

ABSTRACTS

THE EAR.

Fatigue of the Auditory Nerve. A. T. BONDARENKE. (*Monatsch. f. Ohrenheilk.*, October 1926.)

Having conducted 169 observations on 52 normal and 117 abnormal persons, the author discusses the fatigue induced by electrically operated tuning-forks, and the further effect of the same when associated with inflation of the middle ear, faradisation and vibratory massage. He summarises his conclusions as follows:—

- (1) Hearing may vary on different days from 30 to 50 per cent.
- (2) The fatigue of hearing varies in normal persons from 10 to 12 per cent. and lasts about 1 to 1½ minutes.
- (3) The fatigue of hearing varies in cases of middle-ear catarrh from 50 per cent. to 100 per cent., and in cases of neuritis of the 8th nerve from 57 to 100 per cent.
- (4) The minimum of fatigue of the hearing is greater in cases of nerve disease than in cases of otosclerosis and adhesive processes.
- (5) Politzerisation has a beneficial action on fatigue of the hearing in cases of middle-ear catarrh, but on the contrary, accentuates the fatigue in cases of neuritis.
- (6) Faradisation in the pathological cases examined caused an accentuation of the fatigue in the hearing.
- (7) A slight stimulative effect followed recovery from fatigue and was most intense between the 2nd and 6th minute after the conclusion of the test.
- (8) The recovery from fatigue lasted rather longer in cases of neuritis than in cases of otosclerosis and catarrh.
- (9) Vibratory massage caused rather less accentuation of fatigue than faradisation.

ALEX. R. TWEEDIE.

Tobacco and Eighth Nerve Lesions: Report of Nine Cases. V. K. HART. (*Laryngoscope*, Vol. xxxv., No. 2, p. 855.)

The histories of nine cases are presented and the following points were common to all: Rinné positive, the drums normal in appearance, the Eustachian tubes patulous, and the malleus movable in all cases.

Eight of the nine cases chewed tobacco, while the ninth smoked twenty cigarettes per diem. The larger proportion complained of vertigo, while two or three complained more of deafness. It is noticeable that those suffering from vertigo gave negative or delayed results to the cold caloric test.

Abstracts

The vestibular branch may be affected with little or no cochlear involvement; similarly there may be irritation of the vestibular nerve without any impairment of nerve conduction. Vestibular and cochlear nerves may be involved concurrently, or cochlear involvement may be marked without any demonstrable lesion of the vestibular apparatus.

ANDREW CAMPBELL.

Sudden Deafness caused by Simple Hyperæmia of the Cochlea. S. CITELLI.
(*L'Oto-Rhino-Laryngologie Internationale*, August 1926.)

The author draws attention to the possibility of sudden deafness, as a result of exposure to cold and damp, attacking middle-aged people, who, for some reason or other, have only one sound ear. This disturbance, which is strictly limited to the cochlea of the previously healthy ear, is comparable, the author thinks, to the difficulty of micturition, to which, for similar reasons, elderly men with slight prostatic enlargement are liable.

A full report of three cases is given. Complete recovery occurred in all the cases after treatment consisting of rest in bed, purgation and the application of counter-irritants to the mastoid region.

G. GILL CAREY.

On Noise-injury of the Ear. DR MAUTHNER. (*Zeitschrift für Hals-, Nasen-, und Ohrenheilkunde*, Bd. xiv., Heft 1 and 2, p. 162.)

Mauthner studied the effect of the noise of type-writing machines on the hearing of twenty typists with different lengths of service. As a rule it was only after about six years that defects of hearing occurred. These were most evident for high tones and bone-conduction was diminished.

JAMES DUNDAS-GRANT.

Vestibular Excitability in Fistulæ of the Labyrinth. CHARONSEK
(Prague). (*Zeitschrift für Hals-, Nasen-, und Ohrenheilkunde*, Bd. xiv., Heft 1 and 2, p. 57.)

Although in patients with labyrinthine fistulæ there was heightened excitability on rapid turning of the head, the excitability to rotation and caloric tests appeared to be lowered. In normal persons rotation and caloric tests produce much more disturbance than sudden head turnings, but when a fistula is present this is not the case. The abnormality may be due to general lowering of excitability or to diminution of the movement of the fluid through coagulation; most probably, however, to change in the physical relations brought about by the "give" of the membrane at the site of the long fistula, in the external or possibly any canal. This "give" in any one canal allows of some degree of lowering of pressure in the others and hence in the vestibular labyrinth as a whole.

JAMES DUNDAS-GRANT.

