MODERN OTO-NEUROLOGY*

THE PROGRESS FROM ACOUSTIC-VESTIBULAR STUDIES TO CRANIAL-NERVE DIAGNOSIS

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In a paper dated 1934, the year in which E. Busch established the first neurosurgical department in Denmark, E. Busch and K. Brøste proposed close co-operation between the neurosurgical department and an oto-laryngologist interested in neurology. After returning from a study tour in England H. K. Kristensen in 1950 took up the question of this cooperation, and since that time all patients with suspected intracranial disease admitted to the neurosurgical department have had an otoneurological examination.

At the outset our interest was mainly in the clinical relationship between neurology and the acoustic-vestibular system, as in the classical otoneurology established by the Vienna School. Our outlook was broadened by later work, especially by English otoneurologists.

Gradually we found that the otolaryngologist was especially equipped to make an exact examination of other cranial nerves, anatomically related to the field of his speciality. Previously these examinations had often been neglected in clinical work.

Owing to lack of space and considering how well modern acoustic vestibular examinations are known, this paper deals only with the examination of the other cranial nerves in which we are particularly interested, i.e. the olfactory, trigeminal, facial, glossopharyngeal, vagus, accessory and hypoglossal nerves.

In reaching his conclusions from the findings, the otolaryngologist concerned with these problems (also called the otoneurologist) should consider the patient's history as well as the results of other examinations, especially neurological, neuro-ophthalmic, radiographic and electroencephalographic studies. In this way, modern oto-neurology takes its place as a natural development in a field where great and inspiring teamwork has overcome many difficulties.

The Olfactory Nerve

For several years we have used the Elsberg (1935) method, Fig. 1. The principle of this is a blast-injection of a known volume of an air

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mixture, saturated with the odorous substance, towards the olfactory region during apnœa. This gives the threshold value on the left and right side in ml. Contrary to Elsberg who uses the minimum identifiable

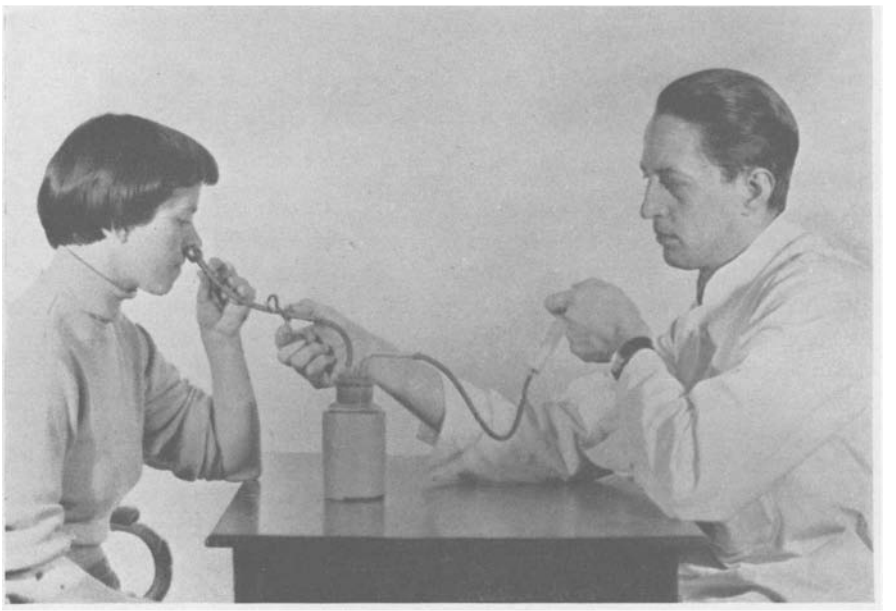


FIG. 1.
Blast-Olfactometer.

odour (MIO) we use the minimum perceptible odour (MPO), which is a more exact expression of the sense of smell than the minimum identifiable odour, the latter depending very much on the patient's previous knowledge of the test substance.

