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Acoustic neuromas

(Diagnostic value of testing the function of the trigeminal nerve, the cerebellum and optokinetic nystagmus

by

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Although the major diagnostic emphasis today is placed on testing the function of the VIIIth cranial nerve in patients with acoustic neuromas, testing for involvement of the facial-intermedius and trigeminal nerves as well as testing for cerebellar function and optokinetic nystagmus may still deserve their place in the diagnostic armamentarium applied to these patients. In a previous paper (Thomsen *et al.*, 1981) we have published our findings regarding the facial-intermedius nerve in a group of 59 patients with acoustic neuromas. We wish here to present our findings concerning the trigeminal nerve, the cerebellum and optokinetic nystagmus.

Previous investigations

a. The trigeminal nerve

Table I depicts the involvement of the Vth and VIIth nerves as described in previous publications. Except in the series of Pulec and House (1964) and of Thomsen and Zilstorff (1975), the trigeminal nerve was more frequently affected than the facial-intermedius nerve. Affection of the trigeminal nerve consists in reduced facial or corneal sensibility. Lundborg (1952) found this affection in 90 per cent of 300 patients with acoustic neuromas; however, in medium-sized tumors, i.e. in those less than 25 mm in diameter, it was found in only 62 per cent. Cleveland and Garvey (1953) found that all their 35 patients had involvement of the Vth nerve, all their tumors being larger than a walnut. Olivecrona (1967), having operated on a total of 415 patients with acoustic neuromas, found that the Vth nerve was affected in 94 per cent of patients with large tumors, but only in 54 per cent of those in whom the tumor measured less than 20 mm.

b. Cerebellum

In the publications depicted in Table I, the frequency of cerebellar involvement varied between 62 per cent (Pool, 1970) and 95 per cent (List, 1933). Thomsen (1976) found cerebellar symptoms in 83 per cent of 105 neuromas larger than 25 mm.

c. Optokinetic nystagmus

Only a few publications contain information about the presence of pathological optokinetic nystagmus among patients with acoustic neuromas. Enoksen (1956) described 4 patients in whom pressure on the brain-stem had elicited a defective horizontal optokinetic nystagmus, while Simon and Gay (1964) described 2 cases of abnormal optokinetic nystagmus, with a decrease towards the side on which the neuroma was located. Tos *et al.* (1973) found abnormal horizontal optokinetic nystagmus in 6 (35 per cent) of 17 patients with acoustic neuromas. The tumors in two of these patients were between 20 and 40 mm in diameter, while in the other 4 patients they were larger than 40 mm. In all cases an impression was noticed in the pons during operation, and in 5 cases the tumor was firmly adherent to the pons, causing the surgeon to leave behind some of the tumor capsule. This occurred in 50 per cent of the large tumors. An abnormal vertical optokinetic nystagmus was found in the 4 patients with tumors larger than 40 mm.

Thomsen and Zilstorff (1975) found that only 10 per cent of patients with tumors larger than 25 mm had defective optokinetic nystagmus. However, they found that 85 per cent of 125 tumors had caused an anatomical impression in the pons, as noted at surgery, and they concluded that the brain-stem was affected anatomically before a significant decrease in the optokinetic nystagmus took place. This indicates that a decrease in the optokinetic nystagmus is indicative of serious compression of the brain-stem.

Present investigation

Material

The material contains 29 males, age 24 to 74 years, mean age 50 years, and 30 females, age 26 to 69 years, mean age 49 years. The age distribution among the two sexes was similar: 24 per cent were below 40 years old, 52 per cent between 40 and 60 years, and 24 per cent more than 60 years old. One patient was 74 years old. The series includes all patients operated on in our department from 1976 to 1978. In only nine cases, at the beginning of the period, was it necessary to perform an additional suboccipital removal, while in 50 patients total removal was effected by the translabyrinthine approach.

Methods

a. Trigeminal nerve

The corneal sensibility was examined by means of a quantitative cornea sensibilometer (Boberg-Ans, 1955). The principle of this instrument is that a nylon thread, the length of which can be varied, touches the cornea outside the visual field of the patient. The patient indicates at what length the touch can be recognized. The shorter the thread the less sensitive is the cornea, and the length of the thread indicates directly, by means of a conversion table, the pressure in milligrams necessary to elicit recognition.

The facial sensibility was examined with a needle for pain and with a cotton stick for touch.

b. Cerebellum

To investigate cerebellar function the Romberg test, gait examination (forwards, backwards, open and closed eyes) and examination for dysdiadochokinesis were performed.

c. Optokinetic nystagmus

This was evaluated with a manually rotated cylinder with black and white stripes, at a distance of 40–50 cm from the patient's eyes. The diameter of the cylinder was 10 cm, and the width of the stripes 4 cm. The angular velocity was varied in order to elicit a response in the best possible way. In cases of doubt the patients were examined by an electric drum, with constant angular velocities of 72°, 180° and 360° per second.

