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A study on chemical cauterisation for small tympanic membrane perforation

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Abstract
To study the effectiveness of chemical cautery with patching on chronic tympanic membrane perforations of the pars tensa. Thirty-eight patients with dry tympanic membrane perforations due to inflammatory or traumatic etiology were selected after treating the primary etiological factors like septal deviation and allergic rhinitis. Fifty percentage silver nitrate was used to cauterize the margin and the perforation was covered with thin sterile aluminium foil as a patch. A maximum number of five applications were made, and the patients were followed up for the next 5 years. In this series of 38 patients, highest success was noted among those patients with traumatic perforation, while larger perforations were reduced to small pinhole sizes which were successfully closed by myringoplasty. An overall success rate of 73.75% was achieved. This is a time tested useful method which was popularized by Derlacki (1953), to close small to moderate sized tympanic membrane perforation and should be considered as a first line management in the treatment of tympanic membrane perforation prior to any surgical intervention. Apart from being a simple and economical mode of treatment, it is associated with minimal complications. Though various materials have been used to modify this technique, the principle remains the same and the results obtained in this study is comparable with the previous ones.

Keywords: Tympanic membrane perforation, chemical cautery, silver nitrate, patch technique

Introduction
Hippocrates (460-377 BC) [1] was the first to regard the tympanic membrane as a part of organ of hearing and described it as a dry, thin spun web. The tympanic membrane got its name from Gabriel Fallopius of Padua (1523-1562), who was the first to use the term “tympanum.” The tympanic membrane is frequently injured and the relative incidence of myringeal lesions has been reported to range from 0.4% to 2.3% of all disorders of the ear [2].

During the period from the Seventeenth to the Nineteenth century, several methods have been attempted at closing the tympanic membrane perforation [3]. At first, closure of the perforation was tried with a prosthesis. Ivory tube (Banzer 1640), rubber disc (Toynbee1853), paper disc (Blake 1887) and various other materials were used. In 1876, Roosa used cauterising agents to promote the healing of tympanic membrane perforations and he used a silver nitrate bead, while trichloroacetic acid was first advocated in 1895 by Okuneff and it still remains the most popular chemical used for this purpose. In 1919 Joynt combined both cautery and paper patch technique and Linn used a moist cotton ball with repeated cautery at weekly intervals [3]. Both these techniques were very effective. The method by Linn was modified and popularized by Derlacki and Wright in 1953 [3, 4].

Etiologically, tympanic membrane perforations are either due to inflammation or trauma. Many of the perforations due to otitis media heal, unless there is a coexisting Eustachian tube dysfunction which is the main reason for a permanent perforation [3]. Traumatic perforations usually heal spontaneously, and it is preferable to wait for at least 3 weeks prior to any intervention.

A perforated tympanic membrane results in loss of hearing due to decreased drum area and liability to recurrent infection of the middle ear mucosa. These problems limit the patient’s participation in water sports, and for job recruitment in the military service and as a motor vehicle driver [5]. Closure of these perforations is gratifying to both the patient and the surgeon. The patient stands to gain as much as 25 db of hearing. In some cases, tinnitus gets relieved.

Also, the patient gets a discharge free ear [6].
While surgical closure of tympanic membrane perforation still remains the choice of management, effective closure of tympanic membrane perforation can be achieved by using chemical cautery and patch technique together for small and moderate sized perforations.

Materials and methods

The study was conducted during the 3 year span from July 2017 to 2020. Age group ranged from 14 to 78 years. The patients did not have any systemic illness. Patients with both bilateral and unilateral perforations were included, making the total number of perforations for evaluation as 52.

Table 1: Showing the category of patients selected for the study

Category of patients	Total no. of cases	No. of patients with bilateral perforations	No. of patients with unilateral perforations	No. of patients with systemic illness	Total no. of perforations
CSOM	13	5	8		18
DNS with CSOM	10	4	6		14
Traumatic perforation	8	1	7		9
CSOM with allergic rhinitis	9	2	7		11
Total no. of cases	40				52