The Ear

Labyrinthine Vertigo as an Early Symptom of Chronic Carbon Monoxide Poisoning. JULIUS LÖWY (Prague). (*Zeitschrift für Hals-, Nasen-, und Ohrenheilkunde*, Bd. xiv., Heft 1 and 2, p. 156.)

The writer refers to Lewin as having identified this association and describes several cases of his own. The caloric test revealed hyperexcitability of the vestibular labyrinth. JAMES DUNDAS-GRANT.

Gradenigo's Syndrome. E. RIMINI. (*Archives Internationales de Laryngol.*, July-August 1926.)

The paper is based on observations derived from three cases in which the Gradenigo syndrome was present.

The syndrome consists of three elements:

- (1) Acute suppuration of the middle ear.
- (2) Paralysis of the abducent nerve on the affected side.
- (3) Temporo-parietal and orbital pain on the affected side.

It is to the last of the above that the author wishes to draw particular attention. He ascribes the pain to a pathological lesion of the 5th cranial nerve, and asserts that this symptom is frequently overlooked in discussing the symptom-complex; its importance being overshadowed by the attention given to the ocular paresis.

The pathology of the condition and the intracranial anatomical relationships of the 5th and 6th nerves are discussed, from which the author concludes that Gradenigo's syndrome is due to an inflammatory lesion of the apex of the petro-mastoid bone. The inflammatory process, which rarely exceeds that of hyperæmia, reaches the apex of the petrous bone through the system of cells surrounding the Eustachian tube, carotid artery, facial nerve and semicircular canals.

In view of the fact that occasionally, if left to itself, the pathological condition may go on to pus formation, the author urges that cases showing Gradenigo's symptom-complex should be operated upon as soon as possible. MICHAEL VLASTO.

Cause and Treatment of Sea and Air Sickness. O. BURNS.
(*Münch. Med. Wochenschrift*, Nr. 24, Jahr. 73.)

The writer bears out his contention that the essential disturbance of the physiological equilibrium which occurs in the production of sea and air sickness is abnormal vestibular stimulation. By turning the individual experimented with to right and left about a vertical axis on Bárány's chair with his head upwards, bent backwards or inclined towards the shoulder, he has succeeded in accurately simulating the various gyrations of a ship at sea. It was found that those who rapidly became sick at sea soon exhibited pallor, perspiration, and sickness, whereas in those who were "good sailors" these disagreeable phenomena remained absent.

Abstracts

This method supplied the important possibility of undertaking therapeutic experiments against sea sickness.

Sea sickness is the result of an abnormal reflex. The sensory limb of the reflex arc is formed by the kinæsthetic, vestibular and optical paths. These are in close alliance and, in conjunction with the co-ordination centre, constitute physiological equilibrium.

With this process there is a corresponding subconscious realisation in the cerebral cortex of the attitude of the body in space. The vago-sympathetic centres, with their afferent branches especially those in the blood-vessels and stomach, form the motor segment of the arc. This reflex arc can be influenced by therapeutic measures at five places:

1. At the sensory part.
2. At the reflex centre.
3. At the motor, that is to say the vaso-motor nucleus.
4. At the afferent branch of the vagus to the stomach.
5. At the stomach itself.

1. The sensory part can be influenced by eliminating, as far as possible, abnormal peripheral sensory stimuli. Ships should be as large as possible or be so constructed as to neutralise oscillation. The traveller is counselled to remain lying down amidships.

2. A sedative is the best means of controlling the reflex centre. Of such, chloral hydrate, veronal, or thalassan are generally useful. It is important not to visualise moving parts of the ship. Stress is laid upon suggestion, the will not to be sick and the occupation of the mind in carrying out some form of physical work or occupation.

3. If the abnormal reflex does actually involve the vago-sympathetic centres, Bier's method of congestion applied to the neck or eventually by means of an abdominal belt will be found efficacious in maintaining the tone of the cerebral vessels. As analeptic remedies recourse may be had to caffeine, camphor, alcohol and atropin.

4. If the abnormal stimulus reaches the gastric motor centre, atropin, owing to its paralytic action upon the vagus terminals, is of pre-eminent utility.

5. To control the abnormal excitability of the gastric muscles opium derivatives are used.

Numerous experiments carried out on the turning chair confirmed the therapeutic utility of the above deductions. J. B. HORGAN.

Is there a Serous Meningitis? F. KOBRAK (Berlin). (*Zeitschrift für Hals-, Nasen-, und Ohrenheilkunde*, Bd. xiv., Heft 1 and 2, p. 135.)