All examinations were performed by the same physician.

Results

a. Pre-operative function of the trigeminal nerve

The corneal sensibility was affected in 47 per cent of patients with tumors larger than 40 mm in diameter, but in only 22 per cent of the total series (Table II). This increase in frequency with increase in tumor size is statistically significant. The facial sensibility was reduced in 37 per cent of patients with tumors larger than 40 mm in diameter, but in only 17 per cent in the total series, and this difference is likewise statistically significant. There was no significant difference between the frequency of pathological corneal sensibility and the frequency of pathological facial sensibility.

TABLE I

FREQUENCY OF INVOLVEMENT OF THE TRIGEMINAL, FACIAL AND INTERMEDIUS NERVES IN PREVIOUSLY PUBLISHED SERIES OF ACOUSTIC NEUROMAS

Author	Year	Number of tumors	Involvement of Trigeminal %	Facial %	Intermedius %
List	1933	175	87	59	?
Revilla	1947	165	86	48	?
Johnsen and Kristensen	1949	81	85	32	?
Lundborg	1952	300	90	55	11
Cleveland and Garvey	1953	35	100	?	?
Graf	1955	100	92	73	?
Rembold and Tönnis	1958	234	84	61	20
Olivecrona	1967	415	94	60	?
Pulec and House	1964	53	57	15	69
Pool	1970	55	82	47	16
Thomsen and Zilstorff	1975	125	59	19	82

TABLE II

FREQUENCY OF INVOLVEMENT OF THE TRIGEMINAL NERVE IN RELATION TO TUMOR SIZE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

Decreased trigeminal function	Intrameatal no = 1	1–25 mm no = 27	26–40 mm no = 12	> 40 mm no = 19	All tumors no = 59
Corneal sensibility		3 (11%)	1 (8%)	9 (47%)	13 (22%)
			$p < 0.01$		n.s.
Facial sensibility		2 (7%)	1 (8%)	7 (37%)	10 (17%) n.s.
			$p < 0.01$		n.s.
Corneal *and* facial sensibility				6 (32%)	6 (14%)
					n.s.
Corneal and/or facial sensibility		5 (19%)	2 (17%)	10 (53%)	17 (29%)
			$p < 0.01$		

χ^2-test

Six patients had affection of both corneal and facial sensibility, and all these patients had tumors larger than 40 mm in diameter (Table II). If only one of the symptoms of trigeminal affection was evaluated, this was found in 17 patients (29 per cent). Among patients with tumors larger than 40 mm in diameter, 10 patients (53 per cent) were affected. Again a statistical correlation could be established between Vth nerve involvement and tumor size.

In examining the facial sensibility, affection of both touch and pain coincided.

The motor function of the trigeminal nerve was found to be normal in all patients.

In Table III, the trigeminal pathology is related to the patho-anatomical findings at surgery, i.e. pressure and/or adhesions of the tumor to the trigeminal root. This evaluation of the patho-anatomical conditions was made blindly on the basis of drawings made immediately after the operation. Among patients with normal trigeminal function, nine (21 per cent) were found with pressure on the trigeminal root, while among the 17 patients with pathological trigeminal function, 12 (59 per cent) had pressure on the root. This difference is statistically significant. However, it must be emphasized that anatomical adherence and pressure on the trigeminal root in this series occurred in 9 cases in whom a pre-operative affection of function could not be registered with our present technique.

TABLE III

RELATION BETWEEN THE PRE-OPERATIVE TRIGEMINAL FUNCTION AND THE PATHO-ANATOMICAL FINDINGS IN THE CEREBELLO-PONTINE ANGLE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

Trigeminal function	no	Pressure on trigeminal root no	%
Normal	42	9	21
		$p < 0.001$	
Decreased	17	12	59
Total	59	21	36

χ^2-test

b. Post-operative improvement of trigeminal function

Corneal sensibility was reduced pre-operatively in seven patients. Post-operatively it was normal in six of these patients, while in one patient it remained decreased (Table IV). This patient was a 54-year-old female with a 50 mm large tumor which was completely removed via a trans-labyrinthine approach. The tumor was located medially, and adherent to the trigeminal root. There was no tumor tissue in the internal acoustic meatus and tomography of the meatus was normal. In four patients, the only trigeminal symptom was a pathological facial sensibility, and all of these patients had normal function post-operatively. In six patients, both facial and corneal sensibility was decreased before the operation; four of these had normal conditions post-operatively, while two still had reduced function (Table IV). Altogether 17 patients (35 per cent) had affection of one of the functions pre-operatively; 14 of these were normal post-operatively, while only three patients had a lasting affection of trigeminal nerve function, with decrease of both corneal and facial sensibility.

