THESIS

on

THE SIGNIFICANCE OF CALORIC LABYRINTHINE STIMULATION IN THE DIAGNOSIS, PROGNOSIS AND TREATMENT OF CERTAIN PATHOLOGICAL CONDITIONS.

By

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THE SIGNIFICANCE OF CALORIC LABYRINTHINE STIMULATION IN THE DIAGNOSIS, PROGNOSIS AND TREATMENT OF CERTAIN PATHOLOGICAL CONDITIONS.

Robert Bárány, while working on the study of the ear in 1909, discovered that when the head was placed in a certain position douching the ear with cold (68°F) or hot water (112°F) produced a nystagmus in a definite direction.

Cooling increases the Specific Gravity of the Endolymph causing it to sink: heating has the reverse effect: in each case a current is produced, but in opposite directions. With the head in the erect posture (maximum effect when inclined 30° forwards) the vertical canals are stimulated. There is produced a slow vestibular "chug" of the eyes towards the ear which has been douched and a quick cerebral "chug" to the opposite side. This quick component receives the designation of nystagmus - rotary in this case. When the head is inclined 60° backward, the horizontal canal then assumes the vertical position, the nystagmus is in the same direction, but instead of being rotary becomes horizontal.

Jones, of Philadelphia, considers that the quick component to the Left of both eyes is probably controlled by a centre in the Right cerebral hemisphere and VICE VERSA. Maxwell, however, has thrown doubts on the cerebral origin of this quick component on account of experiments on dog fishes and pigeons in which he was able to demonstrate that the nystagmus was not affected by the loss of the cerebral hemispheres.

Stimulation of the hairs of the cristae produces a subjective sensation of turning in a direction opposite to the endolymph movement, but the actual falling and past-pointing are in the same direction. Vertigo is essentially

a cerebral disturbance resulting from impulses conveyed from the ear to the cerebral cortex, and in the absence of vertigo there can be no past-pointing: the pyramidal tract supplies the motor force for pointing: the cerebro-cerebello-spinal tract may be called the accuracy tract whereby the cerebellum is able to exercise its synergic influence. Unfortunately, these pointing accuracy tests are subject to discrepancies on the part of the patient.

<u>To summarize:</u> Douching of:-

R ear, water 68°F, head erect	Rotary nystagmus to L. Falling and p.p. to R.
L ear, do. do.	Rotary nystagmus to R. Falling and p.p. to L.
R ear, water 68°F, head back	Horizontal nystagmus to L. Falling and p.p. to R.
l ear, do. do.	Horizontal nystagmus to R. Falling and p.p. to L.

By these tests we may, in a very short time, become acquainted with the extent of vestibular efficiency and obtain information regarding the state of the labyrinth, the vestibular nerve and its central connections, and by repeated examinations be able to consider the prognosis and effective treatment of any lesion. A detailed examination of adjacent structures is essential. By using a known volume of water, e.g., 30 c.cs at 68°F., we can standardize results. Normally, the reactions are induced in approximately 30 seconds and last from 60-200 seconds. A hyperexcitable labyrinth is denoted by a shorter latent period and longer duration of the nystagmus; hypoexcitability by a longer latent period and shorter duration.

The advantage of the Caloric Test over Rotation in the Bárány chair is that it enables the clinician to test the ears individually and thus procure more reliable information.

A further disadvantage of Turning is the extreme disorientation of the patient on completion of the test and the likelihood of other factors, e.g., false retinal impressions and interference with the tonic neck reflexes obscuring results. The Electrical Test is of even less importance owing to its generalized stimulating effect on the whole labyrinth and Eighth nerve.

The semicircular canals may be termed the kinetic portion of the labyrinth: the otolithic apparatus (saccule and utricle) constitute the static control. In the latter it is apparently possible to induce similar reactions to that of the canals, viz., nystagmus, etc. Professor Magnus and de Kleijn (Utrecht) have examined separately the functions of these two systems by centrifugalizing normal guinea-pigs, thus detaching the otolithic membranes, which normally by their "pull" on the maculae help to determine the position of the head in space. In man, however, the otolithic apparatus is essentially a degenerative organ, normally of very little importance and only becoming evident in pathological processes - it is probable that tonic neck reflexes, which are influenced by labyrinthine impulses, are the only ones of importance and are tested thus (Magnus and de Kleijn:-

Note presence or absence of nystagmus or past-pointing in the following head positions after lapse of 30 seconds in each case:-

(1. Head erect.
(2. Head inclined to R shoulder.
(3. Head " " L "
(4. Head back.