Kobrak says that the answer to this question is in the affirmative, but that the name is not well applied. Some cases are early stages of

The Ear

severe infectious purulent meningitis and are better termed "benign." In young subjects an exudative, and in older ones an angioneurotic diathesis may explain the development of the signs of serous meningitis. For the diagnosis of serous meningitis, as such, Kobrač postulates: 1. The clinical picture of meningitis; 2. increased pressure of cerebro-spinal fluid; 3. macroscopic transparency of the fluid; 4. improvement in the symptoms after lumbar puncture; 5. all the more if optic neuritis is present.

JAMES DUNDAS-GRANT.

The Chemotherapy and Serum Therapy of Pneumococcus and Streptococcus Meningitis—(The Treatment of Septic Meningitis). JOHN A. KOLMER, M.D. (Philadelphia). (*Archives of Otolaryngology*, Vol. iii, No. 6, June 1926, p. 481.)

Incidence.—Yerger estimates that about 5 per cent. of cases with otitic and 1 per cent. of those with nasal accessory sinus infections develop meningitis.

The *mortality* of leptomeningitis has been estimated at 93 per cent., but in that of acute, diffuse purulent streptococcal and pneumococcal infections of otitic or nasal origin, it approaches 100 per cent. when treated by the usual methods.

In the production of experimental meningitis, Kolmer, Rule and Madden employed highly virulent cultures of a type I pneumococcus or of a hæmolytic streptococcus. Most of the experiments were conducted upon dogs of 5 to 10 kilograms in weight. The writers introduced, by intracisternal injections, under ether anæsthesia, 0.1 c.c. of a 1:5 dilution of twenty-four hour brain-hormone broth culture of a hæmolytic streptococcus per kilogram of weight, or 0.1 c.c. of a 1:50 dilution of a similar culture of pneumococcus. Symptoms of meningitis were apparent within twenty-four hours after infection with pneumococci, but were sometimes delayed up to four days in the case of streptococci. Treatment was delayed until symptoms appeared, including leucocytosis. The cerebro-spinal fluids were always cloudy or purulent and contained myriads of organisms. Untreated controls died within five days after the onset of symptoms. The dogs were kept under morphine and all treatments were given under ether anæsthesia. Bacteriæmias with positive cultures from the heart blood sometimes occurred, and, as a rule, the experimental infections were more severe and fulminating than septic meningitis in human beings.

1. *The Chemotherapy of Septic Meningitis.*

Bad results were observed in experimental pneumococcus meningitis of dogs treated with intravenous, intracisternal and intraventricular injections of ethylhydrocuprein. (In treating human cases Kilmer gives 12 to 18 c.c. of a 1:1000 solution for an adult of average weight.)

Abstracts

Repeated intravenous injection of mercurochrome in doses of 0.005 to 0.008 gram. per kilogram had no appreciable effect on the course or mortality of experimental pneumococcus and streptococcus meningitis of dogs. The dose by intracisternal or intraventricular injection should not be much more than 0.0001 to 0.0003 gram. per kilogram, corresponding to 1 to 3 c.c. of a 1:1000 solution.

Gentian violet, neutral acriflavine and rivanol were also tested. These three dyes are capable of destroying *in vitro* pneumococci and streptococci in purulent spinal fluids, but the tolerated dose by intracisternal or intraventricular injection in dogs was not more than 6 to 24 c.c. of 1:1000 solutions for adults weighing about 130 lb. Repeated subthecal administrations were without appreciable influence on the course and mortality of the disease in dogs.

Chemotherapy alone, therefore, has little or nothing of real value to offer to-day in the treatment of severe septic meningitis, though intravenous injection may prove of aid in overcoming an infection of the blood if bacteraemia is found to be present.

2. *The Serum Therapy of Septic Meningitis.*

Treatment of pneumococcus meningitis with intraspinal injections of type I serum was not successful in rabbits. Intramuscular, intravenous, intracisternal and intraventricular injections of polyvalent antistreptococcus serum failed to influence the mortality of experimental meningitis in dogs.

Clinically it has been found that subthecal injection of pneumococcus antibody solution offers far more hope for success than antipneumococcus serum. This impression gained some confirmation from the results of the writer's experiments in the treatment of experimental pneumococcus meningitis of dogs. Injections of antibody solution alone did not save the lives of any of the animals, but the duration of life was prolonged for a few days, and when administered along with lavage of the ventricles to the cisterna magna complete recoveries occurred.

3. *Lavage and Drainage in the Treatment of Septic Meningitis.*

Surgical drainage by laminectomy (Hill), of the cisterna magna (Danday), or continuous spinal drainage (Rainey and Alford) have resulted in some recoveries. Danday, for example, has been able to save three out of a series of four cases of septic meningitis by continuous drainage from the cisterna magna.

