SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOLOGY

November 2nd, 1934

President—E. A. PETERS, F.R.C.S.

Infections of the Eustachian tube and Pulmonary Tract

(PRESIDENT'S ADDRESS)

By E. A. PETERS, F.R.C.S.

I PROPOSE to compare the respective methods of infection in the Eustachian tube with that of the pulmonary tract which, after the protection of the regulating valve of the glottis opens into open and almost fixed tubes, and then into the bronchioles, which contract or dilate and regulate the admission of air into the alveoli where the limit of pressure is 0·19 mm.

The Eustachian tube is a diverticulum of the first cleft. It commences as a cartilaginous tube, in which the walls are in contact, exercising control of the entry of air and exit of mucus. Swallowing opens the tube.

With an open lumen the outer two-thirds passes through a bony canal, and expands into the middle-ear cavity—the antrum and pneumatic mastoid cells.

The upper respiratory tract and its sinuses are lined by ciliated epithelium from the anterior margin of the middle turbinate to the palate level. The bucco-pharynx, containing the lower half of Waldeyer's ring, is covered by stratified epithelium and is cleansed by either swallowing or screeding.

Septic processes, whether acute or chronic, set up by organisms introduced with respired air, result in a rhinopharyngitis. Worms and Le Mée say that the tonsils share with the mucous membrane the early incidence of infection, which subsequently extends to the lungs; in acute cases infection of the rhinopharynx and lungs may be co-temporary. Chevalier Jackson has said that chronic sinusitis and septic tonsils stand in a causative relationship to bronchiectasis. Sinusitis loads the nasopharynx with infected pus and infects the blood with organisms. Septic tonsils in the adult

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show ulceration just within the mouth of the crypt, and infiltration of the cryptal epithelium with lymphocytes, which are poured out into the saliva. Few organisms are seen in the crypts.

In the enlarged tonsils of the child there is hypertrophy of the adenoid tissue as a reaction to not very obvious sepsis of the crypts.

In the lacunar tonsillitis of middle age, the large crypts are full of various micro-organisms, and even of actinomyces, but the ulceration and adenoid tissue is small, whilst scar tissue is pronounced. We know that absorption from the crypts may lead to septicæmia and other diseases, but so far as pulmonary and aural infection are concerned the evidence agrees with Flurin who states that rhinopharyngitis is localized in the tonsils.

For some years I have treated septic tonsils which are unsuitable for enucleation by cupping with a two-way cup exhausted by a pump, and the introduction into the crypts, by negative pressure, of an antiseptic—either hydrogen peroxide or 1 : 10 camphorated phenol. During early treatment blood escapes from the ulcers, but these gradually heal, and finally no blood exudes during the treatment. The patients feel much better afterwards, therefore absorption presumably takes place in septic tonsils.

The efficient action of the nose is an important factor in controlling, or diminishing attacks of rhinopharyngitis. The association of septic tonsils with nasal obstruction in the adult is well known ; and the diminution of rhinopharyngitis after the correction of the nose and enucleation of septic tonsils is a matter of everyday experience.

Normal nasal inspiration yields air saturated with moisture, warmed and free from ordinary dust and bacteria. Expired air is also free from micro-organisms, but talking, sneezing, and coughing, distribute infected droplet spray up to 7 ft. The commonest method of catching a cold is to go from a heated crowded room into cold air. Such a room is full of droplet-spray and dust ; the mucous membrane of the nose becomes dry and turgescent, and more mouth breathing occurs ; exposed to cold air the mucous membrane blanches.

Recently two types of inflammation have been described :—

(*a*) The leucocytic type, characterized by polymorphonuclear and mucoid outpourings ; it is the common catarrhal form and is followed by hypertrophy of connective tissue ; it is said to be due to bacterial infection.

(*b*) The serous type, said to be of virus origin and, as such, to occur in influenza ; it is characterized by destruction of epithelium and atrophy of connective tissues.

These two types approximate to the vasomotor hypertrophy seen in obstructed noses, and to the dry and atrophic rhinitis usual in patent noses.

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The milk we consume is pasteurized by the dairy companies; the water we drink is filtered and chloramined by the Water Boards. The external air of cities has improved, but crowded cars and dusty houses induce a real communism of micro-organisms.

(1) Infection by inhalation has latterly come to the front.

Gond is of opinion that tubercle bacilli enter by this method: (*a*) Dust may be a factor, either as a vehicle for the conveyance of micro-organisms or as an irritant combining with bacteria to cause infection. Jones has shown that sericite, a silicate of aluminium and potassium, an impalpable powder that floats indefinitely in the air and is not brought down by water spraying, is the cause of miners' phthisis. The particles, 3 microns in size—about the length of bacilli—reach the alveoli and cause tissue change and the formation of fibrous nodules in the lymph-glands. Kettle finds that kaolin is equally dangerous and shows that its particles act as irritants and may be combined with the action of an organism, usually the tubercle bacillus. The concomitant effect of dust may be a factor in cases in which massive infection was supposed to be potent. Thus a case of unsuspected cerebrospinal meningitis led to the examination of the orderlies of an isolated block; 13 out of the 15 orderlies were found to be carriers. On the other hand, the unmasked orderlies in a cerebrospinal ward where the windows were open were free from the meningococcus. (*b*) Interference with the efficiency of the cilia is also regarded as a factor, and Proetz and Negus have shown how dryness and acids put the cilia out of action. Noses with dry catarrhs do not, however, show greatly increased infection, except in the case of erysipelas.

(2) Direct extension occurs both in the pulmonary and Eustachian tracts. In a mild degree it follows many attacks of catarrh.

(3) Infection by way of blood and lymph. I do not propose to deal with this section except to note that Blake and Cecil have suggested that primary bronchial infection extends by way of the lymphatics to the alveoli.

(4) I do not propose to deal with sensitization or other biochemical factors.

In the pulmonary tract ciliated epithelium extends from below the vocal cord to, but not including, the cubical epithelium at the alveolar entrance. Briscoe relates that this cubical epithelium has no resistance, while the alveolar epithelium is sluggishly resistant. Mucus and débris are normally carried to the level of the cords by the cilia, where the débris swallowed is small in amount and screeded if considerable. With inspiration the glottis relaxes and the bronchioles dilate; during expiration the glottis and bronchioles contract. At the beginning of inspiration the alveolar air leaves

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the alveolus and returns with the main inspiratory wave. In expiration the air first of all enters the alveoli and then leaves the alveoli during the main expiratory effort. In this way the pressure of respired air is controlled and its constituents mixed.

When inflammation affects the bronchioles, the resulting constriction, in addition to the normal contraction of expiration, reduces the airway—with three possibilities :—

(1) A slight narrowing produces the asthmatoid wheeze.

(2) If the obstruction is increased the check valve is produced in which expiration is impeded. The obstruction to expiration results in dilatation of the alveoli, already softened by previous inflammation, constituting emphysema.

(3) The third of Chevalier Jackson's types is the stop-valve, in which there is complete obstruction in the bronchioles, causing collapse of the lung (atelectasis) and drowning by exudation. The pneumococcus causes such atelectasis and exudation (Henderson).

