ROUND WINDOW MEMBRANE FISTULA REPAIR: I

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SUMMARY

There was a deficiency in animal model which showed the results of repairment of the RWM rupture. For this reason we planned to make an investigation in guinea pigs. We created a standard core perforation in the round window membrane of 15 healthy albino guinea pigs. Experimentally produced perforation of the RWM were repaired with gelfoam in right ears and left to spontaneous healing in left ears. The results of the RWM perforation healing process were followed in experimental and control groups. Our comperative histopathologic results which were encountered in light microscope are presented.

Key Words: Round window, fistula repair.

INTRODUCTION

Round Window Membrane (RWM) rupture and perilymph leakage was first described in 1960. It is well known that this condition can present with permanent or temporary sensorineural hearing loss (SNHL) and various vestibular symptoms (1-4).

Axelsson et al. reported that a surgically created perforation of the round window membrane in the guinea pig, began to heal spontaneously on the third day (5).

Another investigation materialized by Choo in 1984 in chinchilla ears in which controlled punctate lesions were made, it was shown in light microscope that spontaneous healing occured completely within 7 to 9 days (6). Some authors advocate the exploration of the ears in which perilymphatic fistula was suspected. Obliteration of the round window has also been suggested whether a perilymphatic fistula existed or not. Fascia, perichondrium, free fat from lobulus auricula and gelfoam have been used as graft material (7-9).

In 1987 Paperalla et al. pointed out that there was a deficiency in animal model which showed the results of repairment of the RWM rupture (10). Review of the literature revealed that there were some clinical researches in which grafting materials and their post operative results were comperatively investigated but there was limited number of reports which dealt with histopathological changes in an animal model. For this reason we conducted this study in order to find the results of using gelfoam as a graft material for repairment of the controlled punctate lesions in guinea pig ears. We present here our light microscope results. As we continue with our investigation, we are planing to report our results of using fibrin glue and temporalis muscle fascia as grafting material.

METHODS AND MATERIALS

In this investigation 21 healthy albino guinea pigs approximately 350 grams obtained from İstanbul University Center for Experimental Research and Application (DETAM) were used. 5 of the guinea pigs were chosen randomly as the control group.

The animals were each anesthetized by means of an intraperitoneal injection of sodium pentobarbital calculated at 25 mg/kg of body weight and ether inhalation anesthesia. All surgical procedures were performed under aseptic conditions. In the same session, first the right then the left ear of the animal were operated on. Following postauricular incision utilizing the operating microscope Zeiss Opmi I, posterior bony wall was partially excised with burr, permitting visualization into the middle ear (11). Martin footplate perferator (catalog number 36-024-01) was used to create a standard core perforation in the round window membrane. Repair was done with small gelfoam particles without any aspiration. After then perforation

was created on the left ear of the guinea pig and left to spontaneous healing. The flaps were replaced, external ear canals were filled with an antibiotic ointment (terramycin) impregnated gauze. Postauricular incision was closed with 2 sutures. No antibiotic was administered. Animals were divided into 5 groups and each group consisted of 3 animals. Three animals from each group and one animal from control group were sacrificed at 1 day, 5 days, 9 days and 17 days by injection of intracardiac formaline. Following sacrification, bullae were removed and middle ear was explored under operating microscope. Stapes was removed and then cochlea perfused via the apex and oval window and then temporal bones were embedded in 10% formaldehid for 24 hours.

Following decalcification in 5 % trichlor acetic acid (TCA) for 3 days they were washed with saline solution and cleared in low degree alcohol and embedded in paraffin. Sections of 5 - 7 micron were stained with hematoxylen and eosin and evaluated by light microscope. The procedure used for control animals was the same as used for the experimental animals, however, in the control animals, round window membranes were not perforated. One of the guinea pigs died during anesthesia procedure.

RESULTS

Middle ear mucosa was normal in control group. There was no sign of inflammation and infection. Only in one of the animals of the control group (9 days) there was granulation tissue under posterior flap. In histological examination of the RWM of the control group, erythrocyte accumulation was observed at the scala timpani site. It was thought that this condition was due to the trauma during the preparation of the temporal bones for histologic sections. This condition was also encountered in histological examination of the experimental group (Fig. 1).

Group 1:
1) Right ear:
a) Macroscopic findings: There was minimal effusion and dark yellowish partially absorbed gelfoam in the middle ear.
b) Microscopic findings: There was blood elements between gelfoam and RWM and also serofibrinous exudate on the scala tympani site of RWM.
2) Left ear:
a) Macroscopic findings: There was no obvious effusion but mucosa had brighter and wet appearance.
b) Microscopic findings: Erythrocyte accumulation and other blood elements were seen at the perforation and scala tympani site of RWM (Fig. 2).

