



## Review

## Success rates for various graft materials in tympanoplasty – A review

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## ABSTRACT

**Objectives:** The aim of this paper is to review how successful each type of grafts is in tympanoplasty.**Methods:** Pubmed, Google and the Proquest Central Database at Kirikkale University were queried using the keywords “graft”, “success” “tympanoplasty”, “success rate” with the search limited to the period 1955 to 2017.**Results:** Various types of graft materials including temporalis fascia, cartilage, perichondrium, perios-teum, vein, fat or skin have been used in the reconstruction of tympanic membrane (TM) perforation. Although temporalis fascia ensures good hearing is restored, there are significant concerns that its dimensional stability characteristics may lead to residual perforation, especially where large TM perforations are involved. The “palisade cartilage” and “cartilage island” techniques have been stated to increase the strength and stability of a tympanic graft, but they may result in a less functional outcome in terms of restoring hearing. Smoking habits, the size and site of a perforation, the expertise level of the operating surgeon, age, gender, the status of the middle ear mucosa and the presence of myringosclerosis or tympanosclerosis are all important in determining how successful a graft is.**Conclusion:** Although temporal fascia is the most commonly used graft material for tympanoplasty, poor graft stability may cause failure. This failure is due to the inclusion of connective fibrous tissue containing irregular elastic fibers present in the grafted fascia. Cartilage grafts offer better ability to resist infection, pressure, and cope with insufficient vascular supply. This means that cartilage grafts are suitable for use in revision cases.© 2020 PLA General Hospital Department of Otolaryngology Head and Neck Surgery. Production and hosting by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

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## 1. Introduction

Chronic suppurative otitis media (CSOM) is a common occurrence issue in children and adults in developing countries (Adoga et al., 2010; Acuin, 2007). The usual presentation is of recurrent otorrhoea as a result of persistent tympanic membrane (TM) perforation, accompanied by conductive hearing loss, which may vary in severity. The onset of CSOM is early in life and the condition represents one of the most common infectious diseases during childhood (Adoga et al., 2010; Indorewala et al., 2015). Tympanoplasty involves the surgical reconstruction of a perforated TM, and is performed to restore auditory function and to protect the middle ear against environmental insults, e.g. infections (Sergi et al., 2011). Tympanoplasty was first described by Berthold and Wullstein. Zollner then further modified the technique (Sergi et al., 2011; Olusesi et al., 2011; Wullstein, 1956; Zollner, 1955). Common approaches to tympanoplasty involve the endomeatal, endaural or postauricular route. Various surgical outcomes may occur, depending on the size or site of the perforation (Sergi et al., 2011). A graft can be surgically placed over or under the remnants of the tympanic membrane (Sergi et al., 2011; Faramarzi et al., 2012; Vartiainen and Nuutinen, 1993). Positioning the graft under the remaining portions of the TM is referred to as the “underlay” technique, and is the most straightforward and routinely performed technique in use (Indorewala et al., 2015; Sergi et al., 2011; Olusesi et al., 2011; Mishra et al., 2007).

Tympanoplasty can be achieved using various types of graft, including temporalis fascia, perichondrium or fascia lata (Kazikdas et al., 2007; Demirpehlivan et al., 2011; Mauri et al., 2001). Although temporalis fascia ensures good hearing is restored (Kazikdas et al., 2007; Mauri et al., 2001), there are significant concerns that its dimensional stability characteristics may lead to residual perforation, especially where large TM perforations are involved (Indorewala et al., 2015). The “palisade cartilage” and “cartilage island” techniques have been stated to increase the strength and stability of a tympanic graft, but they may result in a less functional outcome in terms of restoring hearing (Indorewala et al., 2015; Sergi et al., 2011).

The aim of this paper is to review how successful each type is in tympanoplasty.

## 2. Methods

Pubmed, Google and the Proquest Central Database at Kırıkkale University were queried using the keywords “graft”, “success” “tympanoplasty”, “success rate” with the search limited to the period 1955 to 2017.

## 3. Factors to consider in surgical approach

The primary aim of tympanoplasty is to achieve closure of a perforated TM, thereby ensuring protection for the middle ear, as well as restoring hearing. The success rate in tympanoplasty reported in the literature varies from 75 to 98% (Sheehy and Anderson, 1980; Westerberg et al., 2011; Callioglu et al., 2013;

Mohamad et al., 2012). Age of the patient, the size and site of perforation, eustachian tube functionality, the status of the middle ear mucosa, the type of graft and surgical experience have all been cited as factors which may influence the surgical outcome (Westerberg et al., 2011; Mohamad et al., 2012; Lin et al., 2011; Şahan et al., 2014).

The overlay and underlay techniques are the most commonly undertaken amongst several surgical procedures that have been identified as suitable for tympanoplasty (Cummings et al., 2005; Tos, 2008; Anand et al., 2002). The overlay technique calls for surgical experience and the operation time is longer. Furthermore, the technique entails certain risks, such as tympanomeatal blunting and cholesteatoma formation. Revision tympanoplasty, involving reconstruction of a TM perforation, is highly challenging, whichever technique is employed, because the tissues have a reduced nutritional supply (Şahan et al., 2014).

