ENDAURAL APPROACH IN TEMPORAL SURGERY

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Operative procedures on middle ear are used not only to relieve life from middle ear diseases but also recently to restore hearing. Fenestration operation for otosclerosis is done by Lempert endaurally and good results are obtained. From then operative procedures on temporal bone became to be done generally through endaural incision.

Operative procedures through endaural route or similar routes were reported in the literature since before: 1892 Hoffmann, 1895 Kessel, 1907 Kashiwabara, 1912 Thies, 1912 Kashiwabara, 1926 Hoshino, 1928 Lempert, 1930 Lempert. Since in 1938 Lempert reported endaural approaches in middle ear operations for all middle ear suppuration and its complications, many reports regarding to endaural route were successively made. There are reports of Wishart in 1939, Maruyama in 1940, Shambaugh in 1941, Kimura in 1943, Bois in 1945, McCurdy in 1945, Morrison in 1947, Lempert in 1949, House in 1949, And McQuiston 1950.

Watsuji and Kashiwabara performed operative treatment for attic and antrum suppurations in 120 cases through entirely endaural route. This Watsuji and Kashiwabara's method has advantages and disadvantages. So that Hoshino in 1926 modified this method.

In 1928 Lempert reported endaural operation performed in 165 acute mastoiditis. In 1930 he proposed a skin incision and landmark not to injure the lateral sinus and the dura located even in abnormal position. Lempert, in 1938, advocated in summary report of 1780 cases that surgical operation on the temporal bone through the endaural, antauricular approach consists of three distinct stages.

In 1940, Maruyama devised a modified radical mastoidectomy in which a semilunar skin incision is made.

Kimura (1943) has stated that complete excenteration of the pneumatic cells is impossible, no matter in what way the skin flap is made, by incision of the skin of the external ear canal alone as described by Watsuji and Kashiwabara or Maruyama, and has claimed that this is possible only by adequate excision of the periosteum.

Morrison, in 1949, placed the first incision in the skin of the ear canal more externally than Lempert's method.

In 1949, Lempert described a method of entering the epitympanum directly through the notch of Rivini, after widening the external ear canal, thus eliminating the search for the mastoid antrum.

In radical mastoid surgical procedures, in an effort to secure as much skin as possible for a subsequent skin graft, McQuiston in 1950 used a technic which

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involves removing all the skin of the ear canal which does not cover the cartilaginous external ear.

The endaural approach in temporal surgery has been used for a long time but problems as the method of incision and indications have differed. Since Lempert described the different incisions according to manner of spread of the pathological changes and accurately described the steps in the manipulation of the bone, the endaural approach has come to be used more widely.

The endaural approach used by the author in the "Enhanced Hearing Radical Mastoidectomy" is described and the endaural approach is discussed.

THE ENDAURAL APPROACH USED BY THE AUTHOR

The "Enhanced Hearing Radical Mastoidectomy" has been performed since 1952. The author has been using the endaural approach in performing this operation. Since 1954 the skin incision used by the author is as follows: (1) A circular incision, reaching the periosteum, is made in the skin of the external ear canal along the tympanic annulus. (2) A second incision, reaching the periosteum, is made along the petrotympanic fissure the entire length of the external bony ear canal in the anterior, superior portion of the external bony ear canal external to the first incision. (3) A third incision, reaching the periosteum, is then placed externally from the first along the length of the external bony ear canal in the posterior, inferior portion of the external bony ear canal. (4) The second incision is extended upward between the tragus and helix along the anterior border of the triangle reaching to the top of the triangle. Both the subcutaneous tissue and periosteum are incised when placing the incision in the anterior border of the triangle. (5) An incision is made from the outer end of the third incision extending upward along the anterior border of the conchal cartilage. The incision is continued along the posterior border of the triangle to the top of the triangle where it meets the fourth incision. Both subcutaneous tissue and periosteum are incised at this time, too. (6) The incision joining the outer end of the second incision and the outer end of the fourth incision is extended along the outer edge of the external bony ear canal to the depth of the periosteum. The skin, subcutaneous tissue and periosteum surrounded by these incisions are removed in the following manner. A small periosteal elevator is inserted in the first incision and by separating the superior and posterior walls of the external ear canal outwardly, the skin, subcutaneous tissue and periosteum, surrounded by the first, second, third, fourth and fifth incisions, are removed. By separating the periosteum of the mastoid process and zygomatic process, the auricle now becomes movable. A self-retaining wound sperror, devised by the author, is inserted, and the tympanic membrane, posterior wall of the external ear canal, mastoid fossa and lateral wall of the tympanum now become exposed in the middle of the field of vision. The skin and periosteum of the external bony ear canal, surrounded by the first, second, third and sixth incisions, are now removed.