These observers only record two cases of pure otolithic disturbance - I have suggested its presence in a severe case of Parkinsonism mentioned later. Giddiness produced by change of posture (postural Vertigo) in the absence

of deafness or tinnitus is very suggestive of otolithic disturbance, if vasomotor disorder can be excluded.

For the purposes of this paper I examined over 50 patients in whom Vertigo was one of their chief symptoms, carefully eliminating those who only admitted its presence in response to a leading question.

Definition of Vertigo (Sydney Scott)

A state of consciousness of the effect on motor centres of a want of harmony between afferent impressions. These impressions in order of importance are:-

(a) Vestibular; (b) Ocular; (c) Kinaesthetic.

In the words of Sir William Gowers "it is a symptom which in many conditions is far more obtrusive than its cause."

A few observations on the description of Vertigo as volunteered by the patient will not be out of place. It is of two varieties, subjective and objective. Frequently there are no sensations of actual turning at all, but of falling to one side or the other, forwards or backwards, of the tendency to stagger to one side and the desire for a companion on that side in order to obviate that inclination . The staggering gives rise to an urgent desire "to hold on to something". Symptoms often overcome such patients in bed or on rising - they may feel that "they are sinking through the bed", and this sensation of sinking is much commoner than the reverse, such as the feeling of "walking on air" or that the "top of the head appears to be floating away". Many do not experience any objective sense of movement as contrasted with those who state that objects seem to move with them or that the room spins round either in a direction which can be detected by the patient or the occasion is one of such intense mental confusion that an accurate account is impossible. Epigastric and visual disturbances frequently accompany or directly follow the attack which may overcome the patient without

warning or, and this is more common, it may be induced by turning suddenly, by stooping, or looking upwards or sideways, on coming into a bright light, etc. In a great number of cases discrepancies may arise which are probably due to false impressions from the retina. In others, particularly in women approaching the climacteric, the symptoms of dizziness, "hot feelings", flushings and fainting attacks can by no means be termed a true vertigo, and must be relegated to the group of Vasomotor and Endocrine disorder.

In fully 85% of cases the vertigo can be accounted for by disease of the ear itself or of its intracranial connections. The remaining percentage can be ascribed to the effect of absorption of either endogenous products of a pathological nature capable of arising from almost every organ of the body, or of exogenous substances (e.g., alcohol, quinine) causing a temporary aberration of equilibrium. But whatever be the cause, the effect is always without exception on a definite part of the brain, viz., the internal ear. Such terms as "renal" or "gastric" vertigo are, therefore, misnomers.

The object of the caloric test is to elucidate the cause of the vertigo, the localization of the lesion if present, and possibly indicate the prognosis and treatment. Thus from being an immature and hap-hazard science, the caloric reactions may enable the observer to understand more effectually the functions and disorders of the internal ear.

PRECAUTIONS:-

1. A careful examination of the Ear, Nose and Throat is essential.

2. Note presence or absence of nystagmus and past-pointing in the four head positions recommended by Magnus and de Kleijn.

3. Remove [illegible] or débris from the external meatus.

4. If the membrane be perforated, meticulous care should be used in drying and powdering afterwards to avoid subsequent otitis media.

I. EXTERNAL AUDITORY MEATUS.

Example: A small plug of wax was impinging against the membrana tympani causing slight deafness and vertigo which disappeared on removal of the foreign body. The vestibular responses were normal, i.e., a nystagmus to the opposite side was induced in 35 seconds in both positions of the head (30° forwards and 60° backwards) employing 30 c.cs of water at 68°F. In addition, there were falling tendency and past-pointing to the same side as the ear which had been douched.

II. MIDDLE EAR.

Acute otitis media almost invariably evoked hyperactive responses, i.e., nystagmus was induced within 35 seconds and lasted for a considerable time varying from 1 to 3 minutes. Falling tendency and past-pointing were marked and the subsequent giddiness and sickness often extreme.

Subacute and chronic otitis media in the majority of cases gave moderately hyperactive responses. In a few cases the [illegible] hypoactivity of the vestibular [illegible] changes on [illegible]

RESULTS OF CALORIC STIMULATION IN OVER 50 CASES EXHIBITING VERTIGO AS A PREDOMINANT SYMPTOM.

