A FENESTRATION TECHNIC FOR AURAL DAMAGE FOLLOWING HEADTRAUMA

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In the past few years the Otologic world has seen a great advance in the surgical treatment of deafness and vertigo by the fenestration operation.

A fenestration operation of the labyrinth was first practised by Passow[1] in 1892, and this procedure was violently condemned by Politzer, Denker and Seiberman. The posterior semicircular canal was fenestrated by Bàràny in 1904. Floderus in the same year made a fenestra in the promontory and covered it with a Thiersch graft. In 1914 Jenkins[2] reported two cases in which the horizontal canal was fenestrated. In 1917 Helmgren introduced the technique of opening the superior semicircular canal, attempting to keep the fenestra open by allowing the dura and arachnoid to cover it. In 1918 Bàràny[3] attmpted to treat hearing and vertigo by a two-stage fenestration operation. In 1920 Holmgren again opened the promontory and covered it with mucoperiosteum. In 1924 Sourdille, the French Otologist, first performed the many-staged fenestration operation.

The more modern efforts of Holmgren,[4] Sourdille,[5] Shambaugh[6] and Lempert are well known to every otologist.

Much has been said and written concering these recent developments, especially since the introduction by J. Lempert,[7-12] in 1938, of a new one-stage operation performed endaurally, in 1941, of fenestra nov-ovalis, and in 1945, Lempert fenestra nov-ovalis with mobile stopple.

Authors' experience of fenestration operation of the labyrinth dates back to 1949, at which time the authors performed our first operation. Since then we have operated on 53 cases. Thirty-six of these cases were aural damage following headtrauma. Patients of aural damge following headtrauma were operated by the fenestration operation technic devised and improved by the authors. In the present paper we report our surgical technic of the fenestfation operation for aural damage following headtrauma.

SURGICAL TECHNIQUE

Preparation of Operative Field.— The mastoid region is shaved. The auricle and the area of skin surrounding it are scrubbed with soap and water, dried and painted with solution of tincture of masonin. About 5 drops of this solution is

then instilled into the auditory canal, and the entire membranous lining of the auditory canal and the tympanic membrane are allowed to bathe in it a few minutes, after which the canal is dried with a sterile applicator.

Anesthesia.— A combination of analgesia and local anestheaia is employed. General anesthesia is contraindicated because in order to carry out this technic successfully bleeding must be kept at a minimum, and because the cooperation of the patient is necessary during the operation.

Analgesia.— A hypodermic injection of 0.02 gm. of opial (alcaroidum opii hydrochloricum) is given immediately before the patient is taken to the operating room.

Local anesthesia.— A I per cent solution of procaine hydrochloride and 1:20,000 epinephrine hydrochloride is injected into the skin, fibrous tissue and periosteum of the antauricurar suprameatal membranous triangle. The same solution is injected into the skin, the fibrous tissue and the periosteum of the membranous portion of the posterior wall of the canal, which includes the outer third of this wall and extends from the anterior border of the concha inward as far as the osseous portion of the posterior wall.

The technic may be divided into the following surgical steps:

1. An endaural extracartilaginous incision (Fig. 1).

Fig. 1. An endaural extracartilaginous incision.

Three endaural incisions are made. The first is begun in the membranous lining of the superoposterior wall of the external auditory canal, at the junction of its osseous and membranous portions. This incision is carried downward and outward along the entire membranous portion of the posterior wall of the canal until the lower end of the anterior border of the concha is reached. The second is begun at the point of commencement of the first incision in the superoposterior wall of the canal, is carried along and through the membranous lining of the outer third of the superopostirior wall and is continued upward adjacent to the tragus, into and along the anterior wall of the antauricular suprameatal membranous triangle and through the skin, the fibrous tissue and the periosteum up to the apex of this triangle. The third, which connects the first two incisions along the anterior border of the concha, is begun from the outer end of the first incision at the lower end of the anterior border of the concha, is carried upward through the skin, the fibrous tissue and the periosteum along the entire anterior border of the concha and continued along and adjacent to the an terior border of the helix, which forms the posterior boundary of theantauricular suprameatal membranous triangle, ut to the apex of the triangle where it meets the outer end of the second incision. These incisions are so designed that they remain extracartilaginous and extramuscular.

The incisions should be carefully outlined at first through the skin only ; when the correct outline is successfully obtained, they may then be carried deeper, through the rest of the membranous layers down to the bony surface of the temporal bone. The importance of making these incisions with the greatest accuracy and precision is towfold: 1. On these incisions depends the surgical accessibility of the temporal bone. 2. The incisions designate the extent of the cutaneous lining of the posterior and superior walls of the canal which is to be left behind. A triangular flap of membranous tissue results from these three incisions.

