Evaluation of Transcanal Inlay Butterfly Cartilage Tympanoplasty

Thesis

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Abstract

Synonyms:

Butterfly tympanoplasty, Inlay cartilage tympanoplasty, Eavey technique of cartilage tympanoplasty.

Objectives/Hypothesis

Since the initial report of the Inlay butterfly cartilage tympanoplasty in 1998 for small sized perforations in children, multiple papers and modifications have been described to extend the utility of this method.

The objective of our current study is to evaluate the overall graft take rate, hearing improvement, patient compliance and complications of the inlay butterfly cartilage tympanoplasty.

Patients and methods

Thirty one patients (19 female and 12 males) were enrolled in the current study between July 2007 and October 2009. Ages ranged from 17 to 55 years. Perforation sizes ranged from the size of a ventilation tube up to 6mm. Follow up observation period ranged from 1-25 months with a mean follow up of 13.96 months. For all patients inlay transcanal butterfly cartilage tympanoplasty was used to repair all perforations

Results

The graft take rate was 93.54% (29/31). There was closure of the air bone gap within 10dB in 21 patients (67.7 %) and within 20dB in 28 patients (90.3%) of patients. Hearing decreased in 3 patients (9.7%).

Conclusion

Transcanal inlay butterfly cartilage tympanoplasty represents a recent method of cartilage tympanoplasty which provides a very high graft take rate ranged from 84% up to 100%. Further, the technique offers advantages such as no post auricular incision, minimal postoperative pain, rapid recovery and return to work or school and shorter OR time which translates lower expenses.

Lastly, recent studies have shown that with time cartilage become thinned and becomes part of the drum and provides excellent hearing results.

Key word: Magnification- ear pressure- cartilage tympanoplasty- Historical- Cartilage Tympanoplasty

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Aim of the work

The aim of this work is to evaluate Inlay Transcanal Butterfly Cartilage Tympanoplasty as one of relatively recent techniques of cartilage tympanoplasty and to estimate how effective it is regarding graft take rate, hearing results, post operative pain, operation time, cost, patient compliance, to compare it to other studies using the same technique and to compare it with studies using different techniques of tympanoplasty.

Review of the literature

Introduction

The history of otology followed the history of medicine. the limited knowledge of the ancient physicians contributed to the delay in marked progress of otology. Otologists have sought to restore hearing loss due to infections of the eardrum since the seventeenth century. And at that time otology was mainly considering foreign body removals and management of trauma. The use of magnification at the end of eighteenth century added so much and evolved the modern otology. This historical review describes the history of otology and the development of modern techniques of ear surgery. **(Rizer, 1997)**

Historical Background

The early Egyptian healers on 1000 B.C. had a large number of prescriptives available for the treatment of ear problems. Many types of otologic problems were treated with herbs and other extracts. Of course, other diseases were attributed to the ear as well and were treated with little effect. It is of note that ear disease was often attributed to brain disease, and efforts directed accordingly. Early work was descriptive. One of the earliest physicians, Hippocrates, who is on 400 B.C. recognized that a painful, discharging ear with fever was a life-threatening condition and described classic symptoms of otitis media. “Acute pain of the ear, with continued strong fever, is to be dreaded, for there is danger that the man may become delirious and die. Aphorisms of Hippocrates have been widely quoted and helped a lot of physicians like the following one”In the elderly, vertigo and deafness are common symptoms”. **(Dennis and Pappas, 1996)**

Surgery for a mastoid infection was first proposed five centuries ago by Ambriose Paré (1510-1590) on the young King Charles II of France, who was dying with a high fever and discharging ear.**(Kimble, 1936)** The king's bride, Mary, Queen of Scots and of France, agreed, but the King's mother, Catherine de Medici, forbade the operation. The king died. This incident helped neither Paré's reputation nor the fledgling specialty of otology. Thus another 100 years passed, before the next recorded attempt at otologic intervention. Paré has some astonishing contributions; he suggested that wounds of external canal may lead to stenosis, so a spongy something like a wick should be used to avoid this. He also used some prosthesis to restore the deficient auricle in cases of trauma or anomalies. (**Rizer, 1997)**