Difference in M.P.O.	No.	Difference in fatigue	No.
≦ 1 ml.	70	≦ ½ min.	71
≧ 2 ml.	22	≧ 1 min.	21
Not comparable as the threshold is over 30 ml.	8	Not comparable; the threshold being too high for determination ..	8
Total ..	100	Total ..	100

FIG. 2.

Using a special technique, the stream-injection (Elsberg, 1935) it is possible to measure the olfactory fatigue, i.e. the period elapsing from the time the sense of smell has been fatigued by a given stimulus until the previous sensitivity has been regained.

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Determining the minimum perceptible odour and the olfactory fatigue in 100 normal persons of all ages for coffee (a pure olfactory) and citral (a combined olfactory—and trigeminal stimulating substance) we have shown that the thresholds decrease with age (presbyosmi) as known before while the fatigue did not increase with age (Zilstorff-Pedersen, 1953).

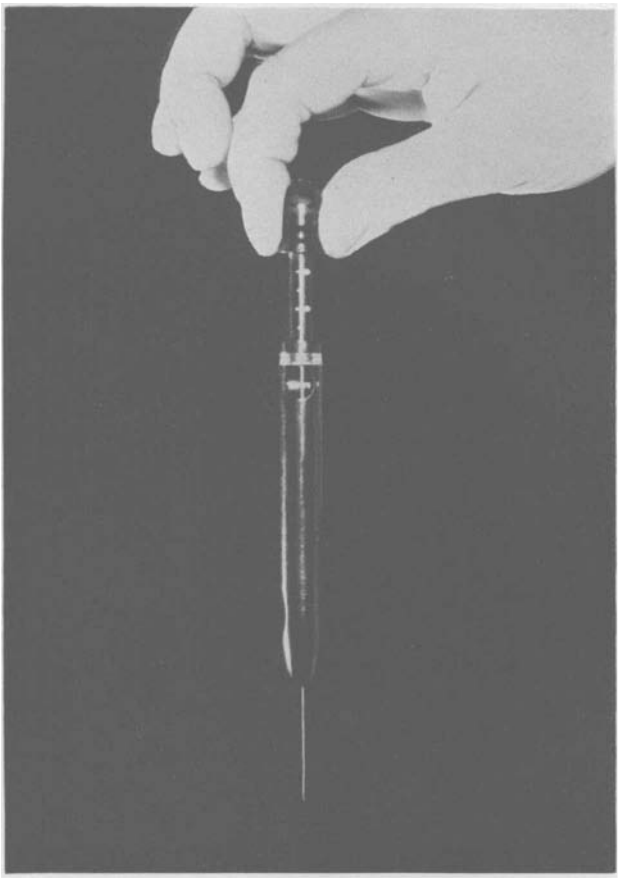


FIG. 3.
Corneasensibilometer.

By the oto-neurological examination, the difference in the threshold and fatigue from side to side is of much greater value than the absolute threshold values. Fig. 2 shows what from our normal material seems pathological (Zilstorff-Pedersen, 1953, 1957).

An exact examination of the air-passage from the nostril to the olfactory region is very essential to exclude hyposmia caused by alterations in this passage of the smelling substance and it is possible, just as in hearing

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defects, to distinguish between conductive and perceptive hyposmia, the latter being of the greater oto-neurological interest.

By combining the examinations of the thresholds and fatigue it is often possible to localize an intracranial process affecting the olfactory pathways (Elsberg, 1935). The principle in this is, that the fatigue is prolonged by processes affecting the anterior part of the temporal lobe (uncus) where



FIG. 4.
Apparatus for Quantitative Examination of the Naso-Lacrimal Reflex.

the olfactory fibres end, while the threshold is normal. Processes in the bottom of the anterior cranial cavity affecting the bulbus and the tractus olfactorius raise the threshold while the fatigue is normal. This refers in all cases to the same side. Combinations are of course possible in large disease processes.

A diminished smell is a very early sign, often the first, caused by tumours situated basically in the anterior cranial cavity.