A periosteal elevator is now inserted into the first incision, and while the underlying bony surface is hugged with the edge of the instrument, the entire triangular flap is subperiosteally lifted from its attachment to the bony surface. The upper and the lower end of this flap are then freed from their final attachments with the aid of curved scissors. This triangular flap, which consists of the outer third of the membranous lining of the posterior and the superoposterior wall of the canal and contains hair follicles and ceruminous glands, is removed and discarded. The removal of this membranous flap results in an endaural extracartilaginous membranous window for the antauricular surgical approach to the temporal bone. This endaural membranous window is now mobilized by a subperiosteal elevation of both the postauricular skin and periosteum covering the outer mastoid cortex and the antauricular skin and periosteum covering the posterior root of the zygoma. Two retractors are inserted and held in position by an assistant.

with the retractors in situ, the endaural membranous window can be moved

in any desired direction over the temporal bone to permit the necessary surgical intervention.

2. The exposure and sharp definition of the horizontal external semicircular canal (Fig. 2).

The cutaneous lining covering the osseous portion of the posterior wall of the external anditory canal is subperiosteally elevated with a specially devised narrow subperiosteal elevator for a distance of about 5 mm., in order to expose the superoposterior bony wall of the canal. With an electrically driven serrated dental burr the antrum is entered through the superoposterior wall. With the same burr an area of mastoid cortex is removed from the superoposterior wall and from the outer mastoid cortex over Macewen's triangle, and a larger point of entrance and greater accessibility to the mastoid antrum are thus created.

With an electrically driven round burr more of the outer cortex is removed.
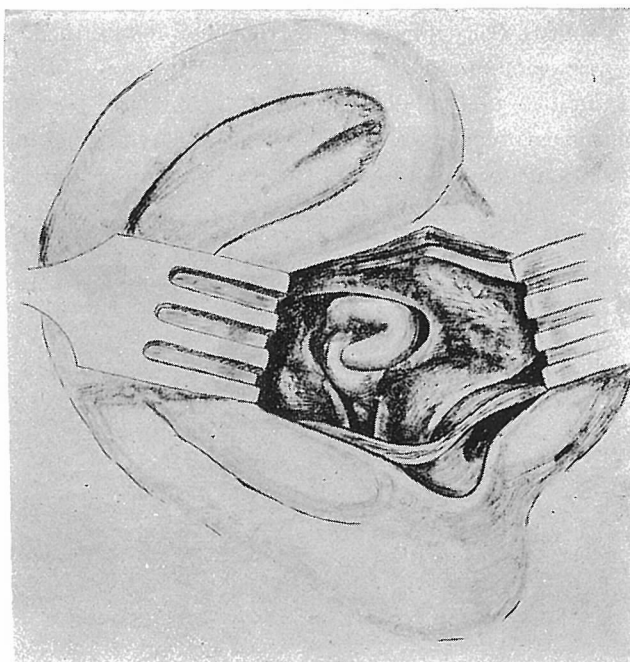

Fig. 2. The exposure and sharp definition of the horizontal external semicircular canal.

The cellular structure immediately underly ing this cortex and surrounding the mastoid antrum is removed with a curet. The roof of the mastoid antrum is quickly located, and the cellurar structure adjacent to it is removed until the smooth inner bony table covering the middle fossa dura in the region of the mastoid antrum is expos ed to view. The outer cortex of the posterior root of the zygoma is removed with a round burr. The zygomatic cells overhanging the entrance from

the antrum to the aditus are removed with a curet. With the same cutet the floor
of the antrum is scraped, and all the basal perilabyrinthine cells encountered are
removed until the solid ebonized base of the basal labyrinthine portion of the
petrous pyramid is exposed to view. The antral posterior end of the floor of the
aditus is curetted, and the external semicircular canal, which forms the threshold
between the antrum and the aditus, is exposed to view. The contour of the hori-
zontal external semicircular canal is sharply defined by removal of all the cellu-
lar structure immediately surrounding it. The sharp definition of the external
semicircular canal is complete when its convexity appears elevated and projects
prominently from the floor of the aditus and antrum, with its anterior and pos-
terior borders freed from surrounding cellular structure.