Myringoplasty is a straightforward surgical procedure that is usually performed for small perforations, not involving inspection of the ossicular chain. During the procedure, the edges of the perforation are refreshed and a trimmed graft of suitable size is placed laterally to the perforation (Aggarwal et al., 2006).

Proper tympanoplasty planning should involve consideration of the location (marginal versus central) and the size (subtotal versus total) of the perforation. Myringosclerosis and foci of tympanosclerosis should be noted, where present. Comorbidities, such as craniofacial disorders and allergic rhinitis, should be borne in mind to achieve a better surgical outcome. Moreover, it should be recognised that several factors, such as severe eustachian tube dysfunction, adhesive otitis media, otorrhoea, cholesteatoma, and revision surgery can impair the surgical closure of a TM perforation (Chang, 2009; Lin and Messner, 2008). The transcanal approach is particularly suitable for small posterior perforations, or for medium-sized perforations with a clear view of the anterior TM. However, the transcanal approach can only be used with difficulty in cases of anterior TM perforation or in patients with stenotic ear canals or with a large bulge of the anterior canal. In some patients where stenosis of the canal is limited in extent, canaloplasty can be undertaken to improve visualisation of the TM (Reilly, 2016).

To decide on the most appropriate surgical approach to tympanoplasty, the following characteristics should be borne in mind: size and site of TM perforation, the status of the middle ear ossicles and mastoid, the surgeon’s level of expertise, and anatomical considerations such as a narrow ear canal (Wehrs, 1999; Wright and Safranek, 2009; Kartush et al., 2002). During the surgical procedure, the middle ear and ossicles should be examined meticulously to look for possible adhesions, granulation tissue and cholesteatoma and the surgical technique should be modified according to the pathology wherever necessary. A clear view of the surgical field should be a major concern and surgeons should be careful not to disrupt the intact and mobile ossicular system during the operation (Luetje and Bailey, 2006).

## 4. Grafts used in tympanoplasty

Tympanoplasty is essentially a procedure involving tissue

transfer. Various types of graft materials, including temporalis fascia, cartilage, perichondrium, periosteum, vein, fat or skin have been used to repair TM perforation (Jansen, 1963; De Seta et al., 2010). Among these grafts, true temporalis fascia is usually the most popular choice for surgeons since it is close to the operation field and easy to harvest. However, the loose areolar fascia of the temporalis muscle is also in use by some surgeons, who save the true fascia for revision cases (Reilly, 2016). Cartilage grafts of appropriate size can be harvested either from the tragus or the concha, with minimal risk of morbidity at the donor site. Cartilage grafts are the usual choice of the majority of surgeons in revision cases, since these grafts possess both strength and durability, albeit their functional capacity remains a matter of debate (Reilly, 2016; Dornhoffer, 2006).

## 5. Success rate in tympanoplasty

Graft viability and the success rate in tympanoplasty are associated with several demographic and clinical factors, such as smoking habit, the size and site of the perforation, the surgeon's level of expertise, age, gender, the status of the middle ear mucosa and the presence of myringosclerosis or tympanosclerosis (Yurttas et al., 2015a; Onal et al., 2005; Pignataro et al., 2001; Caylan et al., 1998; Yurttas et al., 2015b; Merenda et al., 2007; Singh et al., 2005; Pinar et al., 2008). Yurttas et al. (2015b) reported that epitympanic patency, the presence of middle ear infection, and the morphology of the TM and middle ear mucosa should be considered as significant prognostic factors in tympanoplasty with mastoidectomy. Onal et al. (2005) found that graft viability was significantly higher in patients whose ears remained dry for more than three months.

There are conflicting reports in the literature about the effect the site of perforation has on the success of grafting. Pinar et al. demonstrated that grafts for central perforations were more successful than those for posterior or anterior perforations (Pinar et al., 2008). However, elsewhere in the literature, it is reported that the location of the perforation had no influence on the success rate (Merenda et al., 2007). Myringosclerosis may result in a reduced vascular supply to the TM, as well as being associated with greater size of perforation, since any sclerotic plaques will need to be excised during surgery (Yurttas et al., 2015a). Onal et al. (2005) deny any association between myringosclerosis and a lower success rate for tympanoplasty. However, the studies by Pinar et al. (2008) and Yurttas et al. (2015b) reported that the absence of sclerotic plaques on the TM increases the success of grafting in tympanoplasty.

The success of any tympanoplasty procedure can be assessed in anatomical as well as functional terms. Anatomical success is defined as an intact graft with a dry ear, whereas an air-bone gap  $\leq 20$  dB after the procedure is defined as functional success. Although temporalis fascia at the time of writing is the most commonly chosen graft material for tympanoplasty, cartilage grafts have become more popular recently due to their resistance to retraction, protection against infections, and possessing long-term viability (Jansen, 1963; De Seta et al., 2010; Scattolin A, D'Ascanio, 2013). In the literature, several studies have compared temporalis fascia and cartilage for TM perforation grafting, using both anatomical and functional measures of success (Yegin et al., 2016; Cabra and Monux, 2010; Mutlu et al., 2012). There was a small difference in surgical outcome between wet and dry ears (Naderpour et al., 2016).