In the present series of experiments, the only effective method of treatment consisted in trephining, puncturing the lateral ventricle and washing one or both ventricles through to the cisterna magna with warm saline or Ringer's solution, escape of the fluid being provided for by the insertion of a needle into the cisterna magna (suboccipital

The Ear

puncture). One treatment alone of this kind saved animals when the untreated controls all died in the usual time. Sometimes pus continued to drain from the trephine opening for a few days, and these animals usually fared better than those without this drainage. It is possible that washing the spinal subarachnoid space between the cisterna magna (suboccipital puncture) and the lower lumbar region of the cord (lumbar puncture) would improve the results, but Kolmer did not find this necessary in the treatment of these experimental infections.

It is essential to make the diagnosis as early as possible by spinal puncture and examination of the cerebro-spinal fluid, and to institute treatment without delay. Kolmer holds that careful removal of a few cubic centimetres of cerebro-spinal fluid will do no harm either in the way of favouring the localisation of organisms in the meninges from the blood, or by favouring the extension of a localised meningitis.

CONCLUSIONS.—*A.* If the fluid is clear, nothing should be injected subtheccally, although it is well to inject antibody solution intravenously or subcutaneously in cases of suspected pneumococcus meningitis, or mercurochrome or gentian violet intravenously in suspected streptococcus infections.

B. If a purulent fluid is recovered, the case should be regarded at once as one for surgery, calling for the drainage of the local focus of infection, the performance of trephining and puncture of a lateral ventricle, along with puncture of the cisterna magna and lavage from the ventricles to the cistern. In dogs, Kolmer used 20 to 40 c.c. of warm saline or Ringer's solution, and never observed any ill effects. Lavage from the cistern to the lumbar region may be done at the same time. Washing out the ventricle on the infected side of the head is recommended, although in severe cases, both ventricles may require irrigation. In pneumococcus infections lavage may be followed by the introduction of pneumococcus antibody solution in dose of about 0.5 c.c. for each 2 lb. of weight.

J. S. FRASER.

THE LARYNX.

The Growth of the Surgery of the Upper Respiratory and Digestive Tracts. TH. GLÜCK, Berlin. (*Archives Internationales de Laryngol.*, June 1926.)

One of the most important landmarks in the growth of laryngeal surgery was the recognition that septic pneumonia could be largely combated by the performance of a prophylactic tracheotomy, and the temporary or permanent isolation of the respiratory tract.

The incisions recommended and carried out by the author in the performance of a complete laryngectomy are along the anterior borders of the sterno-mastoid muscles and transversely above the sternum. The flap is turned up to the level of the hyoid bone. The trachea

Abstracts

is severed, and the distal extremity is united to the skin through a special button-hole opening below the transverse incision. In other respects, presumably, the steps of the operation are similar to those in other operations where the larynx is removed from below upwards.

In their series of cases, the author and Sorensen have carried out the operation of complete laryngectomy 788 times.

In their last series of 150 cases in which the growth was limited to the laryngeal structures, 142 "are cured."

Good results are claimed in laryngo-fissure for tuberculous laryngitis and in papilloma of the larynx.

Ten cases of tuberculous laryngitis were treated by tracheotomy and silence treatment, and all were cured.

Glück and Sorensen's experience of laryngo-fissure for localised carcinoma is based on 103 cases, of which 3 died as a direct result of the operation; in 6 cases the growth recurred locally, and the remainder were cured.

M. VLASTO.

The Indirect Inspection of the Larynx, especially its Anterior Portions, without Protusion of the Tongue. EUGEN POLLAK (Graz). (*Zeitschrift für Hals-, Nasen-, und Ohrenheilkunde*, Bd. xii., No. 3, p. 353.)

This consists in pressing the tongue down with a spatula and examining with a laryngeal mirror while the patient utters the sound "eh" or "ee," and Pollak finds that it succeeds in about 80 per cent. of adults.

JAMES DUNDAS-GRANT.

PERORAL ENDOSCOPY.

Bronchography by Means of the Laryngeal Catheter. OSCAR BECK and M. SGALITZER (Vienna). (*Zeitschrift für Hals-, Nasen-, und Ohrenheilk.*, Bd. xiv., Heft 1 and 2, p. 9.)

