of acute OM, when bacteria (purulent inflammation) or their toxins (serous inflammation) enter the inner ear through the oval or round windows, myringotomy should be performed. Any acute otitis media and any complications of acute otitis require decompression and incision of the tympanic membrane. Myringotomy is also recommended in balance disorders in the course of OM.

In case of facial nerve paresis or facial nerve paralysis in the course of acute OM, a wide incision of the tympanic membrane should be performed and intravenous antibiotics administered. If facial nerve disorders persist after paracentesis, ventilation tube insertion should be performed.

In case of very severe pain not responding to analgesics and tensed tympanic membrane in otoscopic examination, paracentesis should be considered. Paracentesis is performed for diagnostic and therapeutic purposes in the absence of second line antibiotic efficacy to exclude or confirm bacterial resistance [4].

COMPLICATIONS OF PARACENTESIS

The most common complication is a chronic drainage from the middle ear, which can cause inflammation of the skin of the external auditory canal. The incudostapedial joint injury, intersection of the facial nerve and the jugular veinbulb puncture are rare complications. Frequent complications include persistent perforation of the tympanic membrane, atrophic scars and tympanosclerosis at the incision site. These complications are most likely to occur in the place of often repeated paracentesis, therefore in such cases tympanostomy tube placement is preferable [4].

TYMPANOSTOMY TUBE

After making an incision into the tympanic membrane in order to keep a temporary drainage of the tympanic cavity, it is necessary to pull out the epidermis around the cut and insert a tympanostomy tube with the use of micro-forceps. The procedure is very short and takes about 15 minutes.

Ventilation tube insertion into the tympanic cavity was first performed by Politzer in 1862, but due to recurrent infections of the operated ears and complications in the treatment he stopped performing this procedure. It was only in 1954 that Beverly Armstrong reintroduced ventilation tube insertion [6]. He implemented new types of ventilation tubes. The middle ear ventilation tubes were inserted in one million people in the United States at the end of the last century [7].

TYMPANOSTOMY TUBE PLACEMENT AND TYPES OF TYMPANOSTOMY TUBES

Proper location of the ventilation tube is the anterior half of the pars tensa of the tympanic membrane, especially the anterosuperior quadrant. Ventilation tube placement is not recommended in the posterosuperior quadrant of the tympanic membrane, because there is a very high risk of damage of the stapes, incus or their connections with sequelae. Ventilation tubes can be made of plastic, metal or teflon and coated with a substance that reduces the possibility of infection. Short, double-lumen tubes seem to be good in providing air into the tympanic cavity and are not blocked with the tympanic cavity discharge or wax, but water more easily penetrates through their short lumen. Longer tubes are more likely to be blocked by secretion or wax. The tube lumen should not be too small, because the aeration of the middle ear is insufficient, but on the other hand, too large lumen causes prolapse of the drain and leaves a larger perforation after removal. Long ventilation tubes remained longer in the tympanic membrane during the first year of treatment, and the silicone from which they are made reduces the risk of leakage during the first year of treatment [8].

The ventilation tube is usually inserted for a few months. It is designed to provide long-term drainage of secretion, ventilate the tympanic cavity and help to cure the lesions in the middle ear lining. A tube inserted for 4-6 months usually allows for full recovery of OME. Ventilation tubes can be short-term and long-term. The short-term definition is reserved for smaller tubes, which usually remain in place for 6-12 months and fall out spontaneously. Long-term tubes are larger and have flanges that hold the tube in place for a long time. Long-term

tubes may fall out on their own but often removal by an otolaryngologist may be necessary. Short-term tubes are most commonly inserted but when there are recurrences of an ear disease, then long-term tubes, such as Goode T-tube or the Paparella tube are used more frequently. Long-term tubes are usually inserted in children with cleft palate, when it is certain, that the Eustachian tube dysfunction is present [9,10].

INDICATIONS FOR THE VENTILATION TUBE INSERTION

The most common indication for tympanostomy tubes is chronic OME. The insertion of a ventilation tube is currently the only recognized treatment in cases of bilateral exudate in the air spaces of the middle ear, persisting for more than three months, nonresponsive to conservative treatment, with conductive hearing loss, with an air-bone gap of at least 25-30 dB and type B tympanogram (with a documented history of the disease and hearing test) [11]. The ventilation tube insertions are also made in children with chronic OME and accompanying speech disorders that are associated with learning problems [12,13], in children with unilateral OME, lasting for more than 6 months (with a documented history of the disease, hearing test), as well as in children who have symptoms that are probably related to a recurrent exudate in the middle ear, associated with vestibular disturbances, behavioral problems, discomfort in the ears, poor academic performance or decreased quality of life [1,12]. Ventilation tube insertion should be considered in children with chronic diseases, *threatened with hearing loss* (one or both sides) with chronic failure of the Eustachian tube, for example in cystic fibrosis, genetic diseases or coexisting facial defects, especially those predisposed to middle ear ventilation disorders (e.g. cleft palate) [14].