All patients had at least 40–50% loss of the total drum surface area in the pars tensa. Diagnostic endoscopic study of the nose and nasopharynx was done in all cases. Factors like deviated nasal septum (DNS) and allergic rhinitis were noted. Those with DNS and significant nasal block underwent septal correction and were included in the study 3 weeks after the surgery, while allergic rhinitis was controlled by antihistamines and local steroid nasal sprays. Eustachian tube patency was assessed by Valsalva's Maneuver. Hearing was assessed by tuning fork tests and pure tone audiometry, with the average airborne gap ranging from 0 to 50 dB.
The technique was carried out as an OP procedure. For those who had bilateral perforations, one ear was treated first and the other ear was treated 6 weeks to 3 months later. For the initial application, 4% xylocaine was used to anaesthetize the tympanic membrane by adding a few drops into a small cotton ball and placing it into the external canal wall over the surface of the tympanic membrane for about 10 min, while subsequent applications did not require local anaesthesia. Under the microscope, the rim of the perforation was cauterized using a cotton tipped applicator dipped in 50% silver nitrate and the excess of the chemical was drained using a dry cotton swab. Care was taken not to scar the promontory. Once the blanching of the rim was completed, a small sterile, thin aluminium foil impregnated with antibiotic cream (soframycin) was placed as a patch over the perforation. The patients were evaluated every 2 weeks, many of them requiring more than one application and the technique was repeated for a maximum of five times. After the first application, an antibiotic was given for 1 week, and Neosporin with hydrocortisone ear drops were instilled for 3 weeks.

Result

The average number of applications for closure was 3.2 with the smaller perforations requiring fewer number of applications as shown in Table 2.

Table 2: Showing the total average application of silver nitrate in the study

No. of silver nitrate applications for closure of TMP	No. of perforations	Total average
1	1	
2	15	
3	14	
4	13	
5	6	3.2

Out of the 13 patients with CSOM alone, 5 had bilateral and 8 had unilateral perforations making up a total of 18 perforations. Two with unilateral and one with bilateral perforations failed to respond even after five applications and underwent myringoplasty later. One patient with bilateral perforations had undergone myringoplasty of one ear and had developed delayed facial nerve palsy. She refused surgery of the other ear, which was successfully closed by cauterising.
Among the 10 patients with DNS, 4 had bilateral and 6 had unilateral perforations, the total number being 14 perforations. There was failure in 3 patients. Among the failed cases, one with bilateral CSOM, had large central perforations which was reduced to a very small size. He successfully underwent myringoplasty. Ten perforations were closed by cauterizing.
The traumatic cases had unilateral perforations excepting one, with a total of 9 perforations and and 7 perforations were closed. Among the 11 perforation cases with allergic rhinitis, 5 had successful closure. All patients were followed up at the end of 6 months, 1 year, and twice a year for the next 4 years. Two patients with allergic rhinitis had reperforation at the end of 1 year and were taken up for surgery. They were considered under the failure group.

Table 3: Showing the results of the study

Category of patients selected	Total no. of cases	Total no. of perforations	No. of perforations with successful closure	No. of perforations which failed to close	Percentage of success
CSOM	13	18	13	5	72.2
CSOM with DNS	10	14	10	4	71.4
CSOM with traumatic perforation	8	9	8	1	88.9
CSOM with allergic rhinitis	9	11	5	3	45.4

Discussion

Perforation of the tympanic membrane causes a conductive hearing loss that can range from negligible to 50 db [3]. A tympanic membrane perforation causes conductive hearing loss due to loss of ossicular coupling which is again due to loss of sound pressure difference across the tympanic membrane which provides the primary drive to the motion of the drum and ossicles. In addition, perforation causes a loss that depends on

frequency, perforation size and middle ear space. Perforation induced losses are greatest at lowest frequencies. Larger perforations result in larger hearing losses. Tympanic membrane perforation leads to an increase in acoustic coupling by 10–20 db caused by a loss of shielding effect of the intact tympanic membrane. The increase in the acoustic coupling allows one to predict that the maximum conductive hearing loss following a perforation will be about 40–50 db [3]. The volume of middle ear space also affects hearing. Smaller volume results in larger airborne gap. For a given sound pressure in the ear canal and a given perforation, the resulting sound pressure within the middle ear cavity is inversely proportional to the middle ear volume. So the transtympanic sound pressure difference will be smaller with smaller middle ear volumes. Identical perforations in two different ears have conductive losses that can differ by up to 20–30 db if the middle ear space volumes differ [3]. The size of the perforation is more important in determining the hearing loss than its location [3]. Perforation induced physical changes such as reduction in the membrane surface area do not appear to contribute significantly to the hearing loss caused by a perforation [3].