Group 2:
1) Right ear:
a) Macroscopic findings: Brown colored liquified gelfoam on the RWM and eustachii orifice was observed.
b) Microscopic findings: Healing of the RWM was observed. There were adhesions between gelfoam and RWM and also there were mononuclear cell infiltration, purulent, fibrinous exudate in and around the gelfoam. Beside the thickening of RWM, eosinophilic proteinous material, scant neutrophils at scala tympani were seen. In one animal these findings were less prominent (Figs. 3-6).
2) Left ear:
a) Macroscopic findings: Middle ear was normal.
b) Microscopic findings: There was fusiform thickening of membrane at one site (healing site) consisting of fibroblast proliferation. Complete healing of experimental perforation was observed in all animals of this group (Figs. 7,8).

Group 3:
1) Right ear:
a) Macroscopic findings: In two animals there were purulent exudate in the middle ear and browny liquified gelfoam in the middle ear of the third animal.
b) Microscopic findings: Complete healing of the membrane in all animals including the two with infection was observed. Gelfoam material was partially resorbed and inflammatory reaction has subsided. Mesothelial cell proliferation was seen at the junction of membrane and bone.
2) Left ear:
a) Macroscopic findings: Middle ear was normal.
b) Microscopic findings: There was no obvious change on the membrane except the healing site. In one animal foreign body type giant cells (probably due to talk powder) and a few mononuclear cells were seen at the healing site of the membrane (Figs. 9,10). In another animal regenerated epithelium was observed on the middle ear site of the healing region (Fig. 11).

Groups 4 and 5: Macroscopic and microscopic findings were similar.
1) Right ear:
a) Macroscopic findings: There was residual gelfoam material in the middle ear.
b) Microscopic findings: Obvious thickening of the whole membrane most prominent at the healing region was observed. There were scant gelfoam and macrophages on the middle ear site (Fig. 12). Almost all gelfoam was resorbed in one animal (Fig. 13).
2) Left ear: Macroscopic and microscopic findings were similar to the third group.

DISCUSSION

Perforations occuring in the RWM are associated with hearing loss and vestibular symptoms. It is suggested that hearing loss is either a result of the primary pathology that caused perforation in the RWM or due to the air bubbles that passed through the perforation to the scala tympani (12-15). In 1986, it was shown in experimental study performed on guinea pigs that perforation of the RWM did not effect the hearing thresholds and closure of the membrane damage had no effect on the brain - stem responses (ERA) (14). Same results were obtained in a similar study performed on cats. As the physiopathology of the hearing loss can not be verified exactly, different approaches are

seen in the treatment principles of the cases where perforation is suspected. There is no answer to the question of what must be the exact time of repair of the RWM rupture. Although the conditions were the same for both ears in our study the infection rate is approximately 3 times higher in the ears in which repair of the rupture is made up with gelfoam comparing to the ears, left to spontaneous healing. There was no difference in the healing period and maintaning of epithelial continuity of the perforation edges of membrane rupture when the gelfoam was applied for reparation. While the thickening of the whole membrane was noted in groups 3,4 and 5 where gelfoam was applied, the reaction was only confined to the perforation site in animals left for spontaneous healing. Eosinophylic proteinous fluid accumulation on the scala timpani site of the membrane was more pronounced and there were neutrophyl leucocytes in the treatment group whereas only erythrocyte accumulation was noted in the scala tympani site of the membrane in the ears left to spontaneous healing and in the control group.

Histopathologic findings of the gelfoam group confirmed previous similar studies (16-18). Application of gelfoam seem to be advantageous as it leads to thickening of the whole membrane, thus creating a strong barrier against the flow from the middle ear into the internal ear or vice versa by decreasing permeability of he membrane. On the other hand, it also has disadvantages, namely more inflammation in the early postoperatuar period, celluar infiltration and accumulation of edematous fluid in the internal ear which would lead to a decrease in the elasticity of the membrane.

Further investigations are needed to find if other materials would have the same disadvantages and which material would be suitable in repairing RWM fistulae. The results of such studies will make the choice of proper grafts possible.