Jenner, a great opponent of specialism, attributed emphysema to cough ; Chevalier Jackson, by bronchoscopic observation, has actually seen the process of obstruction.

As evidence of the frequent infection of the pulmonary tract it will be noticed how, in the later stages of an ordinary catarrh, a patient coughs—an indication of the extension to the larynx and the trachea or even lower.

Examination of the larynx and bronchi will show catarrhal changes. Radiography has revealed infection in many unsuspected cases.

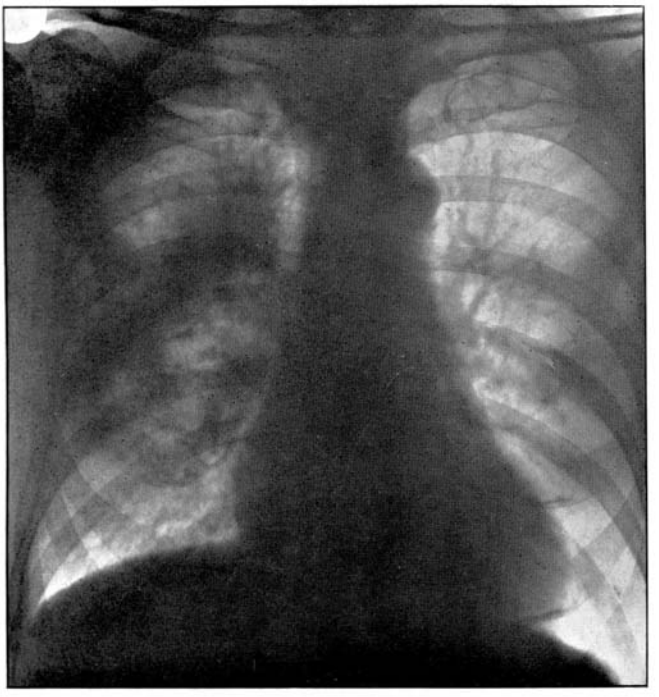
A doctor, aged 53, with rheumatism, septic tonsils, and deflected septum, underwent tonsillectomy and resection of the septum. Ten days later his temperature rose and a suppurating antrum full of thick pus was opened, with every precaution to avoid inhalation. For two months the fever ran up to 102° F. Dr. Aston Key could find only a slightly high-pitched note and a few râles. A pellet of sputum came up once a day. A skiagram (Dr. Beverley Bird) shows extensive broncho-pneumonia.

Again what little evidence there is of the fatal broncho-pneumonia which ends the lives of so many cancer patients !

Gaskell has expressed the view that the extensive change of lobar pneumonia and the patchy infection of broncho-pneumonia depend on the virulence and dosage of organisms. The modern tendency is to lay more stress on the virulence of the organism than on massive infection.

A broncho-pneumonia may be followed by the gradual development of (*a*) Bronchiectasis—a dilatation of the bronchial tubes with ulceration at the entrance to the infected area ; this is either due to, or accompanied by, a formation of inflammatory connective-tissues

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Broncho-pneumonia of right lung—few physical signs.

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outside the affected airways. Or (*b*) by a residual effusion into the bronchioles and alveoli of the affected area. This may gradually be resolved or further infection may determine the formation of a lung abscess.

J. M., aged 8, sent to me by Dr. Pearson, at University College Hospital. Broncho-pneumonia three months previously, no cough, no fever; physical signs and radiography showed an unresolved pneumonia at the right base. A rubber-ended suction tube was passed into the area through a bronchoscope tube, and 1 oz. of turgid fluid was withdrawn; the fluid did not contain any living micro-organisms. The child improved but bronchiectasis was suspected. Such an effusion bears some resemblance to the chronic mucoid effusion of the middle ear.

The results of pleural effusions are not dealt with.

The Eustachian tube throughout its 1½ in., and also the floor of the tympanum, are covered with ciliated epithelium. The tube, middle ear, antrum, and pneumatic cells are derived from the first cleft. The attic is said to be cut off from the atrium by an inflammatory swelling of the folds of von Troeltsh, and the antrum by a swollen narrow aditus. As in the lungs, the peripheral section is the more vulnerable. Much damage may be done to the middle ear and there may be fatal extensions. Luckily the membrana tympani is a safety-valve for the commoner middle-ear infections. Some think that the antrum is affected in most cases of acute middle-ear disease and it is extraordinary how frequent is the tenderness in such cases over the antrum. Pressure on the tip of the mastoid is the more definite sign of involvement of the superficial mastoid cells. Tension and want of drainage probably play more important parts than damming-off. An infected antrum with a dense mastoid exhibits more pain but less disease than one having the cancellous form. The posterior wall and superior quarter of the anterior wall of the Eustachian tube are covered by the pothook-shaped cartilage, while the anterior and interior walls, to which part of the tensor and levator are attached, are fibrous in character. The anterior and posterior walls of this section are in contact, and the narrowest part is near the outer end of the cartilaginous tube. On swallowing, the inferior and anterior walls are pulled forward and the tube opens. Variations in the entrance of air, as indicated by Valsalva or by catheterization, is heard as a gradual rush or sudden distension. Such variations may be heard on the two sides in one patient. They are probably caused by swelling of the mucous membrane or by a collection of mucus. I have a patient who can normally Valsalva one side only, but subacute catarrh transposes the patency of the two sides. Toynbee's experiment, e.g. swallowing with mouth and nose closed, followed by an ordinary swallow, is a more efficient way of opening the tubes than Valsalva. I have seen a case in which

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the Eustachian tube was so wide open that the membrana tympani moved in an outward respiration. Yet there was no obvious middle-ear trouble.

The most definite factors in tubal infection are : (1) In the young, adenoid infection, particularly of the fossa of Rosenmüller, where an adenoid mass is adherent to the posterior lip of the Eustachian cartilage.

A child with chronic suppurative otitis media had undergone removal of adenoids and tonsils but the fossa of Rosenmüller was left untouched. This was subsequently cleared and the ear healed in a month's time.

(2) In the adult, acute and chronic pharyngitis are the forerunners of tubal infection. In a case of phlegmonous pharyngitis in which it was necessary to palpate the nasopharynx, the forefinger could only just be introduced into that cavity. The Eustachian tubes were slightly fuller than normal and their margins were ill-defined. It would appear that direct extension, not air-borne infection of the infinitesimal air exchange, is the prevailing method of infection. The tube is further guarded from forcible inflation by the fact that it is impossible to breathe while swallowing.

In the ear, by watching the drum-head, we have a method of observing the condition of the middle ear, and such observations suggest that the state of the middle ear approximates to that of the nasopharynx. If the drum-head is examined about five days after an attack of nasopharyngeal catarrh it will frequently be noticed that the drum becomes swollen and red vessels appear along the malleus ; all that the patient feels is a sensation of fullness or slight bruising in the ear.