PRECAUTIONS:-

1. A careful examination of the Ear, Nose and Throat is essential.
2. Note presence or absence of nystagmus and past-pointing in the four head positions recommended by Magnus and de Kleijn.
3. Remove all wax or débris from the external meatus.
4. If the membrane be perforated, meticulous care should be used in drying and powdering afterwards to avoid subsequent otitis media.

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Subacute and chronic otitis media in the majority of cases gave moderately hyperactive responses. In a few cases the reactions revealed hypo-activity of the vestibular mechanism presumably due to fibrotic changes on the promontory.

This chronic disease may become lit up by acute exacerbations, e.g., acute nasopharyngitis, and frequently by influenza, during which the labyrinthine mechanism is hyperexcitable. A similar instance might be cited in which excessive shag smoking was the exciting cause - doubtless the puridin base present in this tobacco was responsible. The vertigo ceased on total withdrawal of the habit.

In the majority of these cases, the Fistula Test was negative except in one in whom a labyrinthine fistula was present.

MICHAEL REILLY - aet 36.

History of two aeroplane crashes in 1917. Frequent headache and vertiginous attacks, during which objects appeared to rotate from Left to Right in a vertical axis. He himself often staggered to the Right and the bed felt as if sinking through the floor. Recent discharge from Right ear associated with deafness and tinnitus.

EXAMINATION: An obvious neurotic element present.

Nose) Nil abnormal.
Pharynx)

L. Ear: Memb. T. normal. Rinné + whisper at (several feet.

R. Ear: Pus in meatus; post-inferior perforation. Rinné - whisper at 9".

Fundi healthy. Visual fields not contracted.

Vision R - 5/6 L - 5/9

Spontaneous rotary nystagmus to R head erect, which became horizontal in the head back position. No spontaneous past-pointing, dysdiadokokinesia, projection error or aphasia. Romberg: swayed laterally, but did not fall. Coarse nervous tremor of hands. Knee jerks exaggerated. No ankle clonus or positive Babinski sign. Wassermann negative.

FISTULA TEST: Compression of Politzer's bag in the Rt.external meatus produced:- Violent oscillations of both eyes in a horizontal direction lasting 5 seconds, indicating a labyrinthine fistula. The Test was negative on the L side.

DIAGNOSIS: Perilabyrinthitis.

CALORIC REACTIONS: R. well marked nystagmus in 20 seconds in both head positions. Giddiness, falling and p.p. were extreme.

L. moderate nystagmus in 35 seconds in both head positions. Giddiness, etc., less marked.

After 4 weeks' rest combined with local treatment, the caloric reactions became normal, and the Fistula Test was only very slightly positive.

III. ~~MIDDLE EAR.~~ INTERNAL EAR

Syphilis, either latent or in the active phase, is a potent cause of vertigo, and frequently gives rise to Ménière's syndrome.

(a) ACTIVE SYPHILIS.

Case I. JORGENSEN, aet 32. Admitted to the medical wards of the Hull Royal Infirmary with syphilitic myelitis, which quickly improved under active treatment. Five months before admission there was a typical history of Ménière's syndrome, and ever since he has had distressing vertigo, deafness and tinnitus referred to the L ear.

NEURO-OTOLOGICAL EXAMINATION:

Wassermann of blood and cerebro-spinal fluid +

Nose: Septum deviated to L.

Pharynx: Normal.

R ear: Memb. T. normal: Rinné + : whisper at several (feet.

L ear: Do. AC and BC not heard: loud voice not heard. Tinnitus present.

NEURO-OTOLOGICAL EXMN. Contd.

Pupils active to light and accommodation. No spontaneous nystagmus or past-pointing: no incoordination ataxia. Knee jerks brisk.

COLD CALORIC TEST:

No vestibular responses on either side after 2 minutes. "Inverse" nystagmus, i.e., in the wrong direction was present on both sides indicative of some brain stem involvement.

NOTE: After active anti-syphilitic treatment, the hearing in L ear became:- conversational voice at 10". The vestibular responses, however, remained absent.

CASE II. KERSHAW, aet 24. Admitted to hospital May 1923 with chronic suppurative otitis media on R side with deafness and tinnitus: also vertigo of gradual onset. Wassermann of blood ++ Discharged after a course of anti-syphilitic treatment.

NEURO-OTOLOGICAL EXAMINATION, JULY 1925.