Table I: Review of histopathological findings

RIGHT EAR	LEFT EAR
GROUP 1 *Macroscopic: Minimal effusion in the middle ear and dark yellowish partially absorbed gelfoam.*	*No obvious effusion, mucosa had brighter and wet appearance*
Microscopic: Blood elements between gelfoam and RWM serofibrinous exudate on the scala tympani site of RWM.	*Erythrocyte accumulation and other blood elements at the perforation and scala tympani site of RWM (Fig. 2)*
GROUP 2 *Macroscopic: Brown colored liquified gelfoam on the RW and eustachii orifice.*	*Middle ear was normal.*
Microscopic: Healing of the RWM, adhesions between gel foam and RWM mononuclear cell infiltration in and around the gelfoam purulent, fibrinous exudate thickening of RWM eosinophylic proteinous material, scant neutrophils at scala tympani (Figs. 3-6)	*Fusiform thickening of membrane at one site (healing site) consisting of fibroblast proliferation Complete healing of experimental perforation was observed in all ears (Figs. 7,8).*
GROUP 3 *Macroscopic: Purulent exudate in the middle ear of 2 animals, browny liquified gelfoam in the other animal's middle ear.*	*Normal appearance*
Microscopic: Complete healing of the membrane in all animals including the two with infection inflammatory reaction has subsided and gelfoam material was partially resorbed mesothelial cell proliferation at the junction of membrane and bone.	*There was no obvious change on the membrane except the healing site foreign body type giant cells (probably due to talk powder) and a few mononuclear cells at the healing site of one animal (Figs. 9,10) regenerated epithelium on the middle ear site of the healing region in another animal (Fig. 11)*
GROUP 4 and 5 *Macroscopic: Residual gelfoam material in the middle ear* *Microscopic: Obvious thickening of the whole membrane most prominent at the healing region scant gelfoam and macrophages on the middle ear site (Fig. 12). Almost all gelfoam was resorbed in one animal (Fig. 13).*	*Similiar to the third group.*