In acute catarrh the Eustachian tube has control similar to that exercised by the bronchioles. Contraction of the tube dams off infections primarily, but when middle-ear infection has occurred, opening the Eustachian tube is important to secure drainage of the middle ear. I have cut short such attacks of acute otitis media by injecting, per catheter, a few drops of glycerine acid carbolic, 10-1.

Infections of the Eustachian tube may be so severe that the Eustachian tube, middle ear, and external auditory meatus may be attacked at once in a way comparable to extensive pulmonary disease.

In the new-born infant the Eustachian tube is half the length of the adult's and is straight, not concave downwards. Further, the pharyngeal opening is at palate level, that is to say, lower. Maizels has reported cases of mastoiditis complicating gastro-enteritis in infants, and probably produced directly by vomit passing into the nasopharynx. Findlay states that suppurative otitis media is the commonest complication of broncho-pneumonia in the child. It is

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probable that either both Eustachian and pulmonary tracts are infected from the nasopharynx, or sputum is coughed up into the nasopharynx; accordingly the ears of children with broncho-pneumonia should be examined, but no question of primary and secondary infection is involved.

The treatment, apart from correcting nasal obstruction, sinusitis, and septic tonsils, falls into headings :—

(1) The hygiene of the upper respiratory tract.

Ung. hyd. nit. dil.	ʒ ss
Menthol	gr. x
Ol. olivae	ad. ℥j

is painted one inch inside the nostrils every night. The oil is carried by the cilia into the pharynx and mixes with the mucus; menthol shrinks-up and anæsthetizes the mucous membrane, while the mercury preparation increases the anti-bacterial properties of the mucus. This preparation not only protects the individual but renders him less infectious to others.

In 1915 it was used in the meningococcal carriers when we were unable to obtain a positive cultivation for one week after treatment of a carrier with the oil. A saline lotion may also be given in the morning.

(2) Pharyngitis may be treated with collosol argentum, 1 : 400, sprayed. It is well to include the postnasal space, larynx, and trachea in this treatment. If there is a trace of asthmatoid wheeze or a sense of obstructed bronchioles, sprays of adrenaline and ephedrine may be used, in addition to the treatment prescribed by the physician : bronchovydrin is also helpful.

Vaccines as a prophylactic are helpful in many cases. There is sometimes an element of gout in pharyngitis : this should be specifically treated.

(3) Reduction of chronic pharyngitis and emphysema. A slow deep-breathing exercise is employed; it consists of one inspiratory phase and two expiratory phases. The inspiratory phase is deep; in the first expiratory phase the clefts between the thumbs and first fingers forcibly compress the sides of the chest, in the second phase the hands slide down, and with thumbs pressed on the chest the outspread fingers compress the abdomen. In the expiratory phases the elbows are turned forwards. By this method the movements of the chest and diaphragm are restored and the pharyngeal catarrh reduced.

The patient shown was treated in this way and improvement to pharynx, lungs and ears resulted. Incidentally he can now play two rounds of golf a day, and smoking does not make him cough.

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Societies' Proceedings

ILLUSTRATIVE CASE

Nasal Obstruction: Descending Catarrh of Lung and Ear (illustrating the Presidential Address).

—E. A. PETERS, F.R.C.S.

J.K., aged 72. Underwent an operation for relief of nasal obstruction sixteen years ago.

Three years ago had extensive emphysema; ½ in. difference in chest circumference between inspiration and expiration. Congested nasopharynx.

Attacks of otitic catarrh indicated by injection of the drums and a sensation of fullness in the external auditory meatus. Heart-beat irregular.

Under local treatment and deep-breathing exercises the emphysema diminished; there is 3 in. movement of the chest, the pharynx is not congested and the otitis media has disappeared, leaving slightly atrophic drum-heads.

Chronic degenerative labyrinthitis has gradually developed.

Present condition :—

Hearing: R.	18 ft.	Conversational voice	18 ft. L.
	$\frac{1}{3}\frac{2}{0}$	c. on mastoid	$\frac{1}{3}\frac{2}{0}$
	$\frac{5}{7}\frac{3}{0}$	c. closing external auditory meatus	$\frac{5}{7}\frac{3}{0}$
	$\frac{2}{4}\frac{3}{0}$	c. value of middle ear ..	$\frac{2}{4}\frac{3}{0}$

On the Function of the Tympanic Muscles

By C. S. HALLPIKE, F.R.C.S.

(From the Ferens Institute of Otology, Middlesex Hospital)

IN 1864 an account was published by Adam Politzer[1] of what must be considered the first significant investigation of the function of the tympanic muscles. After a lapse of seventy years it is difficult to read Politzer's account without admiring the grasp of physiological methods displayed in these experiments by a practical otologist, and Politzer's work can properly be regarded as constituting the foundation of our present knowledge of the subject.

Politzer investigated the innervation of the tympanic muscles, and he noted the disturbance of the labyrinthine fluids set up by contractions of the tensor tympani produced by electrical stimulation of the fifth nerve in the dog.

In addition, he observed the effect of such contractions upon the transmission of sound-waves by the simple method of auscultation of the tympanum *viâ* a tube sealed into a hole bored in the bulla of the animal. In this way he was able to report that contraction of the muscle appeared to exercise a damping effect upon sound-waves passing across the tympanum.

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At this time, the fact that the tympanic muscles reacted reflexly in response to auditory stimuli was not known, but was discovered soon after by Hensen.[2] Köhler[3] extended these observations to man and, later, Kato[4] and Kobrak[5] have investigated the subject very fully in the cat and rabbit.

Although at present the fact of the reflex response of the muscles to auditory stimulation is fully substantiated, the further and more important question of the effect of such contractions upon what goes on in the internal ear has not been answered so satisfactorily. Although most important investigations, such as those of Politzer and Kato, attribute to these contractions a protective function, the opposite view that the muscles are concerned in increasing the sensitivity of the internal ear, as in listening, still finds support. That opinions so diverse should be in circulation finds its explanation in the inherent difficulties of obtaining any objective assessment of the working of the internal ear. The present paper deals with some experiments carried out by Mr. Rawdon-Smith and the writer,[6] in which an attempt has been made to overcome this deficiency by investigating the effect of reflex contractions of the tympanic muscles upon certain electrical changes set up in the internal ear in response to physiologically applied sound-waves, changes which have come to be known after their discoverers as the Wever and Bray phenomenon. Without dealing extensively with all that has been said concerning the origin and biological significance of the Wever and Bray phenomenon, it will nevertheless be necessary to describe briefly some of the more important aspects of what is now known.

Micro-potential changes are generated within the intact mammalian cochlea in response to sound-waves. The potential changes reproduce accurately the frequency of the sound and the phenomenon is in this sense a microphonic one. With appropriate amplification, speech and music may be reproduced upon a loud-speaker.

The central question demanding solution has concerned the origin of the potential changes. Although within the last two years most of the evidence has rather contra-indicated the important possibility that the changes are generated by the neural elements of the cochlea, some recent experiments seem to show that this possibility is one which must still be seriously considered.