The authors, laryngologist and radiologist respectively, advocate the injection of lipiodol under the guidance of the Röntgen rays. For this purpose a half-soft catheter of 2 mm. in diameter is introduced into the larynx and trachea previously anæsthetised locally. The catheter is fortified by having a silver wire attached to the concavity of its angle, and is protected from the teeth by a vulcanite collar. The anæsthesia can be so complete that no cough occurs to expel the liquid, but a gentle cough has to be given when it is desired to send it into the upper bronchial tubes, appropriate alterations in the patient's attitude being made. It has been found by Sgalitzer that when the larynx and trachea are well anæsthetised the mere swallowing of iodipin is accompanied by its entrance into the trachea and bronchi.

JAMES DUNDAS-GRANT.

Peroral Endoscopy

Use of Iodized Oil in the Diagnosis and Treatment of Bronchial Affections. STUART PRITCHARD, M.D., and BRUCE WHYTE, M.D., and J. K. M. GORDON, Battle Creek, Michigan. (*Journ. Amer. Med. Assoc.*, 10th April 1926, Vol. lxxxvi., No. 15, p. 1119.)

The authors first describe the oil used as 40 per cent. metallic iodine with oil of poppy seeds, employed by Forestier, primarily as a diagnostic agent in lesions of the bronchial tree. Stress was laid on the fact that the oil is not to be used if it has turned brown. Four methods of introducing it are discussed, including the supraglottic, transglottic, subglottic, and bronchoscopic. The supraglottic method, with 10 per cent. cocain as local anesthetic, is the method of choice. The position of the patient must be such as to allow the oil to gravitate towards the area to be explored, and X-ray study should be made immediately following the injection, as the oil may be shifted by coughing.

This is a valuable aid in thoracic surgery and in exploring thoracic fistulæ, as shown by three case histories. By injections of iodised oil into the bronchial tree, small bronchiectatic dilatations in and around the roots of the lungs and cylindrical fusiform enlargements of the descending branches may be revealed in many cases of chronic cough, which a previous exhaustive examination of the chest failed to show. The entire bronchial tree cannot be visualised at one injection. Small sections should be injected at intervals until an abnormality is discovered or the entire field is studied. The nose and throat should be studied in all cases.

Bronchiectatic cavities occur as the result of chronic upper respiratory infections, and may continue to cause cough after the tonsils are removed or the sinuses are drained. In more than 600 bronchial injections of iodized oil, there were no ill effects seen in the patients. No cases of iodism occurred. Negative results of an injection are no diagnostic proof that bronchiectatic dilatations do not exist. In acute affections or pulmonary tuberculosis, the authors hesitated to inject iodized oil either for diagnostic or therapeutic purposes. Three case histories were given where 10 c.c. doses of from six to ten injections were used with great advantage in affections of the lower respiratory tract.

ANGUS A. CAMPBELL.

Razor Handle in Bronchus. C. EDWARD CAMPBELL, M.D. (*Journ. Amer. Med. Assoc.*, 17th July 1926, Vol. lxxxvii., No. 3, p. 168.)

During a fit of depression a man admitted that he had "swallowed" the handle of a safety razor, not saying anything about it at the time. There was no suffocation or uncontrollable spasmodic coughing. X-ray verified the patient's statement, showing the razor handle in the left main bronchus. Œsophagoscopy and bronchoscopy failed to

Abstracts

disclose the presence of the foreign body or any evidence of perforation. On the third day it was coughed up. No serious changes were produced to the lung.

ANGUS A. CAMPBELL.

Obstruction of the Œsophagus caused by a Persistent Ductus Arteriosus.
A. J. JEX-BLAKE. (*Lancet*, 1926, Vol. ii., p. 542.)

The writer describes this curious case which occurred not in man but in a puppy. The dog was slowly starved of food and oxygen by the natural contraction of the ductus arteriosus. No instance has been recorded in medical literature, but there is in the Museum of the Royal College of Surgeons of England a specimen of an anomaly similar to the one here described; in the former the cord of the ductus had become sufficiently elongated to allow of the passage of food and air. Sir Arthur Keith supplies a description of Dr Jex-Blake's specimen, which is now in the same museum.

MACLEOD YEARSLEY.

Diverticula of the Œsophagus. JOHN MORLEY. (*Brit. Med. Journ.*, 12th June 1926.)

The general use of radiological examination in all lesions of the œsophagus has shown that diverticula are not so rare as was formerly supposed. In this paper three illustrative cases are described, typical examples of the condition as it usually occurs in elderly men.