   3. Skeletonization of the bony wall of the external auditory canal (Fig. 3).

   With a mastoid curet all the cells lying adjacent to and covering the pos-
terior surface of the mastoid portion of the posterior bony wall of the canal are
removed until a smooth bony surface free from cells is obtained. The cells lying
adjacent to the posterior surface of the tympanic portion of the posterior wall
are removed to the level of the bony capsule of the vertical portion of the facial
nerve. The prominence of the external semicircular canal is employed as a guide
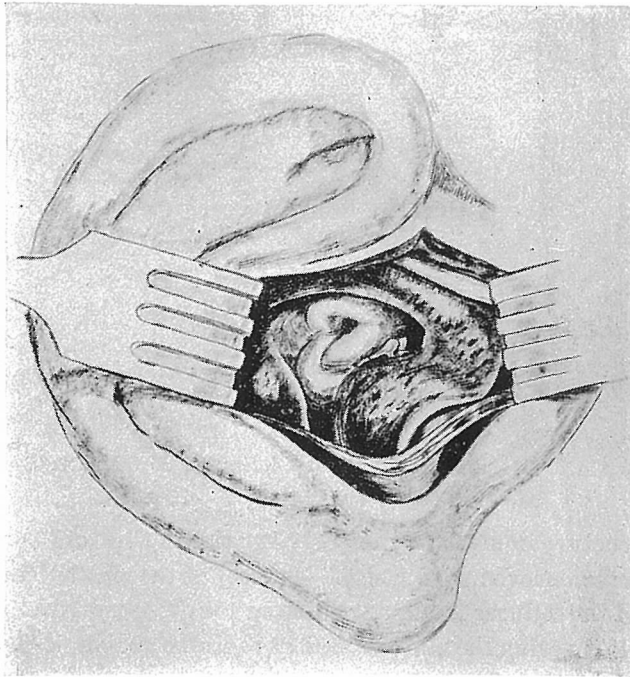in tracing the anatomic position of the vertical portion of the fallopian canal.

Fig. 3. Skeletonization of the bony wall of the external auditory canal.

The outer cortex of the remains of the posterior root of the zygoma is removed further anteriorly, and the zygomatic cells lying adjacent to and covering the squamous portion of the superoposterior bony wall of the canal are removed until a smooth continuity of bony surface with that of the smoothened posterior surface of the mastoid portion of the posterior wall is obtained. As a result of this step in the surgical technic, the posterior aspect of the incus, occupying a position almost parallel to and anterior and adjacnet to the horizontal course of the prominence of the external semicircular canal, is brought into view.

With a round burr the outer cortex of the posterior root of the zygoma is removed farther anteriorly to expose the zygomatic cellular stucture lying anterior and external to the incus and adjacent to the upper surface of the squamous portion of the superior bony wall of the external anditory canal. With a curet this cellular structure is completely removed, the operator working in a direction anterior to the already smooth and skeletonized superoposterior bony wall of the canal. Curetting gradually progresses from without inward, the entire upper surface of the superior bony wall of the canal up to the sulcus tympanicus being skeletonized until a smoothened continuity with the superoposterior wall is obtained. As a result of this step in the surgical technic, the entire incudomalleoiar joint in its position within the epitympanic recess is exposed to view.

4. *The excavation of a fenestra in the bony capsule of the external horizontal semicircular canal or vestibular dome* (Fig. 4).
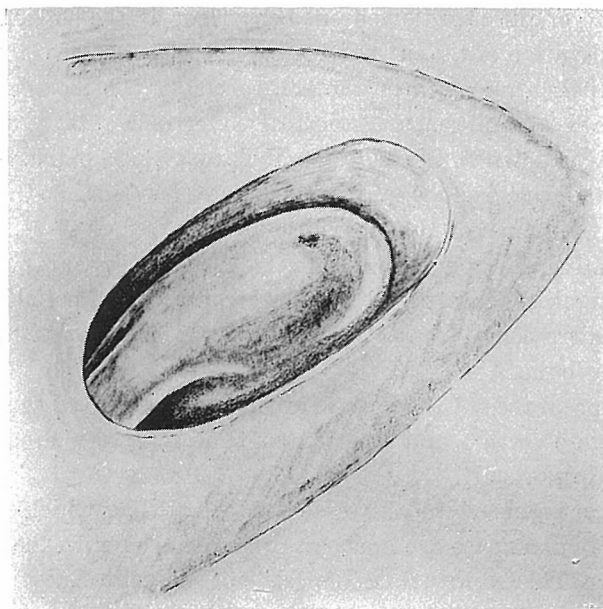

Fig. 4. Fenestration in the bony capsule.

The fenestration of the external semicircular canal or vestibular dome is an especially devised surgical means of mechanically preventing the eventual closure of the fenestra by regeneration of bone, which has defeated all former surgical efforts.

This part of the surgical technic requires most delicate instrumentation and manipulation. It must be done carefully and slowly, under brilliant illumination and with the aid of extremely powerful magnifying glasses. It must be accomplished without injury to the membranous labyrinth.

An electrically driven round dental finishing or polishing burr, the circumference of which is about one-half the width of the outer surface of the bony capsule of the external semicircular canal or vestibular dome, is employed for the excavation of the fenestra. The burr must be held in perfect control, and its excursion must be light and most carefully guided. The troughlike excavation should be begun on the outer surface of the bony capsule, immediately below the ammpulla, and should be extended for about 3mm. along the longitudinal axis of the capsule and limited to the center of the width of the canal.