Witmaack[7] found that section of the eighth nerve in the cat led to degeneration of the neural elements of the cochlea. We have found that this occurs in some cases, but that the issue is much confused by the effects of section of the internal auditory artery which usually accompanies division of the nerve. Such section of the artery leads to massive necrosis of the entire cochlear content with the formation, in some cases, of masses of heterotopic new bone.

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When, however, the nerve is cut without division of the artery, there occurs an isolated degeneration of the neural elements of the cochlea, with preservation of all other cochlear structures. In such a cochlea the Wever and Bray phenomenon has been found to be absent.[8]

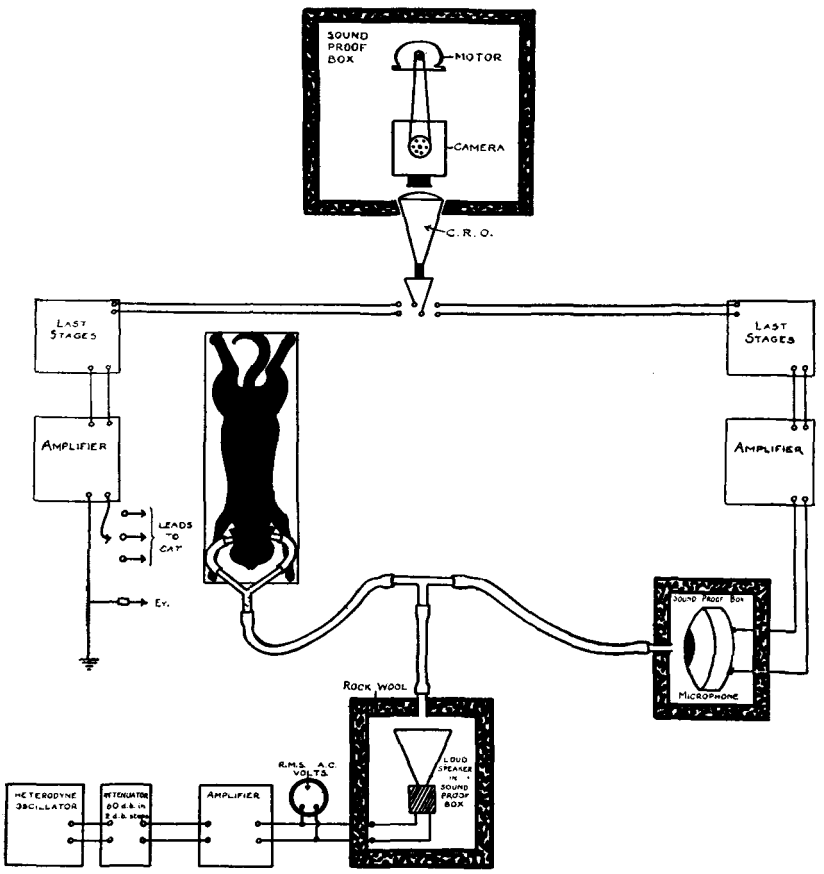


FIG. 1.

It would appear likely, therefore, that normally functioning nerve elements are required for the production of the Wever and Bray phenomenon. But whatever the ultimate solution of the problem, it is sufficient at present to regard the phenomenon as something of vital significance, and moreover as something which goes on in the internal ear which can be assessed in an objective way; and should thus provide us with a key to the problem of the intra-cochlear effects of reflex contractions of the tympanic muscles.

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The technical procedure employed in these experiments is shown in Fig. 1. Sound from a source controllable for frequency and intensity is led into the external ear of a decerebrate cat *viâ* a brass tube securely tied into the meatus. The tympanic cavity is exposed by dissection, and viewed through a low-power binocular dissecting microscope. An active electrode is placed upon the round window margin, whence it is led to the input stage of a high gain amplifier of conventional design. The output of the amplifier is connected to a cathode ray oscillograph.

The sound passing to the cat's ear is led by way of a brass cross-piece, one limb of which passes to a microphone.

The output of the microphone passes to the input of another amplifier the output of which may also be connected to the cathode ray oscillograph. Thus a record may be obtained, not only of the sound passing into the animal's ear, but also of the electrical response to such sound.

The contractions of the tympanic muscles are observed through the dissecting microscope. Fig. 2 shows the view so obtained of the operative field. The tympanic muscles are observed to contract briskly in response to sounds over the range of 500~—2,000~, of an intensity some 70 or more decibels above the human threshold. Less brisk responses can, however, be observed over a much wider range of frequencies.

The response, as observed through the microscope, consists of an initial twitch, a sustained tetanic contraction and a terminal twitch when the sound ceases. Although crossing of the reflex contractions is described by Kobrak, and, more lately, by de Nó[9] in the case of the rabbit, these, we find, do not generally occur in the cat.

Coming finally to the results of these experiments, Fig. 3 shows records of the Wever and Bray response at the onset of trains of sound-waves, the tympanic muscles being active.

In Record 1, full amplitude of the cochlear response is rapidly attained, the presence of well-marked overtones being a conspicuous feature. Within a period of some 10σ after the beginning of the stimulus, there ensues a rapid decrease in amplitude of successive waves with a well-marked tendency to elimination of the overtones. This decrease reaches its maximum at a point some 30σ after its initiation, and thereafter the amplitude shows a gradual increase, but its initial value is never regained.

In Record 2, the intensity of the sound stimulus was greater, and the decrease in amplitude of the response after the initial waves is relatively accentuated.

In Record 3, a relatively low intensity of a frequency of 1,000~ was employed as a stimulus. The decrease of amplitude of the response after the first few waves is seen to be less in degree and of more gradual onset.

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That the changes in amplitude and wave-form displayed in these records must be attributed to the contractions of the tympanic muscles observed through the microscope to occur during the taking of these records, is shown by Record 4. In this the reflex contractions of the muscles were eliminated by chloroform inhalations. Following this, the changes in amplitude and wave-form displayed in Records 1, 2 and 3, were found to be eliminated, the response now sustaining its full amplitude in an entirely unbroken manner.

The following conclusions can be drawn from these records :—

Firstly, that since the reflex contractions of the tympanic muscles occur in response to sounds of fairly high intensity, the theory of their action as increasing the sensitivity of the ear, as in listening, seems *a priori* unlikely.

Secondly, that the contractions do in fact exert a protective damping effect upon sound vibrations reaching the internal ear is proved by the conspicuous decrease in amplitude of the electrical response of the cochlea brought about by these contractions.

Thirdly, it has long been known that the sensation resulting from a compound tone generated by a number of pure tone generators may undergo no distinguishable change when one or more of its components are withdrawn, and it has been suggested that the missing overtones are in some way re-created by the vibrating elements of the ear. That the vibrating system of the ear is capable of manufacturing such overtones is shown by the fact that, whereas microphone records of the stimulating tones employed in Records 1, 2, 3 showed them to be of approximately sinusoidal wave-form, the records of the cochlear response to these tones showed a marked overtone content.

In conclusion it will be noted that nothing has been said of the individual action of the two tympanic muscles, though much attention is devoted to the literature on this problem. For the present, however, it has been thought of greater physiological significance to study the action of the two muscles acting physiologically, that is to say, together.