The operation employed is one of primary excision. A large œsophageal bougie is passed to help in defining the sac. With the bougie *in situ*, two pairs of Schoemaker's colectomy forceps are applied to the neck of the sac transversely and the pouch removed by cutting between them with a knife. The divided mucosa on the stump is sterilised with pure carbolic and a continuous Cushing suture of fine catgut inserted over the forceps with a fine needle. On removal of the forceps the suture is drawn tight, inverting the edges. The same suture is then brought back as a second layer covering the first, after the manner of a continuous Lembert suture. Another row of invaginating catgut suture is superimposed and the wound closed with a drainage tube down to the site of excision.

In the first case rectal saline was given for the first twenty-four hours with no fluid by the mouth. For the next three days sterile water and brandy were allowed by the mouth and then a fluid diet until the end of the tenth day. The tube was removed on the third day. On the seventh day the wound was completely dry and remained so.

In the second case Senn's gastrostomy was performed on account of the patient's poor condition and the gastrostomy tube retained for ten days.

It is pointed out that the pouch, strictly speaking, is pharyngeal. The

Peroral Endoscopy

frequent association with retrosternal goitre suggests that sometimes a goitre is the cause of the increased intrapharyngeal pressure which leads to herniation of the mucosa.

It is concluded that before a pouch can form there must be obstruction below the pharynx, due either to spasm of the upper oesophageal sphincter, to retrosternal goitre, or occasionally to organic stricture.

Dysphagia caused by a pouch differs from that met with in malignant stricture in the intermissions in its early stages, the regurgitation of food in bulk a long time after a meal, and the attacks of characteristic choking and coughing with which this regurgitation is often associated. In the later stages a fullness of the neck, with gurgling and ejection of food on pressure over the sac, may make the diagnosis clear. The only certain diagnostic method, however, consists in an X-ray photograph after a bismuth meal. The different operations for dealing with diverticula of the oesophagus are then discussed. These include Goldmann's two-stage operation, consisting of isolating and ligating the neck of the sac as the first stage, with extirpation of the mummified sac ten days later by thermocautery. Wilkie and Hartley's modification of this operation consists in submucous resection of the sac, leaving the outer covering or tunica propria *in situ*. Hill's and König's operations are for the isolation and suspension of the sac in an upward direction by suturing it either to the hyoid bone or to the upper part of the omohyoid muscle. Inversion of the sac or its invagination into the pharynx is condemned.

The operation of primary excision and suture is believed to be the operation of choice, but certain precautions are necessary if grave danger is to be avoided. The sac must be rendered as sterile as possible by frequent washing out with a mild antiseptic, and it must be emptied before operation. When the sac is isolated a large bougie should be passed into the oesophagus and kept there until suture is complete. The suture of the neck of the sac must be carried out with the most extreme accuracy and care, for in this detail lies the crux of the operation. Six very good X-ray photographs accompany the article.

R. R. SIMPSON.

A Case of Complete Plastic Operation on the Oesophagus. S. RIESENKAMPF. (*Zentralblatt. f. Hals-, Nasen-, und Ohrenheilkunde*, 1926, viii., 293.)

The author followed the method of Roux and Herzen. At the first operation a loop of small intestine, about 30 cm. long and 30 cm. from the duodeno-jejunal flexure, was mobilised, obliquely divided, and the ends closed. The intestine was re-united by a lateral anastomosis with implantation of the lower end of the free loop. A subcutaneous tunnel

Ablation Experiments on Frogs

was made from the xiphisternum to a point 10 cm. below the left clavicle. The mobilised loop was drawn up through this, and the upper end sewn, unopened, to the skin. Three weeks later the œsophagus was freed and divided between the sterno-mastoid and the trachea, and the oral end sewn to the skin above the left clavicle; the upper end of the intestinal loop was opened and sewn to the skin. After five weeks an anastomosis was made between the lower end of the displaced intestinal tube and the anterior surface of the shrunken stomach. Only a small opening was made, which proved impervious. As a result, after three months, another attempt was made to establish a satisfactory opening, and this succeeded. In the meantime a wide rubber tube had been inserted between the œsophagus and the intestinal loop, so that the patient could swallow. After five months, connection was established between œsophagus and loop by a tube of skin. This works satisfactorily, and now, after two and a half years, swallowing is accomplished without discomfort and the new œsophagus shows regular peristalsis.

F. W. WATKYN-THOMAS.

ABLATION EXPERIMENTS ON THE LABYRINTH OF FROGS.

By JOHN TAIT (McGill University, Montreal) and W. J. McNALLY.
(*Archives of Otolaryngology*, October 1926, vol. iv., no. 4, p. 281.)

(Abstracted by J. S. Fraser, F.R.C.S.E.)