The tendency of even very large perforation of the tympanic membrane to heal spontaneously was noted as early in 1876 by Roosa [7]. In 1851 Toynbee demonstrated five distinct layers of the pars tensa of the tympanic membrane as follows.

1. An outermost epidermis
2. Dermis of fibrous tissue, blood vessels and nerves
3. Outer radiate fibrous layer
4. Inner circular fibrous layer
5. Innermost thin mucosal layer.

A large perforation of the tympanic membrane heals often into a thin atrophic scar which lacks the fibrous layers, having only an outer epidermis and inner mucosal layer. This may rupture easily by external trauma, forcible inflation of the Eustachian tube and in otitis media [7]. But a perforation closed by repeated acid cautery of the rim usually results in a normal appearing tympanic membrane with all the five layers [7].

Histo pathological study of a newly formed perforation shows proliferation of squamous epithelium within 12 h at the edge of the perforation, granulation formation within 18 h, while the inner mucosa of the membrane takes several days to regenerate [3]. In chronic tympanic membrane perforation, squamous epithelium is found adjacent to the middle ear mucosa and creates a perforation edge with no raw surface. This is a contributing factor for a perforation to persist and was observed by Dunlop and Schuknecht in 1947 [7]. The principle of chemical cauterization is that when on application, it breaks up fibrosis, promotes granulation and new tissue formation at the margin of the perforation [4]. The patch acts as a splint to bridge the margins of the perforation. Given a flat surface, the epithelium grows at the rate of 1 mm per day.

Three guidelines have to be kept in mind when promoting healing of perforation by acid cautery of the rim [7].

1. The outer squamous epithelium that has grown inward across the edges must be destroyed repeatedly, to permit fibroblastic proliferation of the fibrous layer.
2. The rim of the perforation should be kept moist as drying immediately kills the young fibroblasts.
3. Hyperemia stimulates fibroblastic proliferation and should be induced by mild irritation.

Simple closure should be under taken only for inactive central perforations with good eustachian tube patency. If the tube cannot be inflated, closure would result in secretory otitis media with no gain in hearing. Myringoplasty may be recommended as a first attempt for perforations involving more than 65% of the pars tensa, for narrow external canal preventing a view of the anterior edge of the perforation and for patients who refuse to come for repeated follow up [7].

In the literature, various methods have been used other than chemical cautery, in the non surgical closure of perforations, like the irritant oil method [8], fibrin glue [8], fat plug [5] carbon dioxide laser trimming of the margins before applying paper patch etc. [9]

Different patching materials have also been used. Wright (1956) used cotton patch with neomycin ear drops, while Mitchell (1958) used sterispon gelatin sponge soaked in patient's own blood [5].

Juers reported an 88% success with an average of 3.7 applications. He had further everted the margins of the perforation under the operating microscope, whereas Derlacki who reported 75% success in office treatment at biweekly intervals had used cautery alone [7]. Dunlop had a 100% success with 3–33 treatment at biweekly intervals [10].

In the present study, it was noted that the highest success was seen among patients with traumatic perforations, and the lowest in those with allergic rhinitis. Among the failed cases, two patients who had large perforations had them reduced to pinhole size, and successfully closed by myringoplasty. This study gave an overall success rate of 73.75%, which is comparable with the previous studies documented in the literature. All reports emphasize the need for persistence by both patient and physician if a high closure rate is to be realized [3].

Conclusion

Reviewing the various studies on the subject of cauterising and patching of tympanic membrane perforations, it may be considered as a first line in the management of small to moderate sized perforation before attempting surgical closure. The present study has led to the following conclusions.

1. Smaller the perforation, better the closure rate.
2. Large perforations may get reduced to smaller size, thereby, making surgical intervention easier.
3. Those with traumatic perforation, had a better healing rate.
4. Correction of primary etiological factors helps for a better closure rate.
5. Surgical complications of middle ear surgery can be avoided.
6. It may be safely tried among those with systemic medical conditions which are under control and in whom surgical intervention is contraindicated.

Apart from the fact that multiple sittings is required which is a disadvantage, this procedure of chemical cautery and patching the tympanic membrane perforation is a relatively safe, simple, and economical technique. As it can be done as an office procedure with minimal sophisticated equipments, this can be tried out even by ENT surgeons working at a peripheral set up.

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