The lines of incisions are shown in Fig. 1, and Fig. 2 shows the field of vision obtained by insertion of the wound sperror after removal of the skin and periosteum of the external bony ear canal.

The reason for using the type of wound sperror, shown in Fig. 3, is to prevent protuberance of soft tissue which obstructs the visual field and to prevent tissue injury.

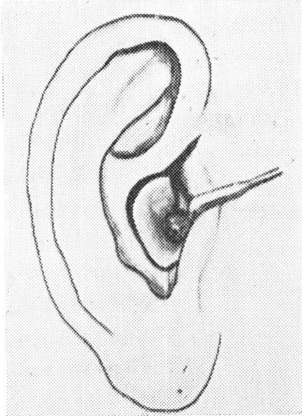

FIG. 1. Skin incisions of the external bony ear wall.

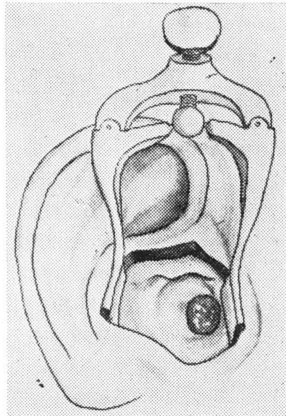

FIG. 2. The field of vision by insertion of the wound sperror.

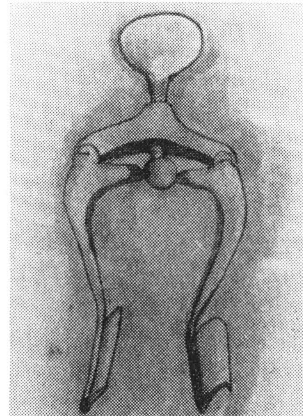

FIG. 3. Wound sperror deviced by the author.

Procedures on the bone differ according to the degree and extent of pathological changes in the mesotympanum and epitympanum. The steps in removing the pathological changes and surgery of the bone are described under the assumption that the changes inside the tympanum, especially the state of the ossicular chain, are unknown preoperatively.

The bony wall of the external ear canal neighboring the notch of Rivini is removed with a burr. By removing the lateral wall of the epitympanum, as well as enlarging the notch of Rivini, the incus and the lateral semicircular canal are exposed (Fig. 4). With these as a landmark, the surrounding bone is removed and the aditus and epitympanum are completely freed. The anterior and posterior spurs are now removed and the granulation and the thickened membrane adhering to the auditory ossicles carefully removed, and the ossicular chain is revealed *in situ*. The procedure thereafter differs according to the condition of the ossicular chain, so will be described individually.

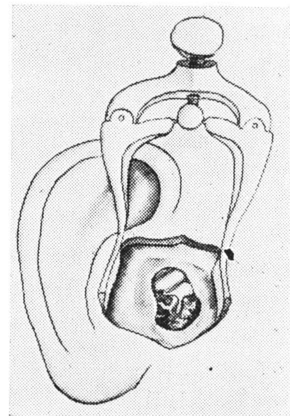

FIG. 4. Landmark (incus and semicircular canal) is visible.

A. Cases where the ossicular chain is interrupted

1) Those with large perforation of the tympanic membrane

In this case, the incudo-stapedial joint is first dislocated and the incus removed. It is needless to say, that the interruption of the ossicular chain may be present here or in the incudo-malleolar joint, and the procedure differs accord-

ing to the condition. Next, after removing the malleus, a cocaine cotton swab is placed in the tympanic cavity and the pathological changes in the mastoideal process are removed. The granulation and thickened mucous membrane of the aditus, epitympanum and mesotympanum are then separated anteriorly and downward from posterior and removed. At times, the facial nerve is exposed in this process, so when separation is carried out from the lateral semicircular canal, care must be taken that the visual field is always clear by irrigation and suction. When pathological changes are found to be present, surrounding the tube and in the hypotympanum, these must be removed, but before this is done, the anterior and inferior walls of the external canal is flattened with a burr and the field adequately widened. The parts left after the above procedures are the regions of the stapes and the round window. The procedure in these regions is delicate and meticulous, so the granulation, etc. are removed while observing under a binocular lupe or operative microscope and the stapes exposed and the round window niche cleaned. This procedure may be inadequate if the spur portion is not completely removed. After exposure of the stapes, the mobility is tested with a probe and when mobility is good, the stapedial tendon is sectioned. When the stapes is fixed, fenestration is done. Surgery in the middle ear is temporarily stopped here and hemorrhage in the operative field stopped with gauze plug. The procedure of taking 1–2 large skin grafts from the thigh and the formation of the middle ear cavity by primary skin grafting has already been reported.[14]

2) Those with perforation in the pars flaccida

In this case, the incus is first removed. The head of the malleus is then carefully removed, taking care not to tear the tympanic membrane, and the pathological changes in the epitympanum cleaned out. The postero-superior portion of the tympanic membrane is now separated with a small elevator and pressed inward. The edges of the pertoration are freshened and primary skin grafting to the bony wound and tympanic membrane carried out. With this method, however, the skin of the inferior and anterior walls of the external ear canal is not removed.