Objective vertigo to R.

Nose)
) Nil abnormal.
Pharynx)

L ear: Memb. T. normal: Rinné +: whisper at several (feet.

R ear: Pus in meatus: large reniform perforation: AC = BC Conversational voice heard at 1 foot.

FISTULA TEST - negative. Pupils irregular in outline and sluggish to light. No spontaneous nystagmus and past-pointing; no Rombergism. Knee jerks active.

CALORIC TEST: R. No vestibular responses within 2 minutes.

L. Normal reactions.

NOTE: Active antisyphilitic treatment and local medications produced no improvement either in the deafness or the vertigo. The vestibular responses remained unchanged. I venture to suggest that if active measures had been continued from the commencement, an improvement

NOTE Contd.

in the hearing and labyrinthine reactions might have resulted.

Case III. SWATMAN, aet 24. Admitted to medical wards on account of blindness and giddiness of ten weeks' duration. Chronic suppurative otitis media on both sides since childhood.

NEURO-OTOLOGICAL EXAMINATION:

Nose: Polypus on R side..

Nasopharynx: Polypus on L side.

R ear: Pus in meatus: granulations on posterior wall, near memb. T., which is almost gone. Rinné - whisper heard at 12".

L ear: Pus and granulations: large inferior perforation. Rinné - whisper heard at 10".

FISTULA TEST - negative.

Bilateral optic atrophy (primary). Pupils unequal and irregular. Argyll-Robertson reaction.

Knee jerks absent.

Wassermann of blood and cerebro-spinal fluid +

COLD CALORIC TEST:

R. nystagmus in 25 seconds in both head positions. Marked vertigo, falling and past-pointing.

L. nystagmus in 30 seconds in both positions. Vertigo and past-pointing only present in head-back position.

NOTE: The deafness is purely catarrhal and not due to any intracranial condition or to syphilis, but there is an absence of response from the L vertical canals fibres at some point in the L middle cerebellar peduncle - possibly an isolated gummatous infiltration.

(b) LATENT SYPHILIS.

A large percentage of patients exhibit repeatedly negative Wassermann reactions even after the administration of a provocative dose of Novarsenobillon or other arsenical derivative. The presence of suspicious physical signs, however, combined with the progressive impairment of vestibular responses render the possibility of latent syphilitic disease highly presumptive. Referring to sporadic congenital deafness, Drs. Browning and Cruikshank state that "where syphilis has become latent, or when the activity of the parasites is limited to a small area, the reaction is negative in fully 50% of cases." The same phenomenon may justifiably be said to occur in acquired syphilis.

One illustration will suffice:-

BLAKELEY, aet 67.

R sided deafness for years. L ear only became deaf recently. He has had several giddy attacks in the last year which began in bed "on turning over", and all the furniture seemed to spin round.

NEURO- OTOLOGICAL EXAMINATION.

Nose)
) Nil abnormal.
Pharynx)

R ear: Memb. T. normal. Rinné + whisper at 2".

L ear: Ditto. Do. whisper at 3'.

Pupils miotic and very sluggish to light and accommodation. No spontaneous nystagmus or past-pointing: no Rombergism: no palatal scars. Knee jerks almost absent. Wassermann of blood negative.

CALORIC TEST: L. no vestibular responses.

R. nystagmus well marked in 50 seconds in both head positions. Giddiness, falling and past-pointing reactions.

CALORIC TEST Contd.

NOTE: After a course of Iodides and Mercury for over five months, the R ear could appreciate a whisper at 3 feet. The vestibular function remained unaltered, indicating a greater power of recovery of the cochlea to specific treatment. In the presence of unequal involvement of cochlea and labyrinth in most of the cases of old standing Syphilis of the internal ear, particularly in the absence of paresis of other cranial nerves, we are led to presume that the labyrinth itself and not the Eighth nerve trunk becomes destroyed by the spirochaete in the majority of cases.

MÉNIÈRE'S SYNDROME.

Of six patients presenting this symptom complex, two will serve as useful illustrations of the vestibular reactions.

CASE I. PETCH, aet 52.

Vertiginous attacks date from August 1922 - often overtaken in the street by a sensation of reeling, and objects whirled about him in no particular direction. (unsystematized vertigo). While performing any work requiring changing positions, giddiness and faintness supervened.

AUGUST 1923. COLD CALORIC TEST.