The ventilation tube is inserted in cases of blood retention in the tympanic cavity (*haemotympanum*), most often after head trauma, after barotrauma (due to pressure changes, after diving or flying by airplane), in cases of autophones (abnormal hearing of one's own voice and respiratory sounds, as a result of a patulous Eustachian tube), Eustachian tube dysfunction with accompanying hearing loss, balance disorders, dizziness, tinnitus, without retention of discharge in the tympanic cavity.

Pathological lesions within the tympanic membrane and retraction pockets, resulting from long-term negative pressure in the tympanic cavity and adhesions of the ear, as well as chronic retraction of the tympanic membrane or pars flaccida of eardrum, require ventilation tube insertion due to the possibility of developing cholesteatomatic otitis media.

After tympanoplastic surgery, when auditory tube function is not sufficient, it is also recommended to insert a ventilation tube.

In oncologic patients with OME and ventilation disorders of the middle-ear air space, in the course of radiation therapy of the head and neck after skull base surgeries, some authors recommend tympanostomy tube insertion. Some authors claim that radiation therapy is a relative contraindication to ventilation tube insertion, due to possible increased incidence of chronic infection within the tube, which can lead to bone tissue destruction due to radiation (*osteoradionecrosis*) [15].

Ventilation tubes are effective in recurrent OM because of direct improvement of middle ear ventilation, impaired due to developed insufficiently and poorly functioning Eustachian tube in children [16,17]. However, the use of tubes in the treatment of recurrent OM (more than 3 episodes of acute OM during 6 months or more than 4 episodes during 12 months) remains controversial [1,7]. Some researchers recommend ventilation tubes especially in younger children (up to 2 years) with recurrent acute OM with no permanent exudate lesions or hearing loss [18,19], especially when antibiotic therapy is ineffective or impossible [13,20]. Others do not confirm the effectiveness of recurrent AOM treatment using tympanostomy tube or prolonged antibiotic therapy [21].

CONTRAINDICATIONS FOR TYMPANOSTOMY TUBE INSERTION

A ventilation tube should not be inserted in children with a single episode of OME in less than 3 months and in children with recurrent AOM who have no chronic exudate in the middle ear [1].

COMPLICATIONS OF VENTILATION TUBE INSERTION

These treatments are classified as minor, low-risk surgical procedures. The insertion of tympanostomy tube is one of the most common surgical procedures performed in children worldwide. The purpose of ventilation tube insertion is achieving direct improvement in hearing, shortening the duration of the disease and preventing the consequences of OME. Unfortunately, despite surgical treatment, in several percent of children, accumulation of exudate in the tympanic cavity tends to recur [21]. Another ventilation tube may be required [22-26].

Infection may occur in the middle ear or around the ventilation tube and topical antibiotic drops are usually required. Sometimes an oral antibiotic is needed. If tube falls out too early and discharge returns, reoperation may be necessary [22,24,27]. One of the most common complications of ventilation tube insertion is exudation of inflammatory secretion through the ventilation tube, which may be recurrent or chronic. Mucous or purulent discharge was observed in about 12-30% of ears immediately after insertion of the tube [28,29]. Leakage from the tubes immediately after insertion into the tympanic cavity may be related to backward movement of discharge from the nasal cavity to the middle ear or to the contamination from the external ear. Such changes were seen in almost half of children and in 2/3 of children with cleft palate in the first 2 years of life [30]. Discharge occurred more often when tube was inserted due to OME than to recurrent AOM. Sometimes the exudate blocks the lumen of the tube. Ventilation tube prolapse happens more frequently in the course of a leak from the ear [22] than in cases, where there is no leakage. It is recommended to take the discharge from the ear for microbiological culture and antibiogram. *Pseudomonas aeruginosa* was the most commonly isolated pathogen. However, in the age group below 3, the bacteria most typical for acute otitis media were isolated, and in older children the typical flora for the external auditory canal. It is recommended to rinse and clean the ear, use local antibiotic [29], rarely oral, and in individual cases intravenous [26]. If this procedure fails, mastoidectomy is recommended (about 0.1%) [25]. In the meta-analysis, the efficacy of ventilation tube insertion in children with Down syndrome was significantly lower than in children without this disease, therefore conservative treatment is recommended as first-line treatment and tympanostomy tube is required only if there are significant hearing impairments and pathological changes of the tympanic membrane as a consequence of OME (tympanosclerosis, persistent perforation, cholesteatoma). In children with Down syndrome, more frequent episodes of ear leakage from ventilation tubes were observed and antibiotic-resistant bacteria were more often isolated from exudates. Hearing improvement after tube insertion was not always observed [14]. Ventilation tubes were removed in case of granulation tissue formation.