This troughlike fenestra is created by several surgical stages.

1. Excavation of a troughlike groove with all its surrounding walls converging toward the bottom to meet its floor, which assumes the form of an extremely thin and transparent innermost periosteal layer of the bone. Through this transparent floor the lumen of the labyrinth capsule can be visualized in the form of a bluish gray line (under strong illumination and magnification).

2. Widening of the thin tansparent bony floor at the bottom of the trough to permit visualization of the entire width of the lumen of the labyrinth capsule.

3. Careful polishing down of the bony floor of the trough, to remove the extremely thinned-out innermost periosteal layer of the bony capsule and the endochondral layer down to the endosteum. Through this extremely transparent endosteal floor the membranous labyrinth can now be visualized within the perilymph space in the lumen of the labyrinth.

4. Gentle pulverizing of the extremely delicate endosteum, which forms the floor of the troughlike fenestra, with a few strokes of the polishing burr, until one or several microscopic drops of perilymph appear through the pores in the pulverized endosteum.

With the appearance of the first microscopic drop of perilymph, the patient complains of severe vertigo, and almost immediately a tremendous improvement in hearing manifests itself.

The lateral margins of the pulverized endosteal floor which cover the widest part of the perilymph space are now carefully removed with the lightest excursions of the burr. This results in an exposure of the widest portion of the perilymph space. With strong illumination and magnification, the intact membranous labyrinth, surrounded by bulsating perilymph, can now be seen.

When completed, the troughlike fenestra within the bony capsule of the external semicircular canal has slightly sloping bony walls extending from the wider aperture on the roof of the bony capsule to the narrower aperture in its floor, which communicates with the perilymph space. The walls surrounding this fenestra must maintain the original thickness of the bony capsule.

5. *Covering the fenestra with a cartilaginous stopple* (Fig. 5).

The spina helicis of the auricurar cartilage is exposed to view and carefully resected with a fine sharp scalpel. With the aid of magnifying glasses, the cartilaginous spina helicis is then carefully trimmed and shaved until it is about 2mm. thick and conforms in width and length to the fenestra. The dimensions are determined with specially devised measuring instruments. This specially prepared solid, smooth and elastic cartilaginous stopple is then placed over the fenestral gap, and with a specially devised instrument it is squeezed into the gap between the freshly cut margins of the bony rim of the fenestra, like a cork into the opening of a fenestra. The inner surface of the cartilaginous stopple should extend approximately 0.5mm. byeond the inner or endosteal surface of the bony rim of the fenestra into the perilymph space of the vestibule, while the outer surface of the stopple should protrude about 0.5mm. outward beyond the periosteal surface of the bony rim of the fenestra into the epitympanum. The cartilage-stoppled fenestra is covered with the tympanomeatal membrane, which is then held in position by a paraffinimpregnated mesh gauze anchor and paraffin.
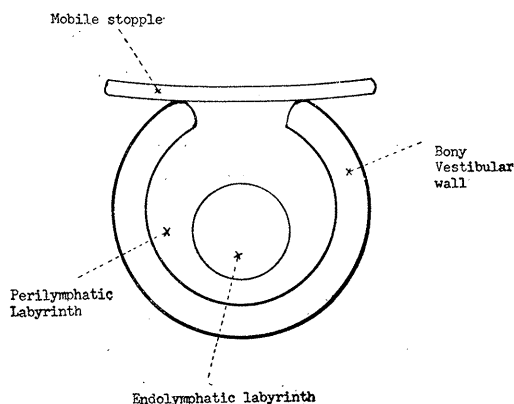

Fig.5. Coveriug the fenestra with a cartilaginous stopple.

The paraffin mesh ball is held in place by additional pieces of paraffin mesh inserted into the mastoid wound. A mastoid dressing and bandage applied in the routine fashion completes the operation.

Postoperative care of wound: The superficial dressing is changed daily. On the eighth postoperative day the first full dressing is made. At this time the paraffin mesh is gently removed, care being taken not to disturb the stopple. All

secretions within the mastoidomeatal wound are wiped and dried with sterile cotton applicators. After the dressing is completed a piece of sterile cotton is placed in front of the entrance to the external auditory canal. The superficial bandage is discarded after the first deep dressing.

SUMMARY

A fenestration technic for aural damage following headtrauma was described.

This technic has been newly devised by the author, and may be divided into the following surgical steps:

1. An endaural extracartilaginous incision. 2. The exposure and sharp definition of horizontal external semicircular canal. 3. Skeletonization of the bony wall of the external anditory canal. 4. Decompression of the dura of the temporal lobe in the region of the epitympanic recess. 5. The excavation of a fenestra in the bony capsule of the external horizontal semicircular canal or vestiblar dome. 6. Covering the fenestra with a cartilaginous stopple.

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