Plester's Angled Prosthesis for Ossicular Chain Reconstruction

A Pusalkar, Consultant Otologist, Mumbai. Usha, 118 Shibaji park M.B. Raut road
Mumbai 400 028 India

G. Schimansk, G. Langhane, E. Steinbach. Germany

Abstract

Reconstruction of a defect of the long process of the incus by means of bone chips, cartilage grafts or other material do not give satisfactory long term results. Plester developed therefore an angled prosthesis to reconstruct the defect. It consists of a cross-slit gold bell which is connected with a double band titanium cuff by a tiny gold wire. The prosthesis crimped on the stamp of the long process with open titanium bands, the bell is kept over the head of the stapes. The authors have inserted 81 angled prosthesis. In 63 cases, the post operative conductive hearing loss amounted to 15 dB on an average.

Chronic inflammation of the middle ear is one of the most frequent and dangerous pathological conditions even today. The concept of reconstructive middle ear surgery was founded and further developed by Professor Wulstein. Hall and Rytznar performed the first ossicular chain reconstruction by using autologous ossicular bone. Subsequently various workers used various autologous, homologous materials with various success rates. Once it was proved that these materials give good results otologists started concentrating on designing stable ossicular interpositions. However, these ossicular assemblies presented some problems after long term follow-up. There were displacements, lateral retractions, fibrous or bony ankylosis, Bulky grafts leading to blocking of air flow in middle ear cleft, resorption leading to discontinuity.

According to Zollner and Plester, conductive hearing loss in chronic otitis media is caused mostly due to destruction of the incus. Various conditions like granulations, cholesterol granuloma, tympanosclerotic plaques and progressive cholesteatoma can lead to partial destruction of long process of incus (fig.1) by

avascular necrosis due to localised osteitis. During the course of surgery if one inspects the ossicular chain it may appear intact. However when the mobility of the chain is tested it reveals that the movements of malleus and

Fig-1 Partial Destruction of long Process of incus

incus are not transferred to the stapes because the continuity of the chain is maintained only by a fibrous band between the long process of incus and the stapes (fig. 2) and hence the mechanical energy cannot be transmitted by this band to the stapes.

Materials & Methods

After favourable experience of ten years with prosthetic gold implants for ossicular replacement. Plester together with the technical laboratory of Mr. Kurz of Dusslingen, Germany developed an angled prosthesis for the reconstruction of the long process of the incus. This prosthesis consists of two parts. A bell shaped socket with four cross slits and a pair of bands of titanium cuff. These two parts are connected with each other by a gold wire.

Fig 2: Showing Fibrous Band Between Long Process of incus and Stapes

The titanium bands are fixed by a Mc Gee wire crimper to the remanant of the incus and the bell shaped socket is put on the head of the stapes. The four elements of the socket then are crimped on the head of stapes (fig. 3). Occasionally partial removal of the lateral attic wall is needed to get a better overview and to facilitate implantation. The specific properties of titanium enables a tight osseointegration to the remnant of the long process. The angled prosthesis is designed in such a way as not to alter the ossicular chain from its original and unique anatomical position.

Results

The authors have implanted 81 angled Plester prostheses during the last three and half years. The causes of incus necrosis were chronic otitis media with or without cholesteatoma, tympanosclerosis, chronic adhesive otitis media and trauma of the middle ear as shown in table

Table1 Partial Destruction of Long Process of Incus	
Causes	Number of cases
Chronic Otitis Media-Tubo Tympanic	37
Cholesteatoma	24
Tympanosclerosis	10
Adhesive Otitis Media	7
Trauma	3
	81

Table II Pre Operative Conductive Hearing Loss	
dB	No. of Cases
10-20	3
20-30	3
30-40	37
40-50	24
50-60	14
	81

1. The preoperative conductive hearing loss in the majority of the cases was more than 30 to 40 dB (Table II). The time interval between the implantation of the prosthesis and the study varied between 6 months to 3 years. The shortest was 6 months in 14 patients and the longest was 2 to 3 years in 15 patients (Table III). The postoperative residual remaining conductive hearing loss was on average 15 dB (40 patients) and less than 10 dB in 23 patients. More than three quarters of all patients could gain sufficient

Table III Duration of Implants	
Months	No. of cases
6	14
12	15
18	15
24	22
36	15
	81

hearing (Table IV). In 5 cases, revision surgery was performed. In these cases, insufficient hearing was due to scars and adhesions. In the other four cases, the follow-up term is yet too short to make a final judgement.