After falling out of the tube, permanent perforation of the tympanic membrane was rare (0.5% -25% of cases), and it depended on the type of tube used and the number of insertion repetitions, and it was observed more often in children younger than 5 years, with the use of Goode T-tubes [10]. Despite success in treating chronic OME by tympanostomy tubes insertion, adverse outcomes, such as local atrophy, retraction of pars flaccida or tensa of tympanic membrane and

tympanosclerosis [1] are observed. Very rarely (1.1%), patients may develop otitis media with cholesteatoma or displacement of a ventilation tube into the tympanic cavity, as a complication of tympanostomy tube insertion [29].

Among 10000 inserted tubes, minor complications, such as leakage or fall out of the tube, occur in 0.016% of ears [22]. The effects of long-term tympanostomy tubes refer to structural changes in the tympanic membrane, such as local atrophy (67.2%), tympanosclerosis (32%, 39.5%) and retraction pockets (39.5%) [32,33]. In the case of short-term tubes, chronic perforation is observed in 2.2% of cases compared to 16.6% of the cases of long-term tubes [32]. The effectiveness of ventilation tube insertion in the first six months compared to paracentesis or non-surgical treatment in pediatric patients with OME was assessed. Tympanosclerosis was observed in about one-third of the ears after tympanostomy tube insertion [27], the location of tympanosclerotic plaques did not always correspond to the area of inserted tubes, and when the ventilation tubes remained in the tympanic membrane for a period longer than 12 months, sex and age were not relevant in their development [10,34].

The incidence of tympanosclerosis in the ears treated with tympanostomy tube insertion was 39-60% compared to 3-10% of surgically untreated ears, and in case of local atrophy 16-44% versus 5-31%, respectively [12,35]. The development of retraction pockets was observed in 10-52% of tympanostomy-treated ears compared to 20-40% of conservatively-treated ears [35]. In 12% of children with OME, there was still an effusion in the middle ear, regardless of the fact whether ventilation tube was inserted or conservative treatment was implemented [36]. In infants up to 16 months of age, undergoing ventilation tube insertion, after 5 years of follow-up, there was still effusion in 7.5% of the cases treated surgically [37] and in 23.7% of the cases treated conservatively [33]. Occasionally, damage of the middle and inner ear components occurred [38].

CARE OF TYMPANOSTOMY TUBES

In order to protect the ears with inserted ventilation tubes, earplugs should be used, especially when diving, to prevent contamination of the middle ear from water contents and development of AOM. However, during hair washing, bathing and surface swimming, insertion of a cotton wool soaked in oil into the external auditory canal is sufficient. In an extensive meta-analysis no higher incidence of otorrhea was found in children swimming with earplugs compared to children swimming without earplugs [39].

VENTILATION TUBE REMOVAL

The issue of ventilation tube removal remains debatable. It is not indicated to remove the tube too early because the function of the Eustachian tube achieves efficiency at different times, even after several years. Indications for ventilation tube removal appear when the tube partially prolapses the tympanic cavity and no longer ventilates it or if it causes chronic infection and leakage from the middle ear or granular myringitis. Typically, tympanostomy tubes remain in the tympanic membrane for approximately 6-12 months, but some remain for as long as several years [13,14]. In contrast to adults, whose Eustachian tube function may be asymmetrical, the patency of the Eustachian tubes in children is usually similar. Tympanostomy tube removal depends on the age of the child (after 6 years of age, the incidence of AOM and OME decreases), on the duration of tube retention, whether the tubes are placed on one or both sides, on the condition of the second ear in which the tympanic membrane should be normal, on the function of the Eustachian tube, on the absence or presence of recurrent or chronic otorrhea (its frequency, severity and duration of discharge), and on the seasons (fall and winter are less favorable seasons).

Tympanostomy tube removal should be considered in cases of unilateral tube insertion with a normal state of the second ear and when no inflammation or exudate is reported in the ventilated ear for at least one year and even in cases of bilateral tube insertion, when long-term patency of the Eustachian tube is obtained (for example, as a result of successfully treated allergy, after adenoidectomy, after cleft palate operation), and also when leakage from the middle ear through the ventilation tube subsided after effective antibiotic therapy, and in cases when a tube is surrounded by granulation tissue that precludes it from functioning.

The perforation resulting from spontaneous fall out of the tube or, more often, after its surgical removal due to prolonged occlusion in the tympanic cavity, always requires tympanoplastic or myringoplastic surgery [1].

SUMMARY

Both the tympanic membrane incision and the middle ear ventilation tube insertion are surgical procedures related to the risk of early and late complications, occurring in the course of otological disorders, but the benefits they provide are very valuable – therefore they are still widely used in the treatment of middle ear infectious diseases, both in children and adults.

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