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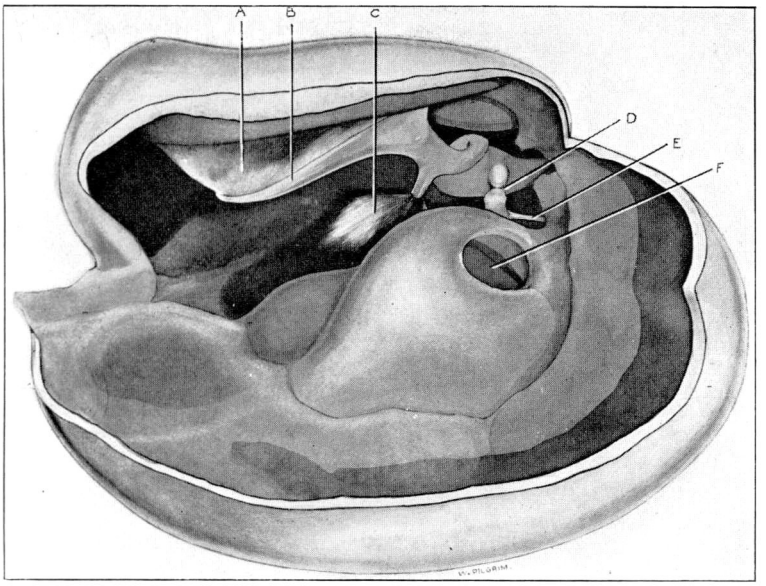


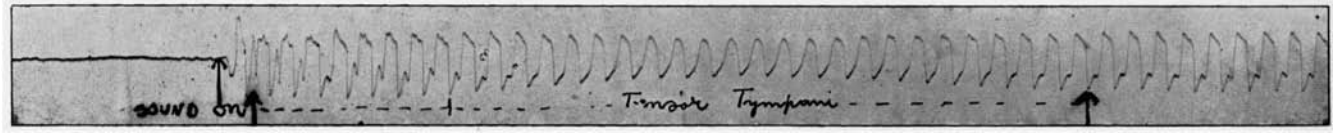
Fig. 2.

A. Tympanic membrane.
B. Long process of malleus.
C. Tensor tympani.
D. Incudo-stapedial joint.
E. Stapedius.
F. Round window.

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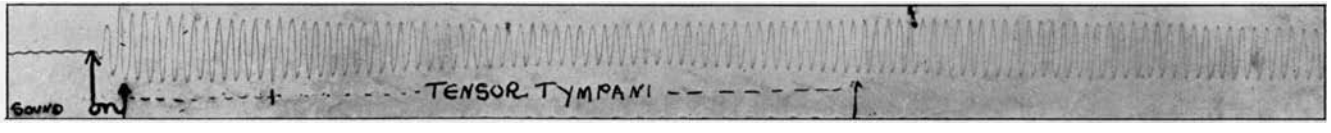
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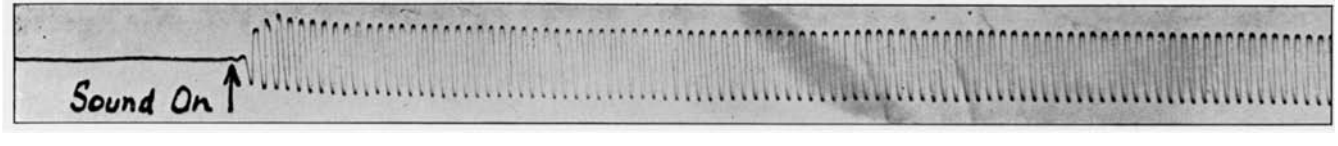
1. Frequency 500 ~. Showing damping action of tympanic muscles with partial elimination of overtones.



2. Frequency 500 ~. Higher intensity. Showing accentuation of damping action of tympanic muscles.



3. Frequency 1,000 ~. Relatively low intensity. Showing slower onset and less marked degree of damping.



4. Frequency 1,000 ~. After chloroform. Reflex contractions of tympanic muscles absent. Showing absence of damping action.

FIG. 3.

Oscillograph records showing the action of reflex contractions of the tympanic muscles upon the Wever and Bray response.

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DISCUSSION.

THE PRESIDENT said that Mr. Hallpike's paper marked a new period in otology. The Wever and Bray phenomenon had opened up a new criterion by which the functions of the various parts of the ear could be assessed, and Mr. Hallpike had shown that the tensor tympani and the stapedius controlled overtones and quick damping of sounds. It had been said that speech destitute of overtones would be unintelligible.

It was assumed that the tensor tympani increased, and the stapedius diminished, the labyrinthine pressure, and he, the speaker, regarded the tensor tympani, the chain of bones and the stapedius as a joint system braced by the muscles.

Mr. F. J. CLEMINSON said he would like to know whether Mr. Hallpike had found evidence to show that the two muscles of the middle ear reacted as antagonistic groups of limb muscles did —i.e. that as one came into action, the other underwent reflex inhibition.

Applying what Mr. Hallpike had said to the mechanism by which speech was heard, it was clear that the fleeting action of these muscles in damping-down the harmonics was the very one which Nature might be expected to provide. The sounds of everyday life were seldom continuously uniform, either in intensity or pitch; what was heard was a series of rapidly changing sounds, as in speech. The middle-ear muscles seem to have been designed to perform the function of damping-out the excessive vibration and harmonics for the successive instants necessary for the hearer fully to appreciate each particular stage of the rapidly-changing sound.

Sir JAMES DUNDAS-GRANT said he wondered whether there were many actually observed cases of apparent inaction of the stapedius. He remembered the mother of a family who had facial paralysis. The paralysis passed off but, at that time, the noises made by her children were a source of acute pain to her, showing, he thought, that in her case the damping effect of the stapedius had been cut off.

In none of the experiments hitherto had there been a demonstration of the behaviour of the round window, when there was ankylosis of the stapes. He had had a case in which the stapes was ankylosed—as far as diagnosis went—and in which he produced a lasting opening or perforation in the tympanic membrane, showing the round window exposed. In such a case as that one could judge, to some extent, of the action of the round window, through which a good deal of hearing could be carried out, perhaps all the better because the round window was exposed and the stapes was ankylosed.

Mr. F. WATKYN-THOMAS said that one very important practical point was raised in Mr. Hallpike's paper. All otologists had found, when performing the conservative mastoid operation, cases in which

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the incus was simply lying loose in granulation tissue. The incus was removed, and the patient's hearing was, if anything, better; certainly it was very rarely worse. What interested him particularly was the after-fate of the ears of those patients when they had lost the incus, and hence were largely without the important protective mechanism when they were subjected to continuous noise. He would like to hear what Mr. Hallpike had to say on this point: he did not know whether any work had been done on it. Such patients would still have their stapedius, but their tensor tympani would be no longer of use to them.

Dr. DOUGLAS GUTHRIE asked whether Mr. Hallpike had investigated separately the function of each of the two intra-tympanic muscles. It was naturally assumed that they acted in unison and fulfilled similar functions, but this could be confirmed only by experiment. Had Mr. Hallpike divided one, leaving the other intact, and if so, what effect had he noted?