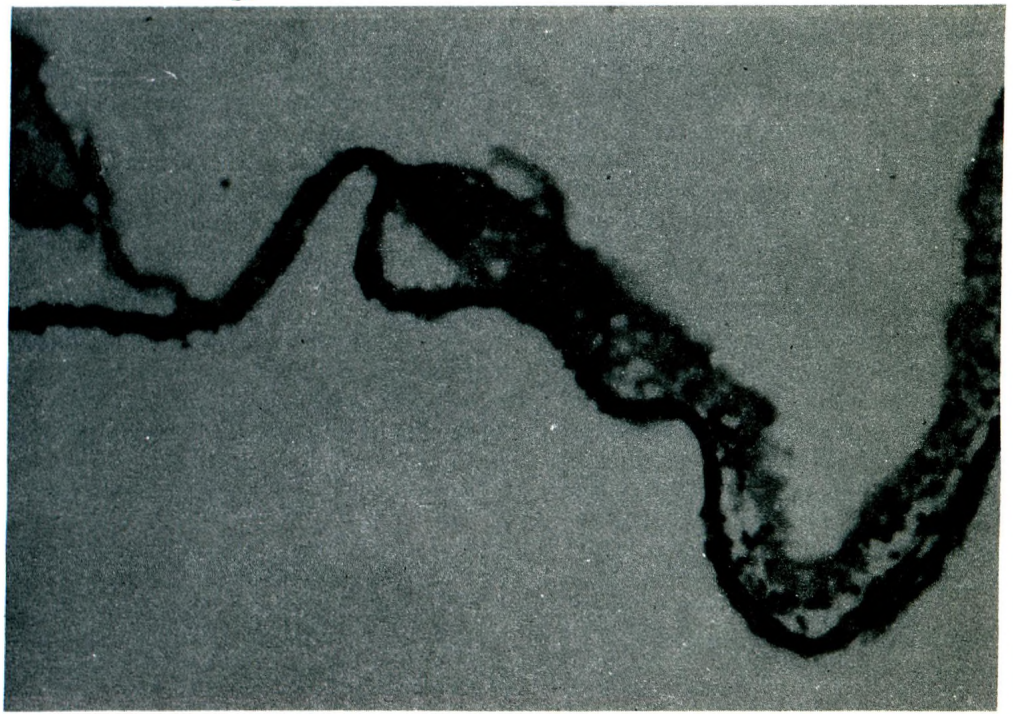

Fig. 1: × *200* *HE.*

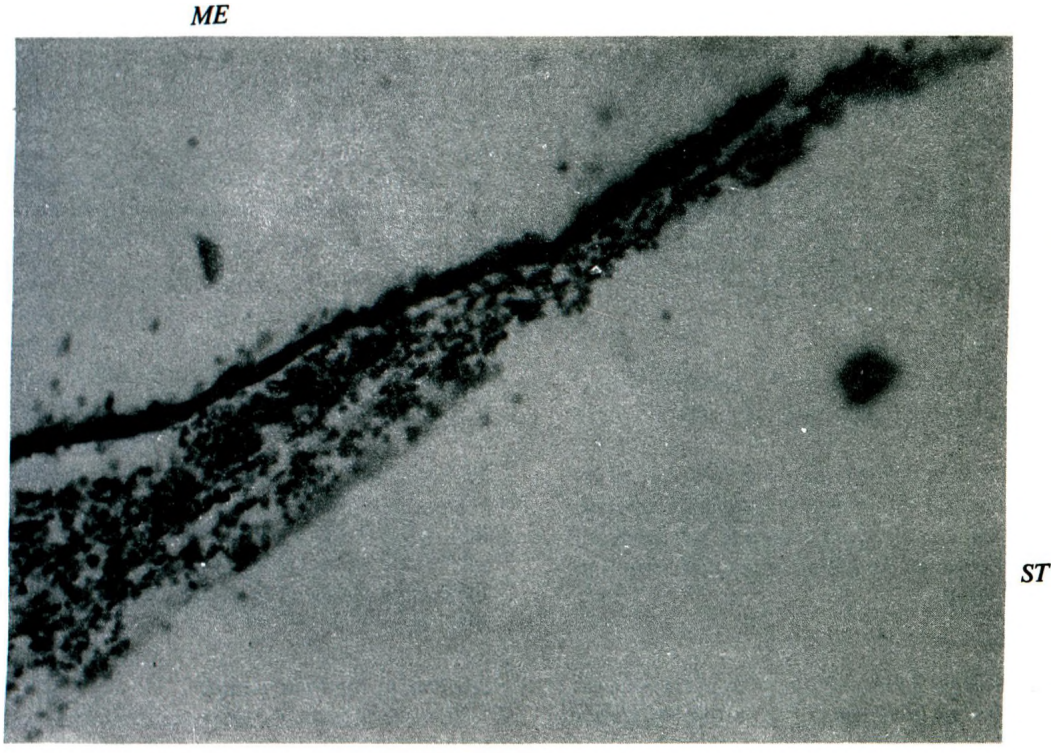

Fig. 2: × *200* *HE.*

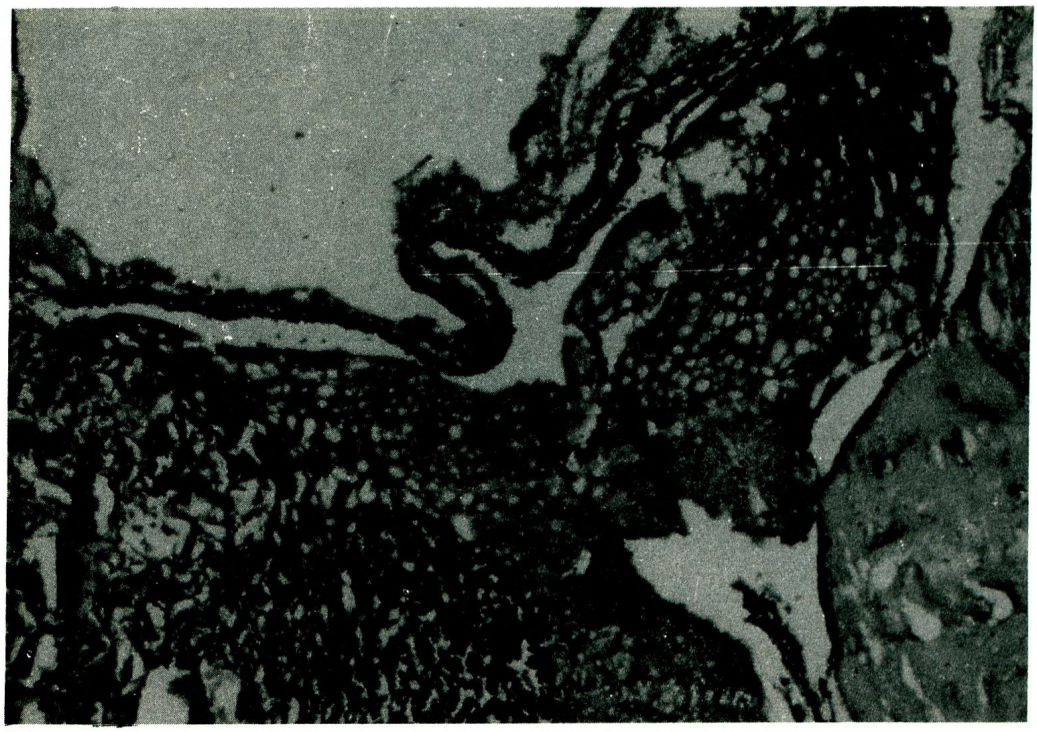

Fig. 3: × 40 HE.

Fig. 4: × 100 HE.