L. very slight nystagmus to R in 60 seconds, head erect, more marked in head back position; slight falling and past-pointing reactions.

R. moderate nystagmus to L in 50 seconds, head erect, otherwise similar to L ear.

JANUARY, 1926. NEURO-OTOLOGICAL EXAMINATION.

Nose)
) Nil abnormal.
Pharynx)

R ear: Memb. T. normal. Rinné + BC < Normal.

L ear: Ditto. Ditto.

Whisper heard at 4" and 6" respectively.

NOTE: This case represents an atypical Ménière's syndrome on account of bilateral instead of unilateral deafness of the nerve type.

JAN. 1926 NEURO-OTOLOGICAL EXAMINATION. Contd.

No spontaneous nystagmus or past-pointing.

Wassermann reaction (blood) negative even after provocative dose of N.A.B: cerebro-spinal fluid also negative.

Pupillary reactions normal; knee jerks active.

CIRCULATORY SYSTEM:

(a) Thickening of Radial arteries.

(b) Waterhammer pulse.

(c) Noises in the ear synchronous with the systolic impulse.

(d) Aortic regurgitant murmur heard only at lower end of the sternum.

(e) Blood pressure: Systolic 160; Diastolic 76.

2ND COLD CALORIC TEST:

L. no response in 2 minutes.

R. slight responses in 50 seconds as before.

NOTE: (1) Illustrates the importance of examining in toto and prescribing specific drugs (e.g., cardiac stimulants) to improve the vertigo, which can undoubtedly be aggravated by a heart lesion.

(2) The progressive impairment of vestibular responses and ultimately destruction of the L labyrinth combined with bilateral nerve deafness and diminished Bone Conduction are strong presumptive evidence of latent syphilitic infection even in the absence of a positive Wassermann reaction.

CASE II. GERTRUDE COOK, aet 30.

Seized while in bed with sudden deafness in the R ear. The furniture appeared to rotate in no particular direction; she tended to fall forward on assuming the upright position and there was accompanying sickness. These vertiginous attacks were worse at the menstrual periods.

JULY 1925. NEURO-OTOLOGICAL EXAMINATION.

Nose)
) Nil abnormal.
Pharynx)

L ear: Memb. T. normal. Rinné +, whisper at several feet.

R ear: Ditto Neither AC nor BC heard.
Conversational voice heard at 2".

Pupillary reactions normal. Slight spontaneous nystagmus on looking to R when the head was inclined to either shoulder and slightly backwards. No spontaneous past-pointing. Knee jerks active. Wassermann negative. No cardiac lesion.

COLD CALORIC TEST:

R. nystagmus to L in 20 seconds. Well marked vertigo, falling and past-pointing reactions, i.e., hyperexcitability.

L. normal responses.

NOTE: (1) This patient stated that the test caused the giddiness to cease for a time. Calcium Lactate when administered previously to the menstrual period greatly improved the vertigo.

(2) The majority of the cases exhibiting the symptom-complex of Ménière have by virtue of the caloric test revealed a hyperexcitability of the labyrinth which would explain its explosive instability when activated by toxic agents.

"NEUROTIC" VERTIGO-OCULAR DEFECTS, VASCULAR CHANGES, ETC.

There is a large class of patients, particularly women, at or near the climacteric, who complain of vertiginous attacks which are not true to type and in whom the vestibular responses are perfectly normal. In the absence of aural disease these cases are possibly due to vasomotor or endocine disorder. Any deviation from the normal caloric reactions suggests an organic basis, and requires careful investigation. There are others whose symptoms are referable to an ocular defect either of refraction or muscular balance. Astigmatism, even of the smallest degree, and especially when the meridians are oblique, may be the sole cause of the vertigo when no aural lesion is manifest. In the majority

of cases, however, the cerebrum quickly learns to ignore ocular faults, but when present in conjunction with labyrinthine disturbance their correction usually affords alleviation of the symptoms without entirely dispersing them. When they co-exist with Ménière's syndrome, the prescribing of suitable lenses often prevents the onset of unconsciousness and diminishes the frequency and severity of the vertiginous attacks.

In conclusion, arteriosclerosis,more especially when associated with hyperpiésia, is a prevalent predisposition to vertigo, and many obscure cases past middle age are possibly attributable to this cause, provided gastro-intestinal, renal and hepatic disease have been excluded.