Distinction between real and functional impairment of the sense of smell is possible by several methods. We have especially used the distinction between pure olfactory and combined olfactory and trigeminal stimulating substances and the psycho-galvanic method described by Semeria (1956). This distinction is especially indicated in post-traumatic smell impairment.

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The Trigeminal Nerve

Besides the usual examinations of the sensitivity and the motor function we use: (1) Quantitative examination of the corneal sensitivity by the corneasensibilometer of Boberg-Ans (1955). Fig. 3. This consists of a nylon thread in a special holder facilitating variation of the length of the thread and thereby the stimulus. Diminished corneal sensitivity is often

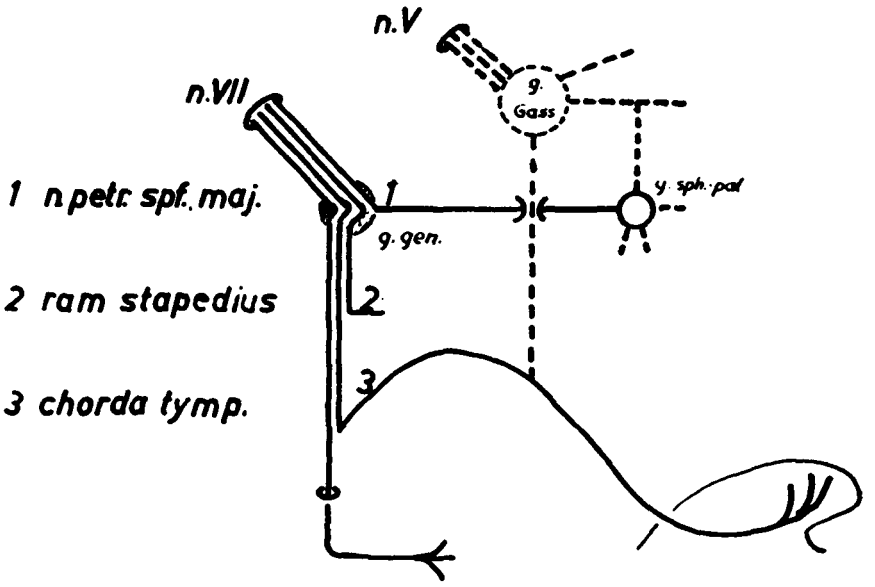


FIG. 5.
Diagram of nerve pathways of importance in the topic diagnosis of peripheral facial nerve palsy.

an early sign in cerebello-pontine angle tumours and is early discovered by this method. The apparatus too is suitable for examination of the sensitivity e.g. in the face and the oral cavity. (2) Quantitative examination of the naso-lacrimal reflex (Zilstorff-Pedersen, 1959). Fig. 4. By blowing a strong trigeminal stimulating substance i.e. benzine from Elsberg's olfactometer through the nasal cavity in a stream of 500 ml./minute in exactly 30 seconds and at the same time placing Schirmers filter paper in the homolateral eye for 1 minute it is possible to measure the secretion of tears in mm. Differences from side to side greater than 20 per cent. are pathological in accordance to our normal material.

The first and second branches of the trigeminal nerve form the afferent path of this vegetative bulbar reflex. Its efferent path proceeds from the superior salivary nucleus along the facial nerve i.e. the intermedius nerve to the geniculate ganglion, where the nerve fibres leave the intermedius

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nerve and *viâ* the spheno-palatine ganglion continue to the lacrimal nerve and the lacrimal gland. Quantitative examinations of the naso-lacrimal reflex, partly after the division of the facial nerve between the nucleus and the geniculate ganglion, and partly after retroganglionic division of the

Taste-substance	In 100 cc. of water		
	gm.	gm.	gm.
Cane sugar	4·0	10·0	40·0
Sodium Chloride	2·5	7·5	15·0
Citric acid	1·0	5·0	10·0
Quinine mono-hydrochloride ..	0·075	0·5	1·0

FIG. 6.