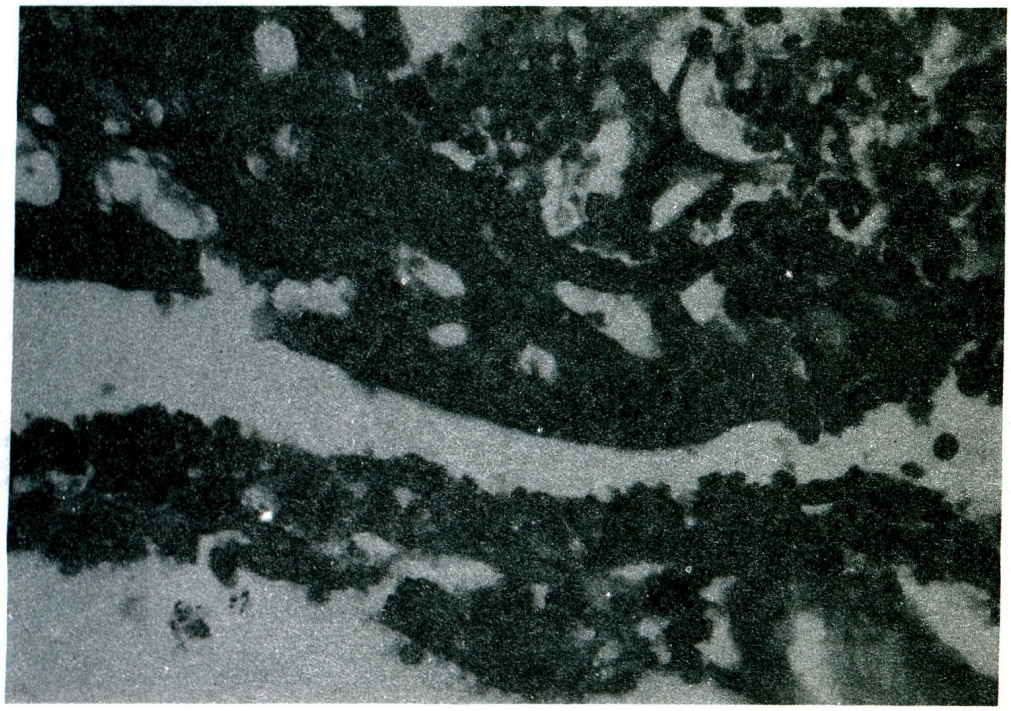

Fig. 5: × 200 HE.

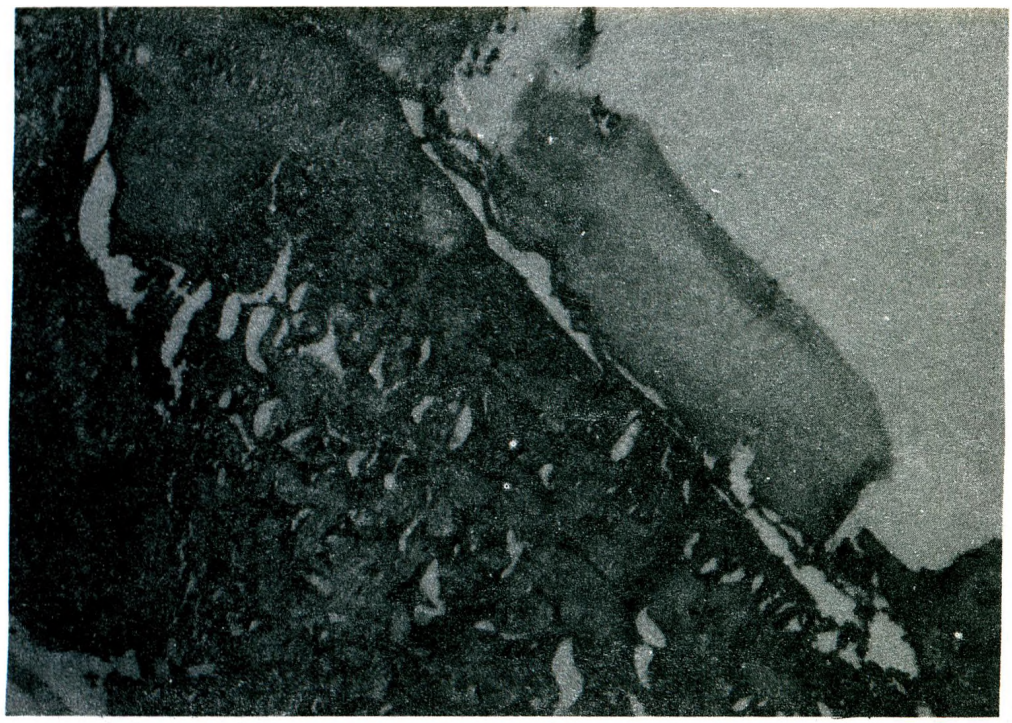

Fig. 6: × 40 HE.