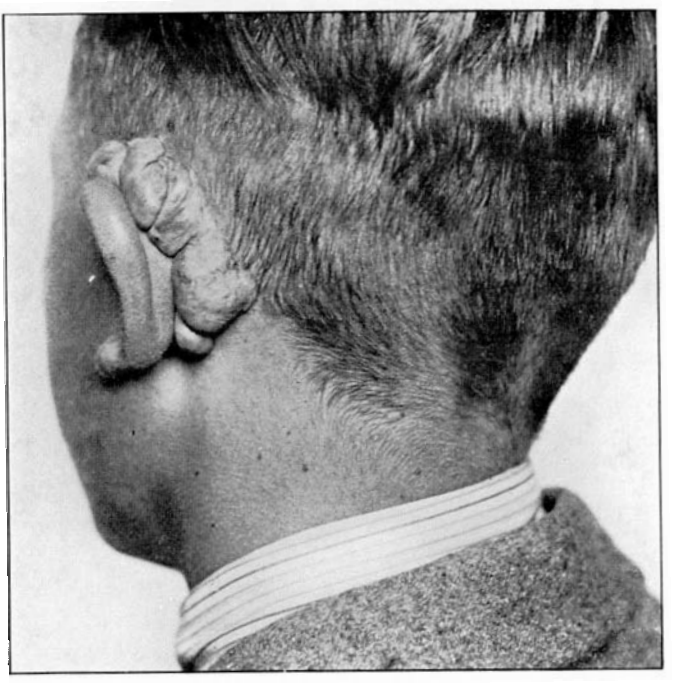
Mr. THACKER NEVILLE remarked that Mr. Hallpike stated that he abolished contraction of the tensor tympani with chloroform or with the diathermy knife, and the speaker would like to know how he stimulated it. Does Mr. Hallpike employ sound alone, and if so did low notes cause relaxation and high notes contraction?

Mr. HALLPIKE (in reply to Dr. Douglas Guthrie) said that the experiments he had been describing represented the effects of contraction of both the muscles acting together. No attempt had been made to differentiate between them; that would be a very difficult thing to do satisfactorily. If one cut the tendon of one muscle, the whole working of the middle-ear mechanism was changed, and at the moment it was not found to be worth while to cut the tendons. The only way was to paralyse muscles individually, so that their resting tension would not be changed very much.

In answer to Mr. Cleminson: Both tympanic muscles, as observed under the microscope, appeared to contract together. If the tensor tympani tendon was cut and the muscle allowed to retract, its stump was observed to contract as vigorously as before on stimulation of the ear with sound. He believed that it had been suggested that the contractions of the tensor tympani described were tendon reflexes, as in the case of the knee-jerk. This, however, was not correct since, following section of the tendon, the stump of the muscle continued to react vigorously. In reply to Mr. Thacker Neville: The form of stimulation used was sound falling on the ear. In reply to Sir James Dundas-Grant: Immobilization of the stapes was not easy to effect. Mercury beads could be dropped into the oval window recess, but it seemed likely that the mercury would be free to move with the stapes. Drops of plaster of Paris had been tried but this, on drying, became detached from the walls of the cavity and was not satisfactory in practice.

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Mastoid keloid after cortical mastoid operation, bilateral.

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In reply to Mr. Watkyn-Thomas : Regarding the effect of continuous noise upon the internal ear following the removal of the incus, von Eicken had shown that after this operation on one side, in the guinea-pig, long-continued exposure to sound failed to produce degenerative changes in the internal ear on the side of the operation, but did produce these changes in the opposite normal ear. It seemed likely, therefore, that removal of the incus would in itself bring about a high degree of protection of the internal ear from the effects of prolonged loud sounds. Compared with this protective action of removal of the incus, the question of the protective action of tympanic muscles would probably not arise.

CASES

Large Keloids on Mastoid Scars.—DAN MCKENZIE, M.D.

Boy, aged 15. Double cortical mastoid operation in 1932. Under treatment by diathermy. It is interesting to note that he also shows a keloid scar on the leg.

DISCUSSION.

Mr. F. C. CAPPS said that the case was still under treatment by diathermy coagulation, and the recent report of the pathologist was that the section resembled fibroma rather than keloid in structure.

Mr. HERBERT TILLEY said that cases of keloid scars after mastoid and other operations had for many years been treated successfully at the Radium Institute by surface radiation.

Mr. RITCHIE RODGER agreed with Mr. Tilley that radium was the best method of treatment for keloid formations. He had seen only one case out of some 1,800 mastoid operations, so that the condition must be comparatively rare. In this case, as in Dr. McKenzie's, the patient, a youth of 23, could also show a keloid on his back. A dermatologist who saw the case suggested that there might be a tuberculous diathesis, and the family doctor then informed him that the boy had slept in the garden for some years, his father having had tuberculosis of the lung.

In this case he (the speaker) had tried a radium plaque at first, but without success. He then plunged eleven 0·5 mg. needles vertically into the scar, about 1 cm. apart, retaining them seven days. Gradual diminution occurred, and then at the end of eight months the swelling quickly receded and disappeared. Seen lately, after two and a half years, there was no trace of keloid.

Labyrinthitis. Concealed Cholesteatoma. Carious Patch on Petrous Bone revealed by X-rays.—DAN MCKENZIE, M.D.

Correct diagnosis in this case was delayed for eight weeks on account of the absence of any discharge from the external auditory meatus during the time of observation.

A woman, aged 35, had had a radical mastoid operation on the *left* ear performed by me in 1932 for cholesteatoma with the labyrinth fistula symptom. Rapid and complete cicatrization had followed.

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In *March* of the present year she was suddenly seized with a violent labyrinth storm in the course of which I saw her. The onset, together with the vertigo, of severe tinnitus and nerve deafness in the *right* ear showed that ear to be the source of her symptoms.

There was no discharge from it, however, nor had there been any for two years. The tympanic membrane showed the typical cholesteatomatous sinus in its postero-superior quadrant and adjoining meatal wall. But all was dry and cicatrized and there was no pain.

In three or four days the acute symptoms subsided, but a feeling of imbalance persisted; and, as time went on, several other crises occurred though much less severe than the first, and the deafness remained.

Every obvious cause of labyrinth disease having been excluded as far as possible, and as the symptoms continued, it was decided at the end of *May* to explore the ear surgically.

As a preliminary, X-ray examination of the labyrinth was made by Dr. Graham Hodgson, who reported: "There is a hazy appearance of the capsular bone of the right labyrinth which is unlike that seen in otosclerosis, and is chiefly affecting the capsule of the superior canal." . . . "It may be caused by an acute infection, but there is no X-ray evidence of infection of the right mastoid process."

