How I Do It A Targeted Problem and Its Solution

Temporalis Fascia Assisted Ossicular Arthroplasty for the Dislocated Incus: Fascial Arthroplastic Ossiculoplasty

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INTRODUCTION

A disruption of the incudostapedial joint or gross dislocation of the incus occurs most often as a result of accidental head trauma but may also result occasionally from surgical injury or temporary disarticulation during ear surgery for clearing the underlying disease or exposing the facial nerve.

The surgical management of a dislocated incus often presents a challenging technical and biological problem because its joints are not designed for reunion like other skeletal joints of the body.^{1–3} They differ in size, strength, and movements permissible to them. Bereft of muscular or soft tissue cushioning for support, these joints depend on fibrous capsular tissue to maintain joint integrity. The role of the atmospheric pressure and gravity is crucial because the incus often gets displaced from its corrected position in absence of capsuloligamentous support. Hence, simple repositioning of the dislocated incus is usually ineffective unless its periarticular (joint capsule) and intra-articular (articular meniscus) structures are reconstituted to prevent recurrence of the dislocation and the post-traumatic joint stiffness or bony ankylosis.³ Free transplantation of fascia in "interpositional fascial arthroplasty" has proven its usefulness as substitute for articular ligaments and as an inlay in skeletal joint restorative surgery.⁴

Fascial arthroplasty of a displaced incus where technically possible should be attempted.³ The original use of

fascial ties by Farrior⁵ in 1969 to secure the position of the bone graft with the incus and the stapes in cases of loss of the long process of incus was the forerunner of our concept. Evolving further, a method referred to as "fascial arthroplastic ossiculoplasty" was used for the repositioning of a dislocated incus with reconstruction of its joint capsule and supporting accessory ligaments using temporalis fascia grafts. The fascial grafts used to refurbish the articular structures initially cover the articular cavity, splint and support the ossicular assembly, provide nutrition through tissue fluids, prevent bony ankylosis and, after its healing, ensures a firm and movable union of the repositioned incus with the malleus and the stapes with full functional restoration.

PATIENTS AND METHODS

A retrospective study was performed by studying the charts of 342 patients who had surgery April 1990 and January 2001. The degree of dislocation varied from simple subluxation of the incudostapedial joint to a complete dislocation of the incus. Follow-up ranged between 1 and 11 years. Their hearing results were also studied.

Subluxation or Separation of Incudostapedial Joint

In 178 cases of subluxation of the incudostapedial joint, 31 cases were of accidental trauma, 11 were of acoustic trauma, and 8 were of surgical trauma, and in another 128 cases the disarticulation was intentional during chronic ear surgery to protect the inner ear from manipulatory and vibratory trauma.

Surgical Technique

It became possible to restore the hearing in these cases simply by repositioning the tip of the long process of the incus on the head of the stapes after interposing a piece of fascia between its joint cavity to prevent bony union. However, often after its replacement the lenticular process springs away laterally and must be fixed again to the head of the stapes with a fascial scarf (Fig. 1E). This small piece of fascia covering the articular surface

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was sufficient to prevent passive movements including pulling apart of the surfaces. The fastening of the incus to the stapes is such that the mobility of the incudostapedial joint is maintained. In a few cases, because of post-traumatic scarring, repositioning of the lenticular process of the incus on the head of the stapes could not be accomplished. In such cases, the bone from the posterior canal wall was removed to expose the incus and head of the malleus, the fibrous tissue responsible for malalignment was resected, the separated incus was replaced in its original position, and the joint reconstituted (Fig. 1C and D).

RESULTS

Hearing results were analyzed after the preoperative and postoperative air- and bone-conduction thresholds (International Standards Organization standard) were obtained based on the differences in the mean thresholds for 500, 1000, 2000, and 3000 Hz (Table I). A comparison was made between the results of the last preoperative and last postoperative tests. The hearing improvement with almost complete closure of the air-bone gap was found in 54 (30.3%) of the ears, within 10 dB in 104 (58.5%) of the ears, and within 15 dB in 20 (11.2%) of the ears. These were found to be in conformity with the severity of the associated tympanic disease varying from mucosal edema and granulation tissue to limited attic retraction pockets.

Total Dislocation of Incus

We have encountered 164 cases of total dislocation of the incus. Of these, 18 (including 2 cases of dislocation with fracture of long process of the incus) cases were attributable to head injury, 10 cases were from accidental surgical subluxation, and in 136 cases the incus was electively removed either for clearance of the scar tissue, squamous debris, or granulation tissue blocking the antrum or for gaining adequate exposure during facial nerve decompression for idiopathic (Bell's) or traumatic facial nerve palsy.