In 1640, Banzer published an account of a case of tympanic membrane repair. A pig's bladder was stretched across an ivory tube and placed in the ear. This marks a trend in repair of the drum, that of placing artificial membranes in the ear temporarily. Around that time 2 textbooks were published 20 years apart discussing ear problems, the first one was "*The treatise of Guichard Joseph Duverney* (1648-1730)". Duverney mentioned in his book some valuable observations like ear drainage is coming from the ear not the brain like what was expected for centuries. The second text of otology was by Antonio Mario Valsalva(1666-1723) and he described the anatomy of inner ear described two channels in the cochlea (Scala) separated by a septum. Domenico felice Antonia cotugno (1736-1822) discovered the fluid of the inner ear in 1760. Antonio Scarpa, described the membranous labyrinth in 1795. **(Dennis and Pappas, 1996)**

The first documented successful surgery for a mastoid infection was performed by Jean Petit of Paris in 1774. Shortly thereafter, in 1776, a Prussian

surgeon named Jasser successfully performed a mastoid operation on a soldier with a draining ear. However, this new operation was discredited when Baron Bergen, personal physician to the king of Denmark, persuaded a colleague to perform this procedure on Bergen himself with the mistaken assumption that it would relieve his deafness and tinnitus. The operation resulted in sepsis, which led to Bergen's death, thus consigning the mastoid operation to obscurity for another century**.** (**Rizer, 1997)**

No significant descriptions of further ear surgery exist in the literature until 1853. Then, a procedure was published by Sir William Wilde for sepsis and suppuration of the ear. He described the post auricular incision and removal of the mastoid cortex for purulent infections. This was the beginning of the modern era of otologic surgery. Nearly every operation that followed until the present built upon this basic technique and expanded the indications and techniques. **(Dennis and Pappas, 1996)**

Twenty years later, in 1873, Herman Schwartze published both the indications and the procedure for removing the mastoid cortex and the underlying air cells with a mallet and chisel for acute mastoid infection. The art of using the mallet and chisel for mastoidectomy persisted for 75 years. Before antibiotics, otitis media was responsible for the death of many children. **(Schwartze, 1873)**

The simple mastoidectomy became a mainstay in the treatment of acute mastoiditis and saved many lives. Whiting described the state of the art: "As a life saving measure, few surgical procedures equal and none surpass in efficiency the modern mastoid operation (**Rizer, 1997).** Also in 1873, von Troltsch and, later, von Bergmann expanded the simple mastoidectomy of Schwartze to include the attic and antrum. This increased the success of mastiod surgery for suppuration

(von Troltsch, 1873), (von Bergmann, 1889). When the radical mastoidectomy was described by Zaufal and Stacke for the chronically draining ear, the battle for control of ear disease began in earnest. Nearly all of the surgical techniques in use today had been described, but advances remained slow for the next 50 years. No significant changes in the therapy of otologic disease occurred until the advent of the operating microscope and antibiotics in the 1950s **(Zaufal, 1890), (Stacke, 1893)**. **(Rizer, 1997)**

Parallel to these developments were efforts to improve hearing. In 1853, Toynbee placed a rubber disk attached to silver wire over a perforation with hearing improvement **(Toynbee, 1853).** Yearsley, in 1863, improved hearing by placing a cotton ball over a perforation **(Yearsley, 1863).** In 1877, Blake introduced the idea of placing a paper patch over the perforation. **(Blake, 1877).** Roosa and Okneue promoted healing of the drum by application of chemical cautery. **(Roosa, 1876), (Okenuff, 1895), (Rizer, 1997)**