3) Those with small perforation

In cases where the perforation of the tympanic membrane is small and almost no pathological change is present in the tympanic cavity, the procedure is as described in the case where there is perforation in the pars flaccida. The perforation is closed by myringoplasty but the primary free transplant, used for bony wound, must cover both the perforation and the external bony ear wall.

B. Cases where the ossicular chain is not interrupted

In cases where the ossicular chain is not interrupted, mobility of the chain is poor in some due to connective tissue, etc., while it is good in others. Even in cases where mobility is good, it may be impossible to remove the pathological changes in the epitympanum and mesotympanum in the presence of the ossicular chain in some cases, and other cases where there is almost no pathological changes in the mesotympanum are also noted. The changes in the epitympa-

num, mesotympanum and hypoytympanum differ widely. The surgical procedure therefore varies according to the state of these pathological changes and technique.

1) Where it is possible to remove the pathological changes in the epitympanum, mesotympanum, etc., without touching the ossicular chain, the mobility of the ossicular chain is ascertained and in those where mobility is good, primary skin grafting is carried out to both the surface of the wound of the bone and to the ossicular chain.

2) When pathological changes in the epitympanum are severe and the ossicular chain made rigid by connective tissue, etc. and the ossicular chain can not be mobilized by surgical means, the procedure is the same as in the case where the ossicular chain is interrupted.

3) Marked pathological changes are found in the epitympanum in the majority of cases in which there are severe changes in the hypotympanum and surrounding the eustachian tube. In this case, the incus and malleus are removed and the procedure follows that for cases where the ossicular chain is interrupted.

4) When the perforation in the tympanic membrane is not very large and cleaning of the epitympanum is possible without disturbing the ossicular chain and almost no pathological change exists in the mesotympanum, the ossicular chain and tympanic membrane are not disturbed and the edges of the perforation freshened, the surrounding epidermis removed, the external bony ear wall and tympanic membrane covered with a large skin graft and primary skin grafting of the entire wound cavity carried out.

5) In cases where there is perforation in the pars flaccida or marginal perforation, only minimal changes in the pars tensa and the pathological changes in the epitympanum are removable without disturbing the ossicular chain, the surgical procedures follows the method in (4).

These surgical procedures are carried out while continuously removing bone, fragments, bone dusts, blood, pieces of mucous membrane, etc. by irrigation and suction, so that it is always possible to have a clear, unobstructed view of the surgical field and care is taken not to leave even a minute area of pathological change. A magnifying lupe or operative microscope is always used for delicate work and procedures involving the oval and round windows.

COMMENT

The external ear canal route for operative procedures on the temporal bone has been used since long before by a limited number of clinicians but it was not until Lempert's report that it has come to be used widely. There are however many methods for the endaural approach and these differ according to the operative procedures carried out later and indications for surgery. For example, the purely endaural operation reported by Watsuji and Kashiwabara and modified by Hoshino, is suited for cases where the pathological changes are limited to the epitympanum and mastoid antrum, while in Lempert's operation for acute mastoiditis and modified radical mastoidectomy, a small triangle of skin is removed by a preauricular and endaural incision. In radical mastoidectomy, Lempert

removed the skin of the posterior wall of the external ear canal completely, and in cases of operation in petrosus the skin of the anterior wall of the external ear canal is also removed. Maruyama recommends a skin incision similar to that of Lempert. Shambaugh used a simple incision which he used in the fenestration operation, also in radical and modified radical mastoidectomy. House carries out all temporal surgery with only a small skin incision of the external ear wall. On the other hand, McQuiston removes the skin of the external bony ear canal completely.

In reviewing these various surgical methods, the incision was small and only a small portion of skin was excised in previous period, but with the discovery of difficulties in surgical procedures and aftertreatment, various incisions were devised, and together with greater size of incision and larger excision of skin, the extent of skin excised came to differ with the extent of pathological changes. The endaural incision therefore became complex for greater ease and perfection of operative procedures. Temporal surgery by an endaural approach using a simple incision or small skin excision was however once again recommended and studies carried out. The endaural approach in which the skin excision is made large has again been reported. That is, the extent of skin incision in the endaural approach became complex, and was again simplified, while the extent of skin excision became larger and then smaller, and this has been repeated over and over.