THE CALORIC TEST IN THE LOCALIZATION OF BRAIN TUMOURS.

Of the several cases of diagnosed tumour of the brain, only 3 have up to the present time come to autopsy. The findings were distinctly at variance with the vestibular responses, which is significant in my experience of the prematurity of neuro-otology, despite sanguine American writers.

Owing to the impressionable nature of brain tissue and its limitation within a closed cavity, the probability of obtaining erroneous results is extremely high, and the caloric test cannot by itself hope to establish a reasonably accurate diagnosis in a great percentage of cases. Its value must be assessed with other localizing signs and, owing to the frequency with which tumours compress or infiltrate, we may be forced to ignore the vestibular reactions altogether. In addition, the lethargic or aphasic patient is often incapable of rendering much assistance to the observer, especially when accuracy of projection is required in the past-pointing test.

EXAMPLES.

CASE I. AT AUTOPSY.

A gliosarcoma was present in the L frontal lobe. The diagnosis was in doubt owing to supposed cerebellar ataxia: cerebellar posture of the head - occiput inclined to R shoulder, chin towards L shoulder - and absence of aphasia.

THE COLD CALORIC REACTIONS were as follows:-

R. no nystagmus in 2 minutes, head erect. Well marked nystagmus head back with falling and past-pointing.

L. well marked nystagmus in 25 seconds, head erect and back. Extreme falling, vertigo and past-pointing.

INFERENCE: Interference with R vertical canal fibres.

Post-mortem showed no involvement of pons, medulla or cerebellum.

CASE II. PEARSON, aet 53.

DIAGNOSIS: Medullary tumour involving cerebellar tracts on L side.

This conclusion was supported by complete paralysis of Sixth and Seventh cranial nerves on the L side: marked static ataxia which caused patient to fall backwards and to the L. A spontaneous inward deviation of the L arm also supported cerebellar involvement, although the patient was too apathetic for much reliance to be placed on this sign - a marked dysdiadokokinesia, however, lent substance to the diagnosis.

The Caloric reactions were normal - projection accuracy was impossible.

At Post-mortem, a cystic degenerated tumour of the R temporo-sphenoidal lobe was found.

NOTE: These cases illustrate the extreme irrelevance of localizing signs and the difficulty of correlating the vestibular responses with the ultimate lesion, viz., in Case I.

In Case II actual paresis of the L arm due to upward pressure of the tumour on the R rolandic area was confused for cerebellar atonia.

CASE II - PEARSON Contd.

NOTE Contd.

Tumours of the cerebello-pontine angle probably offer the most reliable information as ascertained by the Caloric Tests.

THE CALORIC REACTIONS in :-

(a) The Parkinsonian syndrome of Encephalitis Lithargica.

(b) Paralysis Agitans.

The characteristic features of both diseases are:

1. Attitude, and 2. Rigidity.

(a). POST-ENCEPHALITIS:

Examination of over 20 cases has revealed a phenomenon which is present to a varying degree in all of them, viz., a diminution or absence of responses from the vertical canals tract of fibres which pass along the dorsal aspect of the pons near the middle line in close proximity to the posterior longitudinal bundle.

In the head back position, the responses in the majority of cases show no deviation from the normal, thus indicating non-interference with the horizontal fibres passing via Deiter's nucleus and the inferior cerebellar peduncle. The fact that in this disease there is no deterioration of the kinaesthetic sense, the fibres for which ascend by a similar route would tend to confirm this view.