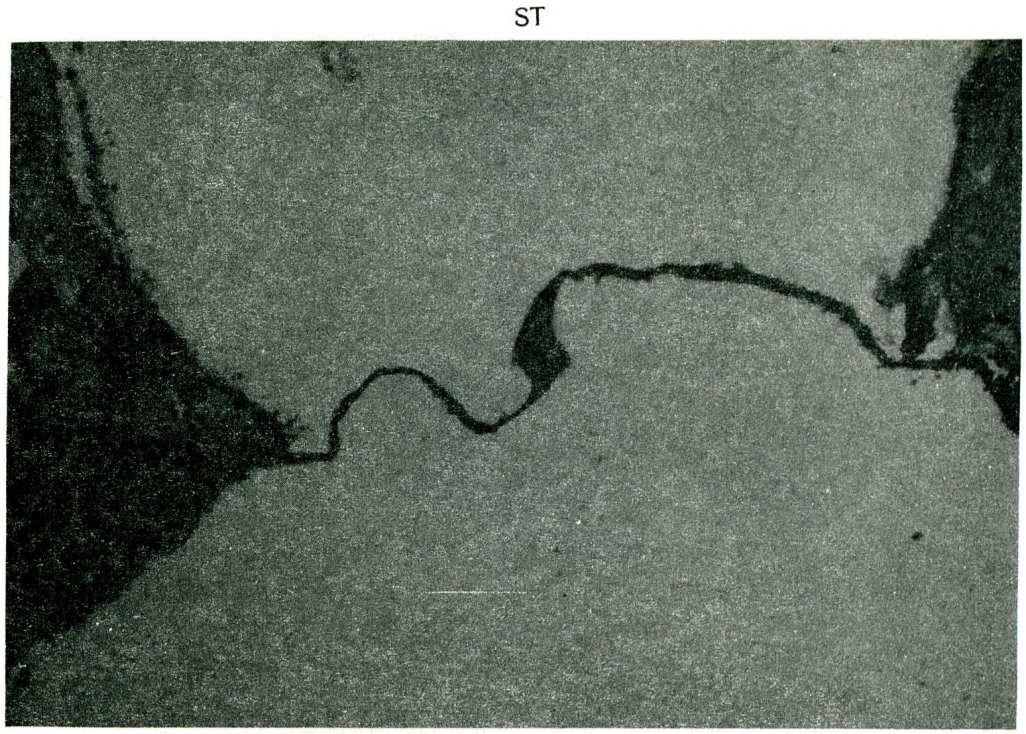

Fig. 7: × *40* *HE.*

Fig. 8: × *400* *HE.*

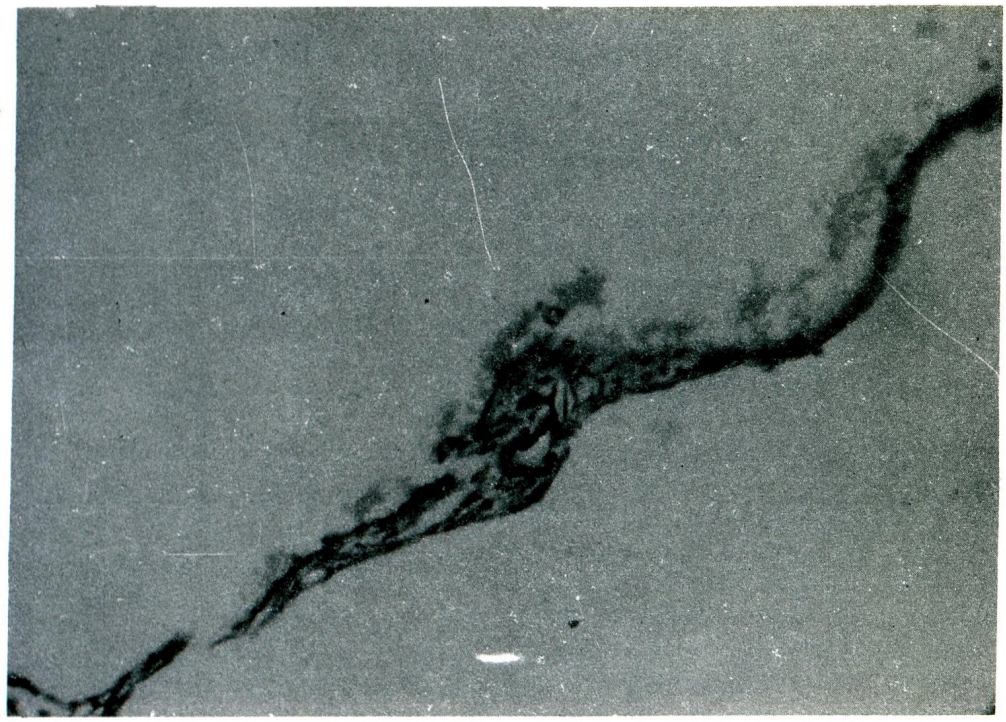