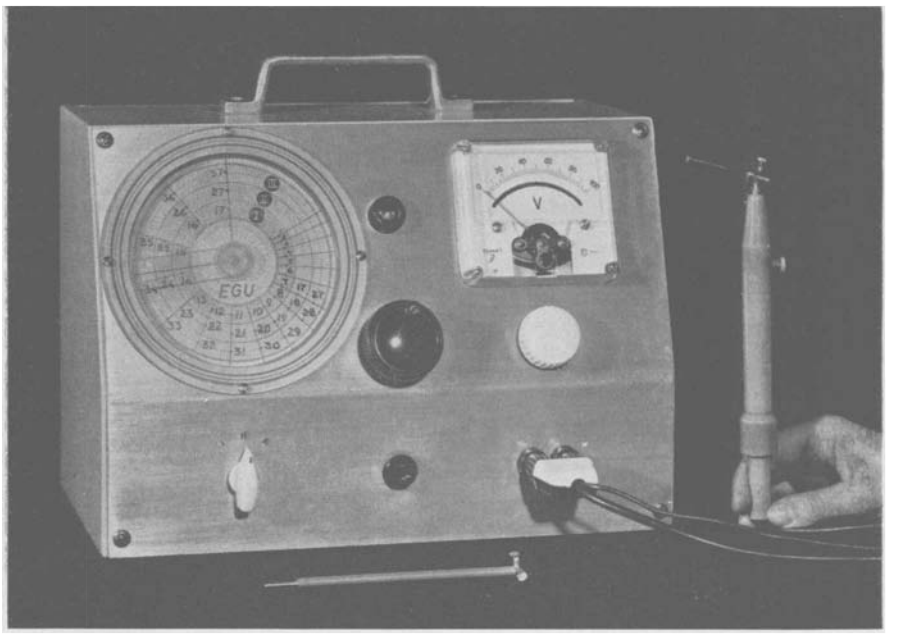


FIG. 7.
Electrogustometer.

trigeminal nerve, significantly shows that the reflex-arc is as described here. The otoneurologic interest in quantitative examination of the naso-lacrimal reflex is in diseases affecting the reflex-arc i.e. primarily space-filling intra-cranial diseases affecting the trigeminal nerve central to the semilunar ganglion, e.g. meningioma in the middle cranial fossa; diseases of the brain stem around the facial and trigeminal nuclei, and diseases of

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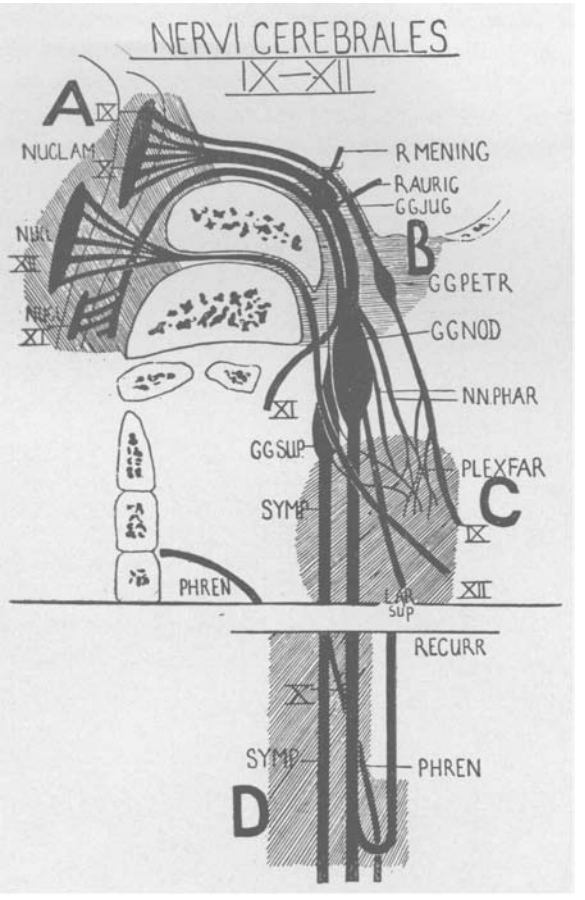


FIG. 8.
Syndromes of Vocal Cord Paralysis (after Burger).