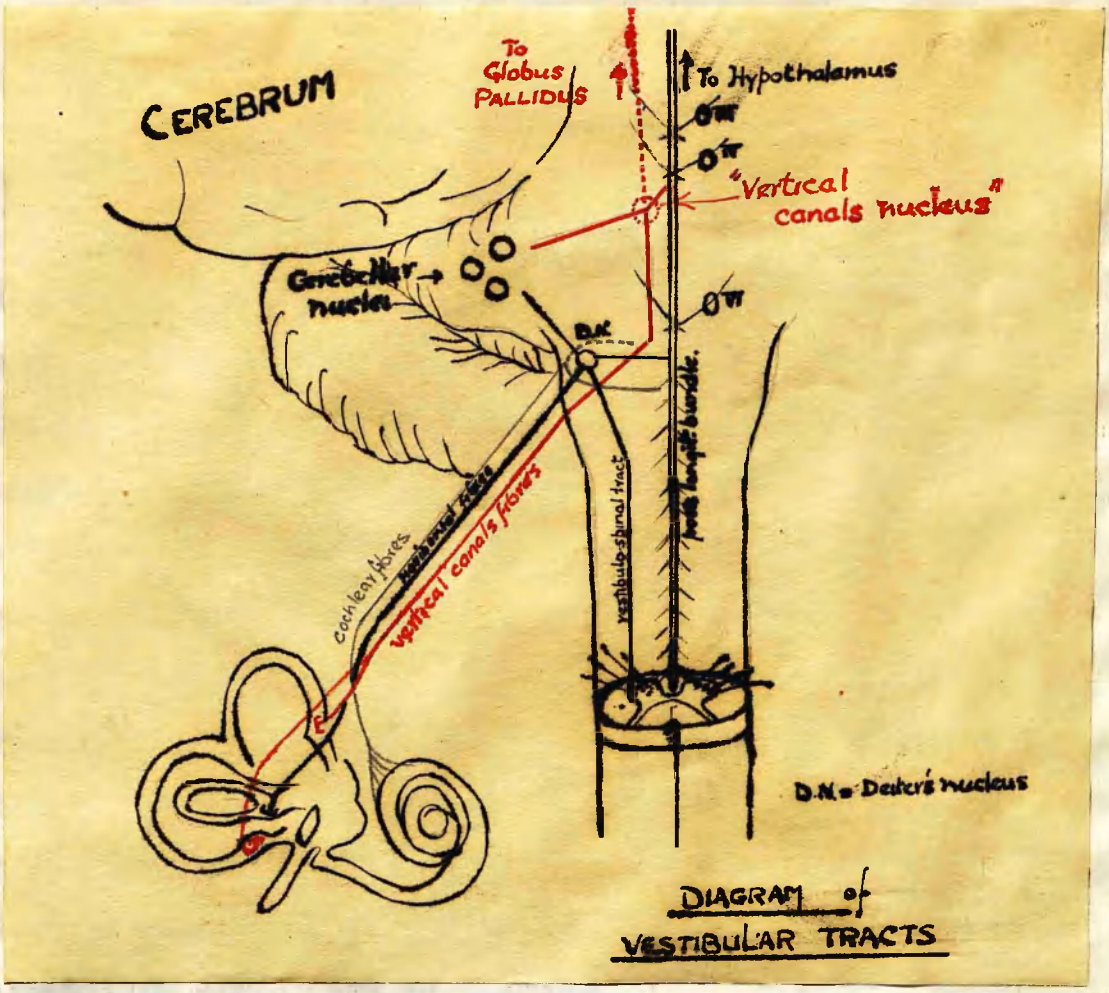

DIAGRAM of VESTIBULAR TRACTS

The degree of depreciation of the vertical fibres corresponds to the extent of the rigidity. When extreme hypertonus is present amounting almost to catatonia, responses are usually absent, whereas in mild types of Parkinsonism there may only be a slight deviation from the normal. Again, and here the value of unilateral aural stimulation is apparent, the degree of rigidity on each side of the body bears a direct relationship to the responses from the labyrinth on the corresponding side.

The nuchal region and shoulder girdles appear to share the brunt of the rigidity so that rotatory movements offer considerable resistance. I venture to suggest that there is an interference with the tonic neck reflexes influenced by the labyrinth of the corresponding side, which is responsible both for the rigidity and also for the typical bowed attitude of head and shoulders in this intractable disease. One of the cases described later makes a fitting illustration.

To capitulate, there would appear to be a "block" in the vestibulo-cerebello-cerebral tracts near the point

of bifurcation of the vertical canal fibres, as yet an undetermined cell nest, into its two terminal divisions - one passing via the middle cerebellar peduncle to the dentate nuclei, the other entering the posterior longitudinal bundle to be connected up with the oculimotor nuclei. It is reasonable to suppose that a "vertical canals nucleus" may lie at this bifurcating point and be of equal co-ordinating importance as Deiter's nucleus. This block probably interferes with the normal cerebellar function whereby muscle tone is regulated, thereby producing a state of hypertonicity. An analogy is seen in an upper motor neuron lesion where the absence of cerebral inhibition gives rise to muscular spasticity (not a hypertonicity).