Fortified by this report, I performed a radical mastoid operation on the right ear. A moderately large mastoid cavity, empty and with dark and jagged bony walls communicating freely with the antrum, was disclosed. No granulations were to be seen anywhere, the bone being quite dry and bare. But lateral to the superior canal, that is to say, at the precise spot indicated by Dr. Graham Hodgson, a patch of disintegrated bone, about 1 × 3 mm. in area, was found and removed with a fine curette, the superior canal not being opened as far as could be seen. The bony granules were of the sand-grain kind found typically in cholesteatoma, and on the floor of the aditus one small patch of cholesteatomatous membrane was identified. The tympanic cavity was equally dry and void of granulations, scar-tissue only being present, in which a fragment of the malleus was embedded. The labyrinth was not opened.

The operation was followed by immediate disappearance of all giddiness, and as time has gone on even the hearing has shown some improvement. Tinnitus remains unchanged.

Attention is drawn (1) to the "Ménière" syndrome arising from latent cholesteatoma; and (2) to the discovery by X-rays of a minute patch of caries on the outer labyrinth wall. The bearing of this latter fact upon the value of X-ray examination of the labyrinth not only in otosclerosis but also in cases with Ménière symptoms, needs no emphasizing.

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Royal Society of Medicine

Acute Exacerbation of Chronic Suppurative Otitis Media. Extradural Abscess. Complete Hemianopia.

—F. C. W. CAPPS, F.R.C.S.

D.W., aged 18, cabinet-maker, admitted to Hackney Hospital, *September 16th*, 1934.

History.—Chronic right otorrhœa "all his life" without pain in the ear. Two weeks ago began to be troubled with pain in the right ear which, a few days later, began to discharge—profuse yellow discharge. A week later the discharge ceased. Three days later pain in the right temporal region began. Patient had occasional attacks of giddiness and mistiness over the eyes. Feels sleepy but has not slept. No vomiting.

On examination.—General condition fair. Temperature 101·8° F. Circulatory system: Bradycardia; pulse 50. Respiratory and digestive systems normal.

Central nervous system: Drowsy. Very definite tenderness over right temple. Little mastoid tenderness. Complete hemianopia to the left. No motor or sensory loss. No stereognosis or loss of sense of movement. Tonus normal. No cranial nerve paralysis. No nystagmus; no head rigidity.

Lumbar puncture: Cerebrospinal fluid clear; not under pressure. Pathological report on cerebrospinal fluid: No excess of cells. No excess of globulin. Protein 0·05%.

Right ear: Chronic otitis media.

16.9.34: Complained of pain in right temporal region. No neck rigidity. Temperature 102·8° F. Pulse 80-64.

Operation.—Radical mastoid. Thick pus in small mastoid antrum. Lateral sinus normal but far forward. Antrum very deep and bone much sclerosed. Long aditus. Cholesteatoma. Dura mater widely exposed. Pulsated well—no obvious tension. Small extradural abscess in middle fossa above the attic. About ℥x of stinking pus. Antrum and tympanum packed with "bipped" gauze. Also pack through posterior wall of auditory meatus. Specimen of pus taken for laboratory examination and culture. Report: Swab dried—no direct film made. Cultures grew *Bacillus proteus*, probably owing to contamination. Both cultures showed some Gram-positive cocci but it was impossible to isolate these, owing to the presence of *B. proteus*.

17.9.34: Complained of some stiffness of neck. Can flex neck a little. Pupils equal, react to light. Reflexes normal. Temperature 99° F. to 100·8° F. Pulse 80-64.

18.9.34: No diplopia. Pupils normal. Feeling better. Flexion and rotatory movements of head improving. Quite sensible in conversation. Hemianopia appears much less. Temperature 99° F. to 99·6° F. Pulse 64-54. Then he made a gradual uninterrupted recovery, with full field of vision.

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10.10.34 : Ophthalmoscopic examination (Mr. Arnold Sorsby) : The fundi are normal but require watching. The margins of the discs, especially of the left, are hazy. Probably a physiological variation. No nystagmus.

Mr. A. B. PAVEY-SMITH said that he had had a similar case recently. There was chronic suppurative otitis media on both sides. The patient had been sent to him because of pain in the left ear three days after his doctor had syringed it. When he arrived at hospital he was apparently very deaf, but his inability to answer questions turned out to be due to aphasia. His ear was dry, but there were a few granulations in the attic region. There was no mastoid tenderness. He (the speaker) operated on the patient the same day, and found cholesteatoma and an extradural abscess, which contained about 2 drachms of pus. The dura mater was red over an area of 1 cm. The whole condition cleared up rapidly, and the aphasia recovered in four days. There was no sign of paralysis in any other part of the body. It was apparently an early case of cerebral œdema.

Temporo-sphenoidal Abscess. Pus in Cerebrospinal Fluid. Drainage of Abscess. Recovery.

—MAURICE SORSBY, M.D., F.R.C.S.

L.C., aged 17. Admitted to St. Andrew's Hospital, *June 10th*, 1934, complaining of (1) drowsiness, (2) vomiting, and (3) a high temperature (104° F.).

Previous history.—Otorrhœa for many years ; deafness, which has increased considerably of late.

Present history.—May 10th: Severe pain in the right ear, lasting for three days. Diagnosis : "Meatal boil." *June 9th:* Sudden onset of vomiting. *June 10th* (on admission) : Temperature 104° F. ; pulse 92 ; respiration 20.

Patient was very drowsy ; could be aroused only with great difficulty, and exhibited great irritability when disturbed.

Central nervous system : Neck rigid and retracted. Patient preferred to lie on the right side. Knee-jerks practically absent ; plantar reflexes flexor. Optic discs normal.

Lumbar puncture : Cerebrospinal fluid, opaque and not under pressure. *Pathologist's report on fluid* (Miss K. M. Collis) : Pus cells present in such large numbers that they could not be counted ; protein 15%. Globulin : present in excess. Chlorides : 720 mg. per 100 c.cm. Organisms : None seen in direct film ; culture report negative.

White blood-cell count : Leucocytes 16,600 ; *Differential :* Polymorphs 77% ; lymphocytes 22% ; large hyals. 1%.

Ears.—Both drums destroyed. Right ear : dry, attic perforation ; left : profuse discharge. No mastoid tenderness could be elicited.

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Operation.—In view of the recent history of pain in the right ear, and absence of otorrhœa in that ear, it was decided to explore the right mastoid. This was found to be a large abscess cavity, containing much pus under considerable tension. The dura was bulging, tense, and of a dark brown colour covered with granulations. The mastoid antrum was filled with cholesteatomatous masses. The brain was explored, and a large quantity of greenish offensive pus was evacuated. Two drainage tubes were inserted.

Pathologist's report on pus from brain abscess : Pneumococci and coliform bacilli seen in film. Culture : *B. proteus.*

Subsequent history.—Patient made an uneventful recovery.

Congenital Abscess of the Ear, with Facial Paralysis.—T. A. CLARKE, F.R.C.S.Ed. (introduced by Mr. LIONEL COLLEDGE).

Patient is a male infant, aged 1 year 6 months. On the left side there are some irregular cartilaginous nodules representing the auricle, but the ear is poorly, if at all, developed.

The left side of the face is paralysed, and there is slight facial asymmetry. There are no other deformities, and no other neruous defects are present.