Fig -3 Ossicular Continuity is maintained with plester's Prosthesis

Table IV Post Operative Conductive Hearing loss	
dB	No. of cases
10	23
10-20	40
20-30	14
30-40	4
	81

Discussion

Over the last 40 years, a variety of methods and materials are used in order to achieve a long-term hearing improvement after reconstruction of destroyed long process of incus. Follow-up studies have shown however that the reconstruction of a defect between the incudal process and head of the stapes by means of bone chips, cartilage grafts or plastic materials does not provide satisfactory long term results.

Wullstein proposed in 1968 to dislocate the incus and slide it down from the epitympanic space to the head of the stapes to restore the bony contact between the ossicles. Zollner and Plester recommended either the transposition of the incus or implantation of a preserved

homologous ossicle. In contrast to bone-chips, ossicles undergo only a slight resorption due to their highly complicated ultrastructure and allow therefore a stable sound conduction. Helms proposed in 1983 the application of cartilage slices for replacement of small defects. (4).

Müller, Geyers, Helms suggested in 1994 the use of ionomer cement. (2). They reported 7 patients with small defects of the incus which could be safely reconstructed by ionomer cement. The postoperative conductive hearing loss was 11 dB on average.

In recent years collaborative efforts between biomaterial scientists and surgeons have led to manufacture of new materials specifically to be used as middle ear implants. Broadly these materials could be divided into metals polymers and ceramics. After reporting extremely high extrusion rate of most of the polymer implants, in recent times ceramics have gained popularity. There are different types of ceramics being used with various success rates of various workers.

Metals are used less frequently in otolaryngology. In former times metals were considered as high infection risk and carried considerable wound reaction. It is a well established fact that pure gold which is virtually indestructible is bioacceptable material. (1,3). The major problem had been that of bioengineering to fabricate a prostheses in miniature form of precise shape, size and purity and in addition have a certain amount of stiffness. The greatest advantage as regards gold is that it can be tempered without combining it with any other alloy. This tempering makes it stiff to the required degree in pure form.

Few years ago Professor Branemark of Sweden started experimenting on various metals and their reaction to bony tissue and he found to his great surprise that titanium dioxide when it comes in contact with osteogenic tissue it forms osseointegration making it into a very firm bond. With this principal in mind, we have been developing various different kinds of ossicular reconstruction prosthesis. We are using the titanium middle ear implants for the past 5

years. And it was Professor Plester, who had an idea to develop this bimetal prosthesis.

When the metal, titanium comes in contact with bone the titanium dioxide gets a firm bond to the bone getting it ossio-integrated. This has been proved and established by dental

implantology. This principle is used in this bi-metal prostheses. The titanium bonds form ossio-integrations and the gold bell which is fixed on the stapes head remains acts as a Incudo-Stapedial joint and due to its shape post implant sound transmission mechanism remains absolutely physiological.

Reference

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4. J. Helms. Wurzburg : *Personal communication*

Conference News

The first West Temporal Bone-cum-Neuro-otology Workshop was held on Nov., 8-9, 1997 in the department of Otolaryngology at the Postgraduate Institute of Medical Education & Research, Chandigarh. Prof.. S. B. S. Mann was the Chairman and Dr. Vikas I. Nehru was the Organising Secretary. The workshop was attended by 25 young up-coming ENT surgeons of the North West Region. They were invited on the recommendations by the respective Head of Deptt., in medical colleges of Punjab, Himachal Pradesh, Jammu and Kashmir, Ludhiana and UT, Chandigarh and majority of them were young Postgraduates launching them in their career in ENT practice. The participants were divided into two groups and while one group performed temporal bone dissection under the supervision of the course Faculty, the other attended lectures and demonstration in Otology and Neurotology. The following dissection procedures were one on the wet temporal bones : (i) cortical mastoidectomy (ii) Modified Mastoidectomy (iii) Radical mastoidectomy (iv) Facial nerve decompression (v) Myringoplasty

There were five temporal bone workstations in the Temporal Bone laboratory. Each workstation was equipped with an operating microscope, microdrill, temporal bone holder, wet temporal bone and surgical instruments. The department faculty actively supervised and assisted the participants. Hands out-on-temporal bone dissection, auditory brainstem evoked responses were prepared by Dr. Vikas Inder Nath Nehru and Dr. Ashok Gupta and were distributed to the participants.

5 hours hands-on dissection experience on wet temporal bone dissection was given to each group.

The neuro-Otology lectures and demonstration included following subjects :

(i) Electronystagmography (ii) Neuro-Otology case work up (iii) Evoked Response Audiometry (iv) Impedance Audiometry (v) Electro-cochlegraphy

The department hopes to host this workshop once a year as an annual feature.