Surgical Technique

After the accident, reduction was accomplished as early as possible because the articular cavity is fresh and of the same size and, if reduction is delayed, becomes partly filled by reparative fibrous tissue. An exploratory tympanotomy was performed, and the bone from the canal wall was removed to expose the epitympanum, dislocated incus, and head of the malleus (Fig. 1A). After positioning a small piece of Silastic sheeting (0.005 inches, Dow Corning, MI) in the epitympanum to cover the exposed facial nerve (if any) or the denuded bone, a gelatin sponge bed was prepared at the recipient site with a piece of fascia spread over it to cover the medial surface of the articular cavity of the incudomalleolar joint of the repositioned incus (Fig. 1B). The dislocated incus was placed in its normal position after interposing a piece of fascia in the gap between the incudomalleolar and incudostapedial articulations for prevention of bony union and for improving the joint mobility. In addition, to avoid bony fixation of the short process of the incus with the fossa incudis, another piece of fascia was placed under the articular surface of the short process of the incus covering the bone posterior to it (Fig. 1C). After an accurate realignment and approximation of the joint surfaces to avoid articular instability, a new joint capsule was reconstructed by wrapping the medially placed band of fascia around the incudomalleolar articulation. Another piece of fascia was positioned on the lateral surface of the incudomalleolar articulation covering the ends of the fastened first fascial strip and the other replaced ossicular fascial ligaments (Fig. 1D). Other accessory ossicular ligaments (posterior ligament of the incus and the superior incudal ligament) were reconstructed at their respective sites by placing suitable-sized pieces of fascia covering the ossicles and walls of the tympanic cavity and were held in position by several small pieces of blood-soaked absorbable gelatin sponge. The cut ends or



Fig. 1. (A) Total dislocation of the incus (the malleus and the stapes intact). (B) Preparation of the recipient bed for the incus. Over a piece of silastic sheet, a thin, compressed piece of gelatin sponge was positioned with a piece of fascia spread over it to cover medial surface of incudomalleolar joint. (C) A piece of silastic sheeting to cover the denuded bone or the exposed facial nerve and two pieces of fascial grafts interposed between the incudomalleolar and incudostapedial joints. (D) Incus replaced in its anatomical position and the medially placed fascial strip turned up to cover lateral surface of the incudomalleolar joint. Another piece of fascia positioned to cover lateral surface of the incudomalleolar joint, folded ends of the first fascial strip, and the superior incudal ligament. Posterior ligament of the incus replaced with a fascial strip. The lenticular process of the incus reattached to the head of the stapes with a fascial scarf. (E) Inset: Magnified image of the incus-stapes coupling with a fascial scarf. The lenticular process of the incus replaced on the fasciacovered capitulum of the stapes with a fascial scarf.

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Pathologic Conditions Encour	ntered in the	Ear at the T	ime of Surgery	and Postoperative H Operated P	e in lealing and Hear atients.	ring Results i	n Relation to T	Type of Incud	al Dislocatio	n Observed i	ז42 ח
		Pathologic	c Conditions Enco	untered in the Middle E	Ear: No. of Cases		Postoperative	Healing and He	earing Results:	No. of Cases	
						Results	of Tympanic ane Healing	Hearing Res	ults: Air-Bone	Gap Closure V	Vithin—dB
Type of Incudal Dislocation	Total No. of Cases	Healthy Mucosa	Granulations	Tympanosclerosis	Cholesteatoma	Healed Well	Graft Perforation	Complete Closure	10 dB	15 dB	20 dB
Incudostapedial joint separation	178	42	102	29	5	178	I	54	104	20	I
		23.6%	57.3%	16.3%	2.8%	100%		30.3%	58.5%	11.2%	
Total dislocation of the Incus.	162+	47*	73	26	16	150	12	I	133	26	ო
		29%	45.1%	16%	9.9%	92.6%	7.4%		82.1%	16%	1.9%
+Dislocation with fracture of long process of the Incus	02+	02	I	Ι	Ι	02	I	I	02	I	I
		100%				100%			100%		
Total no. of cases	342	91	175	55	21	330	12	54	239	46	ი
		26.6%	51.2%	16.1%	6.1%	96.5%	3.5%	15.8%	69.9%	13.4%	0.9%
*Includes 01 cases of facial new	decompress	io.									

the detached tendon of the intratympanic muscles, if any, were reapproximated and securely moored with a fascial splint. Similarly, the fracture injury of the long process of the incus was repaired by reducing the fracture and immobilizing the fragments with a cartilage splint secured by fascial ties. The chorda tympani nerve was later positioned over the reposed ossicular assembly supporting it. These wet fascial strips readily conform to bony surfaces and cause no rumple at the site of reconstruction and do not impede transmission of the acoustic vibrations. Eventually, these joints are put through the full range of movements with those of the tympanic membrane and with the reflex actions of the intratympanic muscles reducing the chances of ankylosis.