The advances in the 20th century can be easily followed. Surgeons were able to control disease with the techniques developed in the previous century. In the ‘30s they had the powerful new tool of antibiotics and were able to achieve dry ears by treating infection. Then, with the operating microscope, they became able to examine the ear and developed instruments for manipulating the drum and ossicles. The stage was set for dramatic advances. House, Sheehy and Glasscock developed techniques for creating a satisfactory onlay graft **(House, 1960), (Sheehy and Glasscock, 1967).** Shea, while performing stapedectomy, discovered that vein graft (connective tissue) could be satisfactorily placed under the drum to repair a tear **(Shea, 1960)**. Storrs switched to fascia, and Patterson et al. determined

the reasons for the success of fascia as a grafting material**. (Storrs, 1961), (Patterson et al, 1967), (Deralki, 1953), (Hough, 1970), (Austin, 1972).**

Developments that evolved the modern otology

Artificial Eardrum

The artificial eardrum refers to a technique of placing a diaphragm of material in the ear on the end of a rod prosthesis. The device could be inserted at the individual's convenience and removed for hygiene. Such devices have been available since the 1600s.

Marcus Banzer was the first, in 1640, to propose a prosthesis as a tympanic membrane substitute. In 1853, Toynbee was able to dramatically improve hearing by placing a small rubber disk attached to a silver wire over a perforation in the tympanic membrane. The description prompted others to devise ways to achieve a more durable closure of perforated membranes **(Rizer, 1997).**

Yearsley, in 1863, used a cotton ball over the perforation. In 1877, Blake placed a paper patch over a perforation. This technique was used later as an indication for a tympanoplasty if hearing was improved with the patch. It is of interest that this procedure is still used by some centers to predict the success of tympanoplasty and to demonstrate to patients the remarkable hearing gain to be expected. This technique was still in use in the 1930s in the United States. Howard House tells of using latex from condoms with a Toynbee silver wire to repair dry perforations. The latex had to be changed daily. In the '30s the purchase of several dozen condoms was not something that many women were willing to undertake, even to hear better**. (House, 1986)**

Pohlman devised an artificial eardrum made of a rubberlike plastic known as Korogel® that was placed into the ear canal by the patient. These nonsurgical attempts to close the drum and improve hearing were used primarily for dry perforations. Tortuous, narrow canals or overhanging drums prevented the use of this device. The patient with poor hygiene or less than meticulous care could not use these devices either. But these prostheses proved that hearing could be restored to infected ears and provided an impetus for further investigation into operative repair of the drum**. (Pohlman, 1951)**

Control of Ear Infections

It was critical that infection be controlled before hearing could be reconstructed. Although the radical mastoidectomy resulted in surgical control of infection, much was to be desired in the way of improving the patient's hearing. In 1906, the first conservative surgical procedures were described by Health and Bryant. Both described modifications of the radical mastoid operation that preserved the tympanic membrane and ossicles. Their procedures did not gain wide acceptance, presumably because of complications **(Heath, 1906), (Bryant, 1906).** In 1910, Bondy described the classic modified radical mastoidectomy **(Bondy, 1910).** Opinions of the day were against conservation surgery, and the procedure was neglected until the 1940s, when it was reintroduced and popularized by Day and Baron. Antibiotics and Instrumentation By the early 1930s, acute and chronic ear infections were adequately managed surgically. At least, the death rate from suppurative complications had declined. **(Day, 1941), (Baron, 1949)**

Medical therapy of the ear was becoming useful with the availability of sulfonamide antibiotics. Instrumentation facilitated further development of mastoid and middle ear surgery. The dental drill was used for mastoid exenteration.

Cautery helped control hemorrhage. The improvement of techniques in general anesthesia, as well as the availability of blood replacement and intravenous fluid therapy, spurred and sustained further advances in surgical techniques**. (Glasscock and Kanok, 1977)**

Cautery of Perforations

Roosa described the office repair of tympanic membranes as it is practiced today. He applied silver nitrate to the edges of the perforation in an attempt to promote healing. Okneuff described the successful use of trichloracetic acid. Derlacki wrote an extensive thesis about the phenomenon of office treatment of tympanic membrane perforations. Successful closure was accomplished in 75% of all perforations. The treatment required the weekly reapplication of trichloracetic acid and a cotton patch to the perforation. Daily drops were applied to the patch to continue the irritation of the edges of the perforation. The success rate was achieved after 14 weekly treatments. **(Roosa, 1876), (Okenuff, 1895), (Rizer, 1997)**