THE writers' observations on disturbances of equilibrium in the frog concerned only the limbs and body of the animal. No attention was paid to the eye movements.

The Saccular and Utricular Maculæ.—When one or both saccular otoliths are removed, or when the nerves to the saccular maculæ are cut, the animal sits, crawls, jumps, and swims absolutely in normal fashion. These results confirm previous work on fishes and on frogs, which show that, in these lower forms of animal life at any rate, the saccular macula is not in any way concerned with equilibrium. The utricular macula is particularly difficult of access and exposure, as its nerve lies very close to the two anterior ampullæ of the semicircular canals. The utricular macula is wholly an organ of *static equilibrium*, as has been recognised since the time of Breuer and recently substantiated by Magnus and his school.

Tait employs a table, the top of which can be tilted by means of a pole or lever (Fig. 1). On this table is placed the animal (or person) to be investigated. When the table top is inclined or tilted from the horizontal, the animal reacts and adjusts its posture so as to be in stable equilibrium in spite of the new inclination of the surface. This reaction is purely a reaction against gravity, and the response is an automatic one, occurring just as well in the decerebrate as in the intact frog. The body of the animal becomes so placed as to rest vertically above its four limbs. The head, too, tends to be held horizontal.

In taking up the appropriate pose the animal depends on nervous

Ablation Experiments on Frogs

messages derived from four possible sources; (1) pressure impulses due to contact with the ground; (2) impulses from muscles and joints; (3) impulses from the eyes; (4) impulses from the utricular maculæ. When the utricular macula is denervated on one side, the frog, notwithstanding the nervous messages from its eyes, muscles, palms, and soles, no longer squats naturally. On a horizontal surface it leans over to the operated side. If both utricular maculæ are denervated, the animal, when laid on its back, has great difficulty in righting itself. If it is blindfolded and thrown into water it loses all sense of the direction of gravity. (A mason who wishes to place any structure in a vertical position, uses a plumb-line. The utricular maculæ may be roughly compared with the plumb-line of the mason.)

The Semicircular Canals.—The canals are for *kinetic or dynamic equilibrium*. Tait explains kinetic as opposed to static equilibrium by reminding us that a tree grows vertically upwards in opposition to the force of gravity, whether it is rooted on a plain or on the side of a hill. In other words, it shows static equilibrium. Animals, on the other hand, are motile creatures. They turn and jump and yet maintain their balance. These accomplishments are reactions of kinetic equilibrium, the static reactions being manifested only when the animals stand still.

To test an animal for disturbance of kinetic equilibrium, all that is necessary is to jerk it about in an effort suddenly to upset it. A normal animal by prompt counter-reaction maintains its balance no matter how quickly the table is tilted. McNally succeeded in removing all six semicircular canals from a frog without other damage to the labyrinths and found that a decanalised animal on a tilt-table is much more readily capsized than a normal frog. When one places such a frog on a horizontal tilt-table and sharply tips the table through a small angle, the body of the frog sways and rocks about. Over its static equilibrium (utricle) the decanalised frog has complete control. If we incline the table very slowly, the frog adjusts itself so that its body remains vertically over the base of support and its head is held horizontal. It is necessary to tilt the table slowly because the utricular maculæ and their connections are more deliberate in operation than the canals. If we tilt quickly, the decanalised animal, lurching to the downward side, may lose its stability and topple off the table. The canals are called into action by something sudden; their effect is momentary and evanescent. The "plumb-line" mechanism (utricle) responds to a steady field of force; its action is sluggish but its effect is sustained.

Differential Function of the Canals.—Tait points out that the *four vertical canals*, lying in vertical planes, point towards the four corners of the body, and that in each case the ampulla is at the outer extremity, *e.g.* the ampulla of the right superior canal corresponds to the right shoulder and that of the right posterior canal to the right buttock. Tait and McNally found that by observation of limb movements it is possible, in the frog, to diagnose quite simply an individual lesion of any of the four vertical canals. The method is capable of easy extension to human beings.

The Horizontal Canals are brought into action in rapid turning movements about a vertical axis. If an animal is placed on a turn-table and rotated clockwise it should, in order to counteract the quick turn of the

Ablation Experiments on Frogs

table, step sideways with its fore limbs to its left, and with its hind limbs sideways to its right, *i.e.* it executes a circus movement in the direction opposite to that of the turn-table. If a frog with an experimental defect of its right horizontal canal be placed on a turn-table and if the table be twisted sharply towards the left (counter-clockwise), the animal behaves normally and makes a short circus turn in the opposite direction. If, on the other hand, the table is sharply turned towards the animal's right, there is no reaction. This proves that when the normal frog is quickly



FIG. 1.

rotated towards its right it is the horizontal canal on that side that is stimulated.