Yegin et al. (2016) compared the anatomical and functional outcomes of tympanoplasty employing temporalis fascia or tragal cartilage in type 1 tympanoplasties performed on paediatric patients. They reported that the rate of anatomical success in the cartilage graft group was significantly better than in the fascia

group, while functional outcomes did not differ between groups. Cabra et al. reported a success rate of 82% in tympanoplasty using palisaded cartilage versus a success rate of 64% in tympanoplasty using fascia. Follow-up lasted 24 months. Mutlu et al. (2012) reported satisfactory results with tragal cartilage island tympanoplasty, in terms of graft resistance and hearing functionality. Cavaliere et al. (2009) quote a success rate for grafting of 100% in a group of 236 patients who underwent cartilage shield graft tympanoplasty.

Allergic rhinitis (AR) is an inflammatory reaction of the nasal and nasopharyngeal mucosa to allergenic substances (i.e. allergens). The middle ear and eustachian tube mucosa may become inflamed, as AR involves mucosal inflammation (Fireman, 1997; Stuar, 2001; Doyle, 2002; Pelikan, 2009). Callioglu et al. (2016) compared graft success rates in type 1 tympanoplasty between patients with or without AR. They found the success rate was slightly higher in patients without AR, although the difference was not statistically significant.

## 6. Failed tympanoplasty

Failure of tympanoplasty may be due to a variety of reasons, including type of graft, operative technique, or patient-related factors (Dornhoffer, 2003; Boone et al., 2004). In the literature, the following factors have been addressed as potential causes of failure in temporal fascia tympanoplasty: atelectasis, eustachian dysfunction, the presence of active infection, myringo- and/or tympanosclerosis, and revision cases (Callioglu et al., 2013; Mohamad et al., 2012; Indorewala, 2004). In temporal fascia tympanoplasty, graft failure was attributed to poor stability characteristics linked to the presence of connective fibrous tissue with irregular elastic fibers within the fascia (Indorewala, 2004). Cartilage grafts offer better protection against infection, and can cope with high pressures, and vascular supply insufficiency. This means cartilage grafting is suitable for revision cases (Mohamad et al., 2012; Şahan et al., 2014; Dornhoffer, 2003; Boone et al., 2004; Indorewala, 2004; Altuna et al., 2012; Ozbek et al., 2008).

Healthy and functional TM depends on free flow of air between the middle ear and mastoid cells. The direction of airflow through the antrum in humans is either between the tensor tympani tendon and the stapes or the short arm of the incus and the stapes tendon (Cummings et al., 2005). The aeration pathway can be obstructed by a number of different pathologies, such as granulation tissue formation, oedema or inflammation, and where this occurs, the mucosa of the middle ear and mastoid cavity undergoes pathological changes. Da Costa et al. demonstrated the presence of granulation tissue and bony pathology in 96% of temporal bones where TM perforation had occurred (1992). Lesinkas and Stankeviciute (2011) detected tympanosclerosis and ossicular changes in 29.5% of patients during primary tympanoplasty, whilst these pathologies were present in 63.4% of revision cases. Furthermore, mucosal hypertrophy or discharge may indicate active inflammation or eustachian tube dysfunction (Noh and Lee, 2012; Webb and Chang, 2008), which significantly reduces the rate of successful grafting in revision tympanoplasty (Şahan et al., 2014). The presence of tympanosclerosis or adhesive otitis media decreases the chance of graft survival (Callioglu et al., 2013; Dornhoffer, 2003; Lesinkas and Stankeviciute, 2011; Bhat and De, 2000). In particularly adhesive cases, retractions may occur in spite of cartilage tympanoplasty, and ventilation tube placement may be required to avoid the development of retraction (Dornhoffer, 2003).

## 7. Conclusion

A healthy and functional tympanic membrane depends heavily

on free airflow in the middle ear and mastoid cells. Although temporal fascia is the most commonly used graft material for tympanoplasty, poor graft stability may cause failure. This failure is due to the inclusion of connective fibrous tissue containing irregular elastic fibers present in the grafted fascia. Cartilage grafts offer better ability to resist infection, pressure, and cope with insufficient vascular supply. This means that cartilage grafts are suitable for use in revision cases.

## Disclose

There is no financial disclosures of the authors.

## Ethical approval

There is no need to take ethical approval, because this paper is review.

## Informed consent

There is no need to take informed consent, because this paper is review.

## Author contribution and responsibilities

**Ali Bayram:** Planning, literature survey, English edition.

**Nuray Bayar Muluk:** Planning, literature survey, writing the manuscript, submission.

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## Declaration of competing interest

Author **Ali Bayram** declares that he has no conflict of interest.

Author **Nuray Bayar Muluk** declares that she has no conflict of interest.

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