Nerve-Graft in the Treatment of Facial Paralysis : Ballance and Duel Method.—SYDNEY SCOTT, M.S.

S.F., a child aged $2\frac{3}{4}$ years, was first seen at St. Bartholomew's Hospital, *April 20th,* 1933, on account of discharge from the left ear of eighteen months' duration.

May 12th, 1933 : Tonsils and adenoids removed by Mr. W. Bell, House Surgeon to the Throat and Ear Department.

December 14th, 1933 : The child was brought to the hospital again, as the discharge had continued. X-ray examination showed extensive pneumatization of the mastoid, the cells being abnormally opaque.

February 20th, 1934 : Admitted as in-patient. Next day Schwartze's operation was performed. The mastoid cells were large and extensive, and contained blackish material on swollen mucosa, with pus and mucopus in the antrum and in the zygomatic and apical mastoid cells. Amongst a chain of cells running vertically down from the antrum, a dehiscence of part of the Fallopian aqueduct was found, which exposed the facial nerve in a bed of vascular mucosa. A discussion took place as to whether the nerve could be identified ; it was possible to do so only after it was divided ; the lumen of the lower part of the Fallopian aqueduct admitted a small stylet, from above. As it was impossible to bring the ends of the facial nerve into apposition, it was decided to apply a nerve-graft in accordance with the Ballance-Duel method. The Schwartze operation was concluded and the cavity was partly closed, and tube-drained.

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Any possible doubt as to the division of the facial nerve was settled by the complete paralysis of the child's face the next day (*see* Fig. 1).

February 23rd, 1934 : My colleague, Mr. Rupert Corbett, isolated about an inch of a branch of the anterior lateral cutaneous nerve of the child's right thigh over the upper part of the sartorius muscle. The nerve was divided above a ligature, which was intended to serve as a means of identification a fortnight later.

March 7th, 1934 : The attempt to identify the divided cutaneous nerve failed. Mr. Corbett therefore isolated another branch of the cutaneous nerve and, at my suggestion, slipped over its distal end a small rubber tube, which was buried in the wound, and left it to ensure its subsequent identification.

March 21st, 1934 : Mr. Corbett re-opened the femoral wound and immediately identified the prepared nerve by withdrawing the tube. He removed about three-quarters of an inch of the distal part, placed it in warm normal saline solution and closed the wound.

Having re-opened the mastoid, and identified the Fallopian aqueduct and the proximate end of the facial nerve, I inserted about a quarter of an inch of the prepared nerve-graft into the gap of the facial nerve, after freshly dividing its proximal end. It was possible to retain the graft in position by placing strands of "bipped" cotton in the external auditory meatus, the posterior wall of the osseus meatus having been removed. No gold foil was applied. The upper two-thirds of the mastoid wound were closed. Except for the removal of outer dressing the wound was undisturbed until the eighth day, when the shreds of cotton-wick were withdrawn.

April 5th, 1934 : The child was transferred for facial treatment to the Massage Department where massage and electrotherapy were carried out twice a week until the end of *October*.

May 24th, 1934 : The child's mother first detected an improvement in the face. In *June* it was possible to be certain of restoration of tone of the orbicularis muscle.

A note early in *October* runs : "All face movements much improved ; can almost shut the eye voluntarily."

November 1st : "Can purse the lips and close the eyelid and frown." (Figs. 2, 3, 4.)

DISCUSSION.

The PRESIDENT congratulated Mr. Scott on the result. Dr. Duel had exposed the greater part of the temporal course of the facial nerve by removing the bone as far as the stylo-mastoid foramen. It was a wonder of surgery that a nerve could be restored in a septic field. During the War, nerves and bones had been most easily affected by sepsis. Sir Charles Ballance had said that in these cases it was essential that the operator should dress the wound daily.

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Fig. 1.
February, 1934. Before grafting operation.

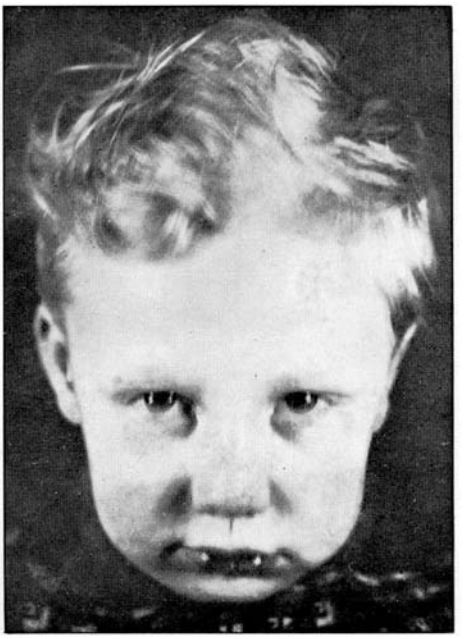


Fig. 2.
November 17th, 1934. Face muscles at rest.

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FIG. 3.
November 17th, 1934. Shutting eye tightly.



FIG. 4.
November 23rd, 1934. Whistling.

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Abstracts

Mr. SCOTT said that he had shown this patient (1) as an example of the beneficial results of the Ballance-Duel method of nerve-grafting for facial paralysis ; (2) because it illustrated certain points in technique, which, he claimed, simplified the operation and identification of the nerve-graft. Dr. Duel* had expressed the opinion that to ensheath the divided cutaneous nerve in a rubber tube which was left *in situ* for a fortnight would interfere with the rapid degeneration of its axis cylinder which he desired, but the successful recovery of the facial nerve functions demonstrated that there could be no such objection as Dr. Duel feared. The success was really due to Sir Charles Ballance's and Dr. Duel's procedures which he (Mr. Scott) had copied in all essentials.

ABSTRACTS

EAR

On the response to stimulation of the cupula. K. WITTMAACK. (*Arch. Ohr-, u.s.w., Heilk.*, 1935, CXXXIX., 1-13.)

Steinhausen's experiments on the cupula of the pike have caused widespread interest. In some quarters these experiments have been quoted as a proof of the correctness of the theories of Mach and Breuer which postulate movements of the cupular end-organ in response to physiological stimulation. The author points out that these claims have no justification whatever.

In Steinhausen's experiments an opening is made into the membranous labyrinth. As a consequence, a " closed " system of fluids is converted into an " open " one. For technical reasons it is impossible to study the cupula without making an opening into the membranous canal, because this end-organ cannot be rendered visible unless some staining material is introduced first.

It is not surprising that movements of the cupula can be observed once an opening has been made and the fluids can circulate freely. In the normal " closed " state mass movements of the endolymph fluids are impossible, although the transmission of pressure variations does take place. Steinhausen admits that the side-to-side movements of the cupula in response to pressure alterations are more easily obtained in freshly killed animals than in the living. Wittmaack sees in this observation a proof of the existence of the " turgor ", or state of tension of the whole cupular structure, which is such an essential feature of his own theory. As soon as the endolymph canal is opened the cupula swells up because of the

* Stockholm, September, 1934, Meeting of Collegium Oto-Rhino-Laryngologica.

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