Syndrome	Paralyses in Domain of Nerves	Vagus Lesion
A. Bulbar	IX, X, XI, XII (V, VI, VII, VIII)	High vagus paralysis
B. Jugular foramen	IX, X, XI, XII sympathetic	
C. Parapharyngeal space	IX, X, XII, (VII) sympathetic	Deep vagus paralysis
D. Arch of aorta	X, phrenic, sympathetic	Recurrent laryngeal nerve, or deep vagus paralysis

FIG. 9.

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the facial nerve between the superior salivary nucleus and the geniculate ganglion e.g. cerebellopontine angle tumours, in most cases acoustic neurinomas.

The last mentioned point leads us to the examination of the facial nerve. Fig. 5. Besides the examination of the nasolacrimal reflex we always

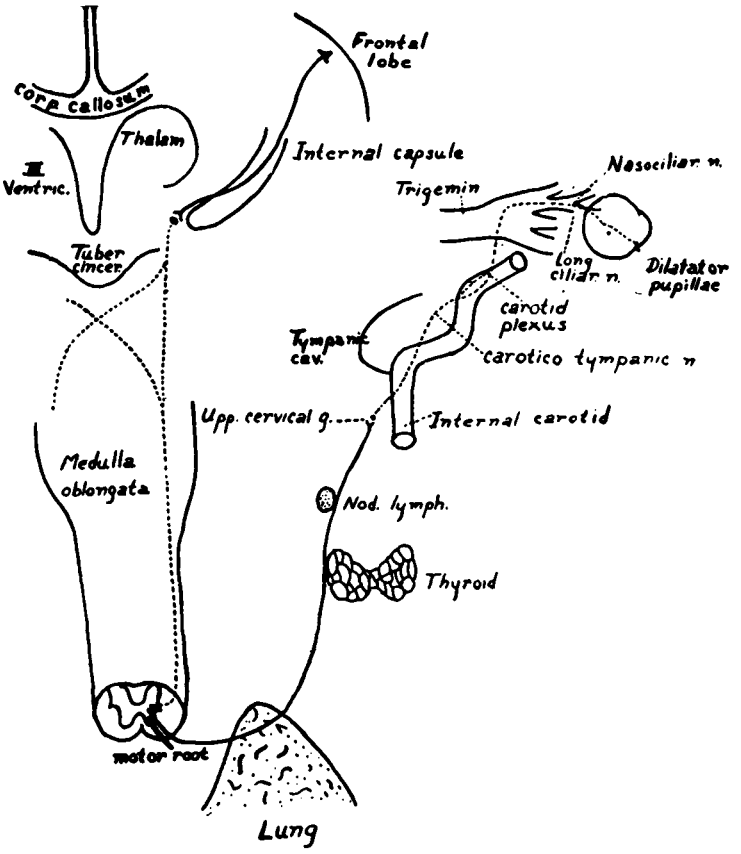


FIG. 10.
The Pathway of the Sympathetic Nerve fibre to the Eye.

use examinations of the stapedius-reflex and quantitative examination of taste on the homolateral anterior $\frac{2}{3}$ of the tongue. It is essential to know that impairment of the taste and the nasolacrimal reflex are the first signs to occur, when a cerebello-pontine angle tumour affects the facial nerve, because the intermedius nerve lies between the acoustico-vestibular and the facial nerve, just as the name intermedius tells us. An examination of the naso-lacrimal reflex and the taste is therefore of great importance,

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combined with the acoustico-vestibular examination, in the very important early diagnosis of these tumours.