Magnification

The operating microscope and the intraoperative use of ocular magnification were revolutionary advances, essential to the fledgling art of microsurgery and otology. Holmgren, a pioneer in fenestration surgery of the horizontal canal for otosclerosis, was the first otologist to use the binocular operating microscope **(Holmgren, 1923)**. Delays in bringing this device to the United States led Julius Lempert to implement the alternative technique of optic loop magnification **(Lempert, 1938).** Shambaugh, who tutored under Lempert, was finally able to bring the operating microscope to the United States and became the first American to use the instrument routinely in surgery. **(Glasscock and Kanok, 1977)**

Tympanoplasty

Many of the dramatic advances in medicine and surgery in the 19th century occurred in Germany. In 1863, a landmark discovery of the workings of the middle ear was made by Herman von Helmholtz. His description of the middle ear transformer mechanism was essentially ignored **(von Helmholtz, 1868).** It was not understood until 90 years later. This work formed the foundation for all reconstructive middle ear surgery. The concept of a tympanoplasty is credited to Berthold, who in 1878 was thought to have performed the first true tympanoplasty. He deepithelialized the tympanic membrane by applying a court plaster against the membrane for 3 days, then removing it with the epithelium. A skin graft was then applied **(Berthold, 1878)**. Nothing more was done with the technique until 1944, when tympanoplasty was reintroduced by Schulhof and Valdez. **(Schulhof and Valdez, 1944)**. In 1952 the procedure was publicized and popularized by Wullstein using split-thickness skin grafts**.** Zollner began his work in 1952 and finished it a year later. They recognized that unless the ossicles were extensively involved by disease, a radical mastoidectomy would lead to an unnecessary sacrifice of middle ear structures. Furthermore, they recognized and expounded on the principles introduced by von Helmholtz almost a century before: a new tympanic membrane and an adequate tympanic cavity with intact ossicles are necessary for the transformation of sound pressure upon the oval window as well as sound protection of the round window. **(Zollner, 1955)** The work of these two surgeons integrated the previous works and formed the basis of modern otologic practice. Concurrently, stapes surgery was being changed radically. Otologic surgeons were applying the techniques and instrumentation to the advantage of their patients. In the latter half of the 19^{th} century, surgeons performed operations on the stapes to improve hearing in patients with otosclerosis. **(Wullstein, 1971)**

Kessel and Miot are credited with the first series of stapes mobilizations,**(Kessel, 1878), (Miot, 1890)** and Blake and Jack with the first stapedectomies **(Blake, 1892), (Jack, 1892)**. It is not clear, however, why these procedures were abandoned. Presumably, the lack of antibiotics, sterile procedure, and magnification was a factor. Rosen reintroduced stapes mobilization in 1952 **(Rosen, 1953),** and in 1956 Shea performed the first modern stapedectomy with replacement by a prosthesis. The broad availability of the Zeiss operating microscope and micro instrumentation spurred further advances in middle ear surgery. **(Shea, 1958)**

Evolvement of Grafting Techniques

The full-thickness and split-thickness skin grafts of Wullstein and Zollner laid over the denuded drum remnant were prone to infection, graft failure, and iatrogenic cholesteatomas.**(Wullstein, 1971), (Zollner, 1955)** They became boggy, edematous, and desquamative as a result of the presence of sweat and sebaceous glands. Histologic studies revealed that years after grafting onto the drum, sweat glands, hair follicles, and sebaceous glands were still present. The graft “take” rate, even in ideal cases, was only 71%. **(Plester, 1963),**

Canal skin grafts

In 1956 it occurred to Sooy that the most readily available skin was the skin of the ear canal. A canal skin pedicle flap was rotated onto the drum remnant for closure of marginal perforations **(Sooy, 1956).** House and Sheehy advanced the technique by using the canal skin as free grafts laid over the drum remnant. As ear canal skin was devoid of glands, it was thought that the problems associated with full thickness and split-thickness skin grafts could be avoided. The take rate was initially excellent in tympanoplasty cases (97%), but the problems of desquamation