The Vertical Canals.—Land vertebrates walk on four struts or legs, and in the usual form of progression the body is supported alternately on pairs, consisting of right fore and left hind, and of left fore and right hind respectively. In each case the girder bridging the upper ends of the limbs passes diagonally across the trunk, and the body may be said to swing in each case about a diagonal axis. Of the four vertical canals, the right anterior and the left posterior constitute a parallel pair, while the left anterior and right posterior constitute another parallel pair. As the vertical canals are arranged as two diagonal pairs, the best way to place an animal on the tilt-table, in examining for defect of the vertical canals, is diagonally (Fig. 2).

Ablation Experiments on Frogs

If we wish to test the left anterior and right posterior pair, the animal is placed so that this pair of canals lies at right angles to the axis of rotation, while the other pair, lying parallel to the axis of rotation, will not be stimulated. If we place a dog diagonally on the table, with his head pointing to the left front corner and his tail to the right back corner, tilting movements stimulate the right anterior and left posterior canals. If we now slowly raise the shaft, the dog's weight mainly rests on the right fore limb. If the tilting occurs suddenly, the animal renders this limb very rigid, or even throws it farther away from the axis of rotation so as to act as a strut to prevent toppling.



FIG. 2.

If a frog in which the ampulla of the right posterior vertical canal has been destroyed be placed diagonally on the tilt-table, and if the front end of the table be tipped quickly downwards, the frog preserves its balance because absence of a posterior canal is of no consequence in a case of forward tipping. When, however, the direction of tilting is reversed, the animal rolls backwards over its limp right hind limb and falls off the table. If the frog be placed in the fore-and-aft direction, *i.e.*, with its body transverse to the axis of rotation, and the table tilted backwards, the left hind limb is shot out backwards so as to save it against a fall, but the right hind limb fails to move. If the rate of tilting be accelerated, the frog actually falls over backwards and to the right.

Numerous experiments of this kind led to the following interesting conclusion. Each vertical canal is especially associated with the limb of that quarter of the body towards which it points. A vertical canal is

Ablation Experiments on Frogs

stimulated when the head is suddenly tipped downwards towards the quarter to which the canal points. The main effect of stimulation of a vertical canal is a sudden extension of its own particular limb, which is thrown diagonally away from the body. Tait and McNally also found that, whereas a vertical canal is specially associated with one particular limb, stimulation of a horizontal canal tends to cause movements of at least two and usually of all four limbs.

The semicircular canals are peculiar to vertebrates and are first met with in the lowest fishes, or cyclostomes, which have four vertical but no horizontal canals. The vertical canals, therefore, are probably the more primitive and the more essential. When the land vertebrate reaches the stage of raising himself up and walking on a single pair of limbs (*cf.* birds and man), his equilibrium is more unstable and the responsibility of the vertical canals greater than ever.

Differential Diagnosis of Canal Lesions.—The canals fall into two groups, (1) a non-gravity set (horizontal canals) which is concerned with waltzing movements; (2) a gravity set (vertical canals), which is concerned in leaping and landing again, in protection against falls and in movements in which the limb muscles are exerted in opposition to gravity. To test (1) Tait uses the Bárány chair, rotating about a vertical axis. He sets the patient in the chair and, after blindfolding him, rotates the chair through a small angle with varying degrees of angular acceleration. The patient is asked to indicate, by signing with the right hand or with the left hand respectively, when he experiences rotation and the direction of this rotation. An angular acceleration of two degrees per second suffices to cause conscious sense of rotation in a normal person. Deaf-mutes with acquired bilateral labyrinth trouble as a result of meningitis do not indicate correctly the direction of rotation. For (2) Tait employs a tilt-table, rotating about a horizontal axis, wherewith to test the gravity set. A stout handle attached at one end gives leverage to the examiner. A normal person kneels on the table and places his hands flat on the top of the table; he is not allowed to grip the sides. It does not matter in which direction he is placed, antero-posterior, transverse or diagonal, his kinetic equilibrium during sudden tilts of the table is perfect. Provided the angle of inclination is not made too steep, he cannot be dislodged. His balance is maintained by a wholly automatic process; it costs him no effort and no attention. On the other hand, if a patient with total loss of his canals takes his place on hands and knees, diagonally across the table, and the tip-table is suddenly tilted forwards or backwards, even through an angle of 10 or 15 degrees, he is easily upset; even on the slightest tilt the body sways markedly.