The sense of taste is examined by Börnstein's (1940) semiquantitative method, using 3 different concentrations of the 4 basic taste-qualities. Fig. 6. The tongue shall be protruding during the test and the test-

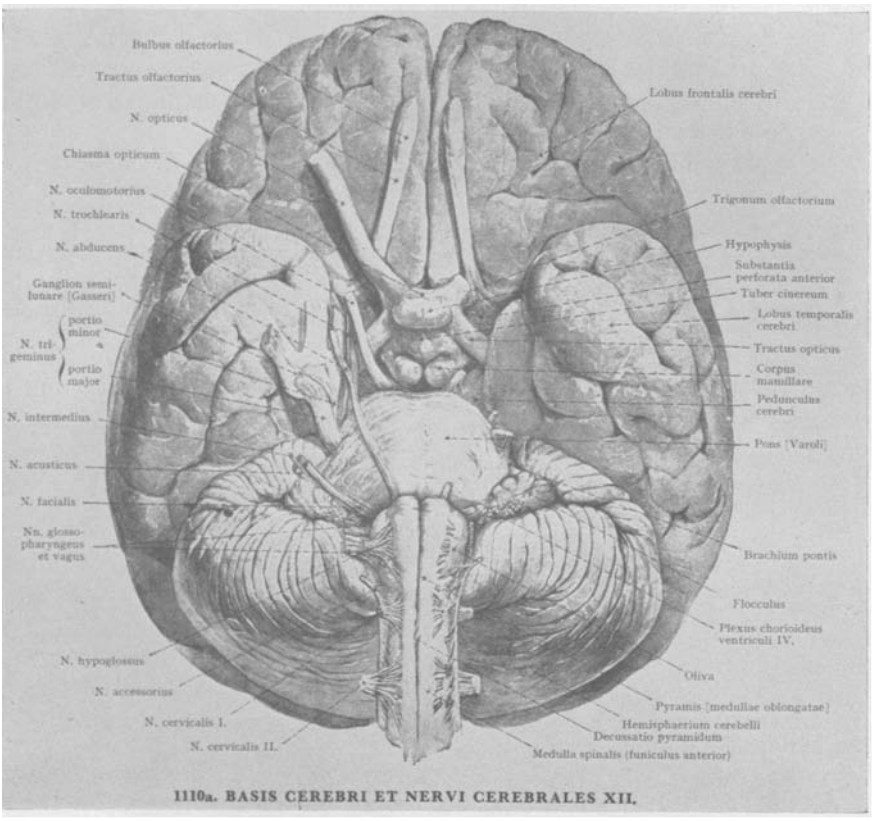


FIG. 11.

(Reproduced from W. Spalteholz: Handatlas Und Lehrbuch der Anatomie des Menschens, Band 2, 1954.)

substance is dripped on the part of the tongue, that is to be tested. The subject is then asked to point to a paper, where the words water, sweet, salt, sour and bitter are written. Much better is the galvanic examination, and we use Krarup's (1957) method, giving the value in relative electrogustometric units. Fig. 7.

The stapedius reflex is examined by the acoustic impedance method, mechanical bridge Metz (1946), Jepsen, (1955), or electro-acoustic bridge Terkildsen and Scott Nielsen (1960).

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Only a few points concerning the examination of the IXth, Xth, XIth and XIIth cranial nerves are noted.

In associated vocal cord paralyses many different syndromes have been described, but we prefer Burger's (1934) simple classification in four syndromes, Fig. 8. A. Bulbar, B. Jugular foramen, C. Parapharyngeal space, D. Arch of Aorta, which at the same time indicate the anatomical site of the pathological process. As shown in the Fig. 9 an examination of the cranial sympathetic system (total or partial Horner's syndrome) is necessary. Horner's syndrome alone is of importance in otoneurology, when we are looking at the long pathways for the sympathetic nerve fibres from the brain stem to the eye. Fig. 10.

In accordance with our experience taste examination of the posterior $\frac{1}{3}$ of the tongue is the best method for testing the function of the glosso-pharyngeal nerve, and the Börnstein method is better for this than the galvanic method, which is more difficult to apply at this place.

An exact examination of sensitivity in the pharynx and larynx is possible by the laryngologist, but is often neglected.

Fig. 11. Lastly looking at a view of the base of the cerebrum—it is easy to see how the oto-neurologist has expanded his field, mainly from the posterior cranial cavity to the middle and anterior cranial cavity and in this way has gained closer co-operation with neurology.

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