Fig. 9: × *100* *HE.* ME

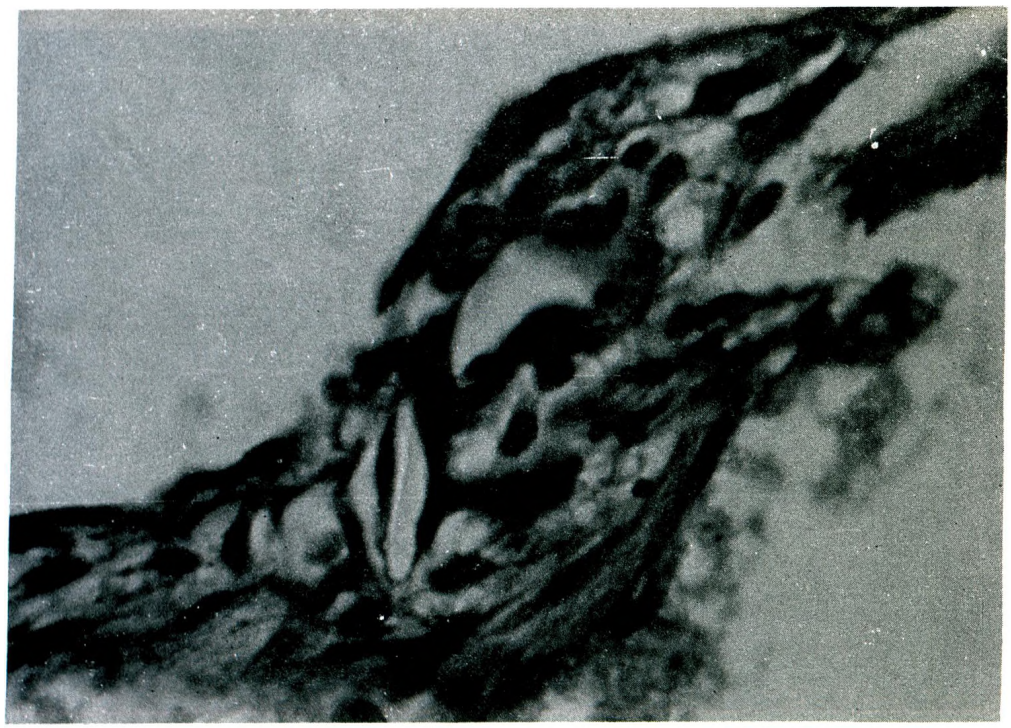

Fig. 10 × *400* *HE.* ST

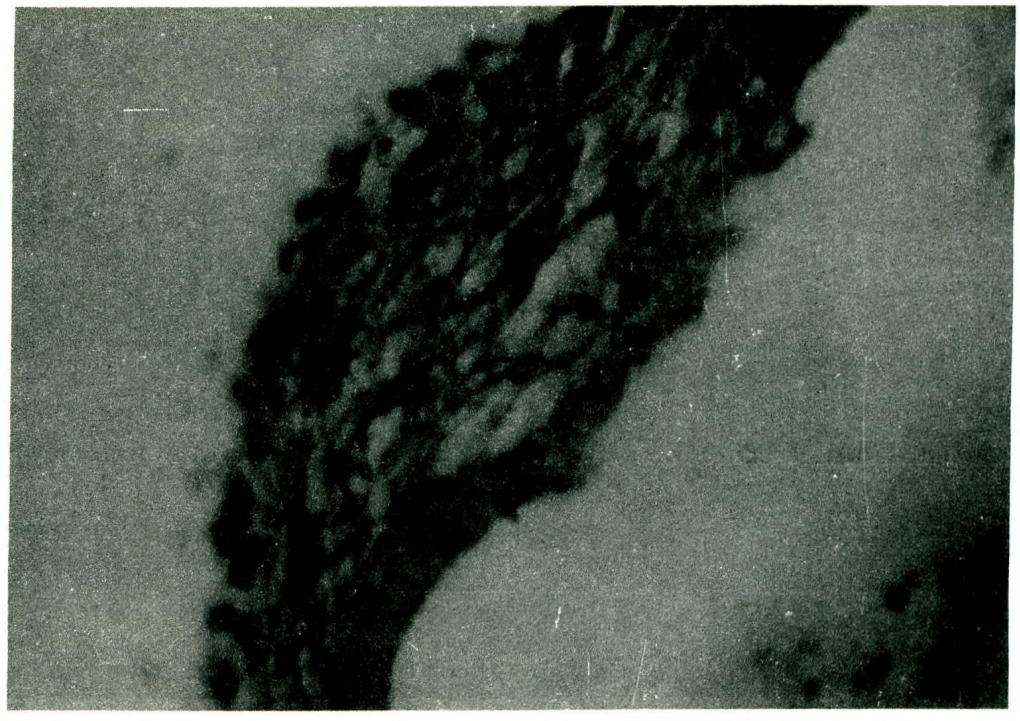

Fig. 11 × 200 HE.