Hearing Results

Of the 164 cases (including 2 cases of dislocation with fracture of the long process of the incus) treated for total dislocation of the incus, 152 cases (92.7%) had good healing of the grafted tympanic membrane and 135 (80.3%) closed the air-bone gap within 10 dB; in 29 cases (17.3%) hearing improved but a larger postoperative air-bone gap than 10 dB was left, and in the remaining 12 cases (7.3%) repeat perforation occurred during the follow-up period that healed after revision myringoplasty. Table I sums up the details of the hearing results of the 342 operated ears. In none of the cases did hearing worsen postoperatively. These results were satisfactorily commensurate to the type and extent of the disease encountered. Unlike subluxation of the incudostapedial joint, in total dislocation of the incus, both incudomalleolar and incudostapedial joints were reconstructed; hence, complete closure of the airbone gap was not feasible. Second-look operations were not routinely performed as part of a general strategy unless the patient had problems with healing or hearing. All these patients were regularly evaluated, and their hearing improvement was found to be stable and unchanged.

DISCUSSION

Technique

The problem of interposing a dislocated incus between the malleus and the stapes is an intriguing one beset with many difficulties. These include a lack of vascular bed for its survival, maintaining it in anatomical position in the absence of its capsuloligamentous support, and avoiding bony ankylosis in the reconstituted incudomalleolar and the incudostapedial joints.³

The precept of our surgical procedure has evolved from the observations of methods of surgical pseudoarthrosis and the interpositional arthroplasty used in orthopedic surgery in which the fascial grafts are interposed between the mobilized bony ends of an ankylosed joint and the fascial strips are used to repair the torn, deficient parts of the articular capsule.⁴⁻⁶ In fascial arthroplastic ossiculoplasty, the fascial grafts were systematically arranged to create the articular structures and the ligaments of the replaced ossicle allowing its free movements. These fascial grafts were found to remain viable, and the grafts interposed between the joint cavities serve to minimize the frictional resistance to movement generated be-

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total dislocation of the incus

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tween two dry, rough articular areas preventing secondary traumatic osteoarthrosis and bony ankylosis.^{4,6} There is ample evidence that the synovial membrane can be reformed from ordinary connective tissue as in cases of pseudoarthrosis or its regeneration after synovectomy.^{4,6} An experimental finding demonstrated that these fascial grafts, when used for ossiculoplasty, achieve blood circulation through longitudinal vascular network within 48 hours and are preserved forever.⁷ Initially, the surface cells of the replaced ossicle imbibes its nourishment from tissue fluids through its temporal fascia covering; finally, the entire reconstructed ossicular assembly gets covered with the middle ear mucosa ensuring its blood supply from the mucosal plexus.⁷

In our experience, this method of ossiculoplasty has granted an essential freedom to an otologist. Formerly, much time was spent attempting to remove granulations or cholesteatoma from an intact ossicular chain, often resulting in recurrence of disease or sensorineural hearing loss from the manipulations. Our technique minimizes these problems by removing the incus temporarily to weed out all disease and the degenerated ligaments with the knowledge that it can be replaced in its original position with reconstitution of ligamentous support at the conclusion of the operation. Initially, we were hesitant to perform standard repositioning of the incus using this method after facial nerve decompression because of the close proximity to the exposed nerve. However, this concern has proved baseless because postoperative recovery of the facial nerve in these cases was good without any significant difference in hearing acuity.

In few cases, the revision operation for the minor graft perforation showed the reposed incus in position with neatly healed incudomalleolar and incudostapedial joints and a delicate band of connective tissue running from the head of the malleus and the incus to the tegmen tympani resembling the superior malleoincudal fold. Thus, there is evidence that the suspensory ligaments of the ossicles can be reformed with this method; the autografted ossicles get biologically adopted with satisfactory joint healing and are able to maintain its size and the shape as this fascial cover prevents further remodeling and the new bone formation around it. This has been clinically confirmed in a number of patients in whom the incus was well visualized through the thin tympanic membrane after a period of 1 year, and it is obvious from the improved hearing results that it works effectively.

The hearing results of the present study are encouraging compared with those of incus transposition techniques previously used. Farrior⁵ and Glasscock⁸ reported that many transpositions had failed because the ossicle was pulled off the capitulum or it slipped and got attached to the bony walls of the tympanum.^{5,8} Nikolaou et al.⁹ performed 40 incus transpositions and achieved closure of the conductive loss to within 20 dB in 74% of the cases. The mechanical advantages offered by this approach have helped us to develop a technique that can be used to repair a wide variety of intricate ossicular defects using autologous ossicular or cortical bone grafts.

CONCLUSION

The contemporary techniques used for the repositioning of the dislocated incus do not involve the repair of ossicular joints, ligaments, and the intratympanic muscles. A new microsurgical concept, "fascial arthroplastic ossiculoplasty," is presented, which was successfully performed in 342 patients for the repositioning of a dislocated incus. The fascial strips used to hold the repositioned incus in its anatomical position and the fascial dividers that separate the coupling surfaces of the articulating ossicles help in maintaining firm, mobile articulations of the repositioned incus with the malleus, fossa incudis, and head of the stapes. The procedure is simple, and its postoperative results are more predictable and reproducible.

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