Dr. Ivy Mackenzie in her masterly treatise on this subject states that "the vestibular nuclei and their associated reflex arcs may become sites of abnormal reaction from stimuli which impinge on them from sources of central origin, and that this abnormal irritation is responsible for the Parkinsonian syndrome."

My observations uphold the view of a basal lesion involving only part of the vestibular tracts, but interfering with the tonic neck reflexes and the anterior horn cells of the spinal cord, particularly in the cervical region.

CASE I. WILLIAM COOKE, aet 20.

HISTORY: Double vision and daily lethargy in April 1924. Six months later, stiffness of the head and limbs supervened with nocturnal insomnia and excessive salivation, which have persisted until admission in April 1926.

WILLIAM COOKE

I. HEAD ERECT.

II HEAD INCLINED TO R. SHOULDER

III. HEAD BACK - MAXIMUM VOLUNTARY EFFORT

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CASE I. WILLIAM COOKE, aet 20, Contd.

EXAMINATION: Typical Parkinsonian attitude, facies and gait. Speech slow and monosyllabic. Complete facial immobility in the absence of paralysis of any cranial nerve. Lachrymation, salivation, infrequent blinking, inability to masticate food were features. Also extreme nuchal and shoulder rigidity and the upper extremities more involved than the lower. Voluntary neck movements were impossible, but when forcibly flexed towards either side the shoulder girdles participated in the movement; c.f. photographs. In addition, a definite nystagmus was induced:-

Head erect (30° forwards) - inconstant vertical nystagmus on looking down.
Head back 60°) Definite vertical nystagmus:
Head inclined to R shoulder) also nystagmus on looking to
Head inclined to L shoulder) the left.

These observations suggest the participation of tonic neck reflexes in the accentuation and even production of vestibular nystagmus - possibly otolithic in part.

COLD CALORIC TEST:

L. no nystagmus to R, head erect in 3 minutes.
Well marked nystagmus, head back with slight falling and past-pointing reactions.

R. no nystagmus to L, head erect in 2½ minutes.
Well marked head back; no falling or past-pointing reactions.

In contrast to this extreme case, many exhibit a delayed response on stimulation of the vertical canals and diminished after-reactions in contra distinction to the well marked reactions in the head-back position.

CASE II. JOHN NOON, aet 35.

This case illustrates the value of the Caloric Test in differentiating the Encephalitic syndrome from atypical Typhoid Fever, which may closely simulate the former disease.

JOHN NOON

I. HEAD ERECT

II. HEAD BACK

CASE II. JOHN NOON, Contd.

HISTORY of an atypical pyrexia associated with lethargy and an amiable delirium.

ON ADMISSION: Facial immobility suggestive of Parkinsonism. Some rigidity of arms and legs, but no nuchal hypertonus. (c.f. photographs taken during convalescence) Abdomen distended but painless, no rash or history of such, spleen not palpable, no diarrhoea.

In favour of the diagnosis of Typhoid were the abdominal distension and a positive Widal Test (agglutination up to 1/500 dilution). There had been T.A.B. inoculation 3-4 years previously, so that the possibility of carrier infection was not remote.

The Caloric Reactions, however, were quite normal for both horizontal and vertical canals, which was against the diagnosis of Encephalitis. This was confirmed by the recovery of facial expression and complete cure.

(b) PARALYSIS AGITANS.

The twelve cases examined by the Caloric Test demonstrate in a remarkable manner the similarity between this syndrome and that of Post-Encephalitis. One case who exhibited marked rigidity and "pill rolling" movements of the hands gave no responses in either position of the head in 5 minutes. The majority, however, showed a depreciation or complete absence of responses from the vertical canals and marked reactions from the horizontal canals. The remarks made in reference to the distribution of the rigidity and its correlation to the degree of vestibular responses in Encephalitis apply to a striking extent in Paralysis Agitans. If the similarity in the facies, attitude and gait of the two syndromes be taken into account, we are forced to the belief that we are

dealing with analogous pathological conditions differing only in their age incidence. It is true, "pill rolling" movements are rarely seen in Post-Encephalitis, but the hand postures, especially in advanced stages, closely simulate those of Paralysis Agitans.

In conclusion, I venture to suggest that there is a degeneration of a tract of fibres hitherto undetermined, connecting up the large motor cells of the globus pallidus system with the vertical canal fibres of the vestibular nerve and its nuclei, giving rise to a pathological syndrome which is virtually the counterpart of the Parkinsonian complex of Encephalitis Lithargica.