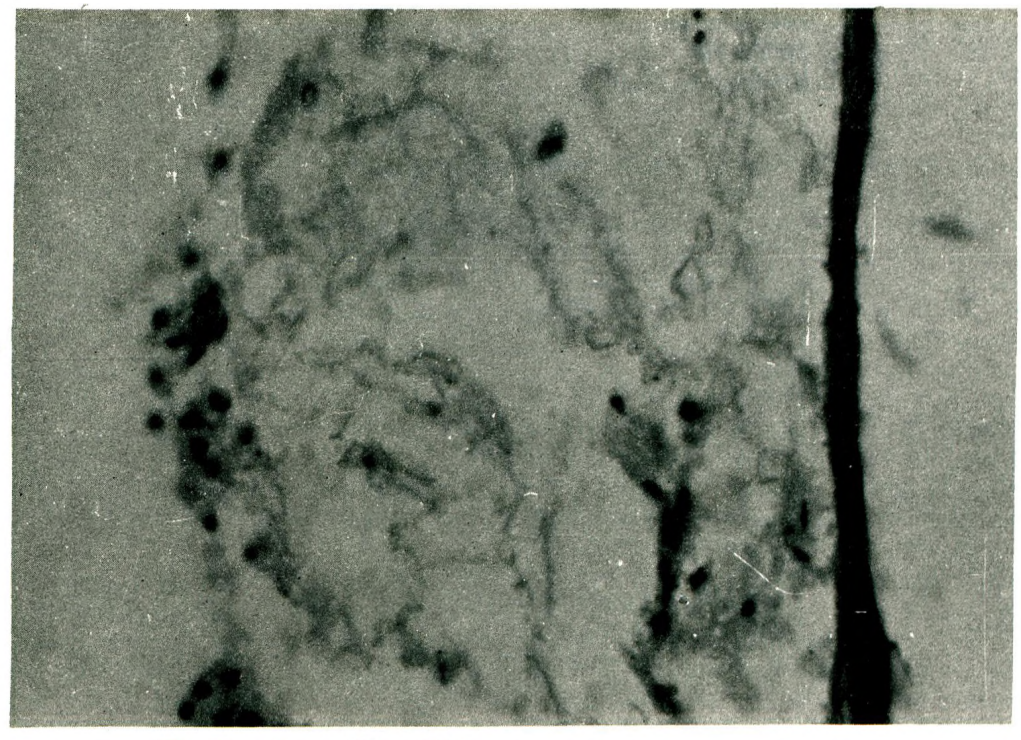

Fig. 12 × 200 HE.

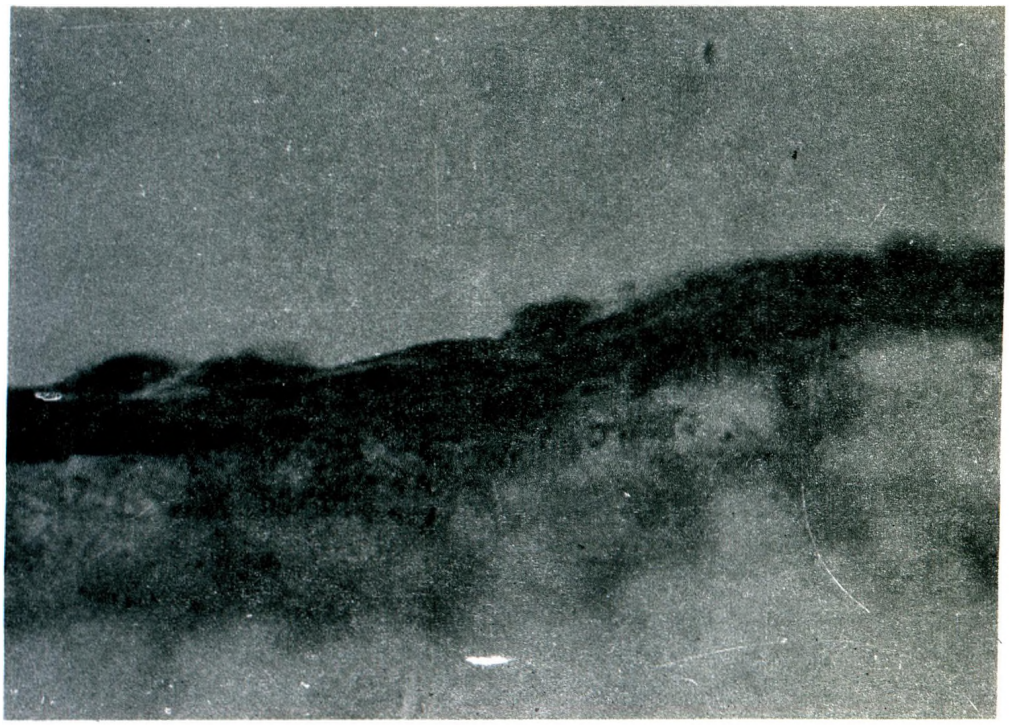

Fig. 13 × 400 HE.

SC: Scala Tympani
ME: Middle Ear
HE: Hematoxylen Eosin

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