The endaural method used by the author, by chance, is quite similar to the method of incision and skin excision reported by McQuiston and the method according to the manner of spread of the pathological change, is like that of Lempert. In the method devised by the author, the extent of skin excision and accordingly, lines of incision, have been made complex and the indications for each set up.

The problem which next arises in the endaural approach for temporal surgery is that of the landmark in operative procedures on bone. Lempert, in 1930, first draw an imaginary line from Henle's spine along the posterosuperior wall of the external bony ear canal to the posterosuperior point of attachment of the tympanic membrane and when operative procedures are carried out using a burr starting at the boundary between the inner one third and middle one third, there is no danger even in cases where anatomical abnormalities are present. However in 1949, he has recommended the method of first thinning the posterior wall of the external bony ear canal and enlarging the external ear canal and then enlarging the notch of Rivini in chronic suppuration. By this method it is possible to enter the epitympanum directly without going via the mastoid antrum. The same year, House has stated that an imaginary line drawn posteriorly from the superior margin of the external bony ear canal will bisect the lateral semicircular canal, so that the point of entrance of the burr is such that this imaginary line forms the upper margin and a line drawn superior from the posterior margin of the external bony ear canal forms the anterior margin. A shelf of firm bone which forms the lateral wall of the epitympanum is exposed at excentration of the zygomatic cells. The aditus is just internal to this shelf, so the shelf is an important landmark. McQuiston, in 1950 declared that the method of approach-

ing the mastoid antrum and lateral semicircular canal by gradual enlargement of the outer three-fourths of the superior wall of the bony canal beginning just above the tympanum and extending outward, is the safest.

In the method of the author, the notch of Rivini is enlarged with a burr, the lateral wall of the epitympanum removed and the incus first exposed. In the beginning, this operative procedure on temporal bone was also started from a point just below Henle's spine but later the method of approaching the mastoid antrum by enlarging the posterior wall of the bony canal has been used and recently, the procedure is started from an enlargement of the notch of Rivini. When operative procedures are carried out using a burr and under constant irrigation and suction, there is no danger even when anatomical anomalies are present. The method of enlarging the notch of Rivini affords great ease, spread and accuracy in determining the condition of the ossicular chain and is quite safe.

The second problem arising in the endaural method, is the danger of giving rise to postoperative perichondritis. As described in detail by Lempert, this is rare if sufficient care is taken not to cut the cartilage in making the incision. If the technic is practiced beforehand in cadavers, this danger is negligible. With the postauricular method too, perichondritis will occur at times unless the operator is experienced. That is, the perichondritis which is said to be a problem in endaural incision cannot be blamed entirely on the method.

The difficulty of postoperative treatment is another problem in the endaural method. Operative procedures in the mastoid process by the endaural approach is a little difficult than by the postauricular approach, but by proper separation, so that the auricle becomes easily movable, the difficulty in procedure can be overcome. The procedure inside the tympanic cavity moreover is easier by the endaural method. Postoperative treatment following the endaural method, when skin transplantation as described by Lempert or that of the author is carried out, is quite simple. In postoperative treatment however sufficient knowledge of the shape of the surgical wound and the shape of healed cavity must be possessed.

In any case, temporal surgery by the endaural method, especially procedures inside the tympanic cavity, is advantageous in that it is possible to visualize the field directly. In other words, it not only has the advantage, cosmetically, of leaving only a small scar but it is advantageous in that it is possible to take full measures toward the focus of the inflammation of middle ear infection. The advantages and precautions given by Lempert in the endaural approach are very adequate. That is, (1) it is possible to reach the required operative field in the temporal bone, (2) the incision must always be extracartilaginous, (3) the temporal bone must be adequately exposed so that thorough surgical procedures can be easily carried out under direct vision, (4) the incision not only must be suffiently large but care must be taken to minimize sacrifice of tissue, (5) the endaural window must move freely in any direction together with the auricle and thus afford ease of operative procedures, (6) the endaural window must be left sufficiently open even after operation, (7) it must heal without leaving a disfigurement.

CONCLUSION

The endaural approach was used in temporal surgery. Literature regarding its advantages and the care required and the method of the author are discussed. The following conclusion was reached.

1) A sufficiently wide field of vision is obtained by endaural incision, so that postauricular incision is unnecessary.

2) Operative procedures inside the tympanic cavity can be carried out thoroughly under direct vision by the endaural approach.

3) By using a burr, there is no damaging of the ossicular chain, semicircular canal or facial nerve.

4) By constant irrigation and suction and using a magnifying lupe or operative microscope, procedures on important parts are easy.

5) It is possible to prevent the occurrence of perichondritis.

6) Cosmetically, almost no scar is left and the disfigurement of too large an external ear opening, is not left.

7) With experience, the method is easy.

8) Postoperative treatment is simple with experience.

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