Among 38 patients who had normal pre-operative function, 35 had normal function after the operation, while three patients had reduced corneal and facial sensibility. The frequency of trigeminal affection was significantly lower post- than pre-operatively (Table IV).

TABLE IV

COMPARISON BETWEEN THE PRE-OPERATIVE AND POST-OPERATIVE FUNCTION OF THE TRIGEMINAL NERVE IN 55 PATIENTS WITH ACOUSTIC NEUROMAS, RE-EXAMINED 1 YEAR AFTER THE OPERATION. CS = CORNEAL SENSIBILITY, FS = FACIAL SENSIBILITY

Pre-operative function		Post-operative trigeminal function			
		Normal	Decreased		
			CS alone	FS alone	CS + FS
	no	no	no	no	no
Decrease CS only	7	6			1
Decrease FS only	4	4			
Decrease CS + FS	6	4			2
Decrease CS and/or FS	17 (35%)	14 (25%)			3 (5.5%)
Normal	38 (65%)	35 (65%)			3 (5.5%)
Total	55	49			6 (11%)
		$p < 0.01$			

χ^2-test

TABLE V

FREQUENCY OF CEREBELLAR SYMPTOMS RELATED TO TUMOR SIZE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

Decreased cerebellar function	Tumor size: Intrameatal no = 1	1–25 mm no = 27	26–40 mm no = 12	> 40 mm no = 19	All tumors no = 59	
1. Romberg		2	1	5	8 (14%)	
			$p < 0.05$		$p < 0.05$	
2. Gait disturbance		5	2	11	18 (31%)	n.s.
			$p < 0.01$		$p < 0.05$	
3. Dysdiadochokinesis		3	2	4	9 (15%)	
			n.s.			
1+/or 2+/or 3		6 (22%)	2 (17%)	11 (58%)	19 (32%)	
			$p < 0.01$			

χ^2-test

TABLE VI

FREQUENCY OF CEREBELLAR SYMPTOMS IN THE EXISTING COMBINATIONS RELATED TO TUMOR SIZE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS (1 = ROMBERG, 2 = GAIT DISTURBANCE, 3 = DYSDIADOCHOKINESIS)

Cerebellar symptom	Tumor size: Intrameatal no = 1	1–25 mm no = 27	26–40 mm no = 12	40 mm no = 19	All tumors no = 59
1 only					0
2 only		3 (11%)		5 (26%)	8 (14%)
3 only		1 (4%)			1 (2%)
1+2				2 (11%)	2 (3%)
1+3					0
2+3			1 (8%)	1 (5%)	2 (3%)
1+2+3		2 (7%)	1 (8%)	3 (16%)	6 (10%)
			n.s.		
1+/or 2+/or 3		6 (22%)	2 (17%)	11 (58%)	19 (32%)
			$p < 0.01$		

χ^2-test

Among the three patients who had affection of the trigeminal nerve both pre- and post-operatively, two patients (with tumor sizes of 45 and 50 mm) were operated through the translabyrinthine approach only, while the third had an additional sub-occipital operation, with removal of a tumor measuring 60 mm in diameter. All of these tumors were difficult to remove.

No patient had decreased motor function of the trigeminal nerve post-operatively.

c. Pre-operative affection of the cerebellum

A significant correlation was demonstrated between increasing tumor size and the presence of a positive Romberg and disturbance of gait (Table V). However, no significant relation between dysdiadochokinesis and tumor size could be established.

One of the three cerebellar symptoms was found in 19 patients (32 per cent), of whom 11 (58 per cent) had tumors larger than 40 mm in diameter.

Six patients (10 per cent) presented all three symptoms (Table VI).

d. Post-operative cerebellar symptoms

Six patients had post-operative cerebellar symptoms, in the form of gait disturbances. One of these patients had a translabyrinthine operation only, with removal of a 50 mm large tumor, and this patient did not have cerebellar symptoms pre-operatively. The other five patients also had a sub-occipital operation, and one of these patients had had no signs of cerebellar affection before surgery.

e. Optokinetic nystagmus

A significant increase of optokinetic nystagmus could be correlated with increase in tumor size (Table VII). Nine patients with tumors larger than 40 mm had a defective optokinetic nystagmus while only one patient with a tumor between 26–40 mm had this defect. All of these patients had a defective horizontal optokinetic nystagmus, with a decreased reaction towards the tumor side, while two patients had also a defective vertical optokinetic nystagmus. The tumor size in the latter two patients was 40 and 60 mm respectively.

Anatomical impression in the pons was found at surgery in 31 of 59 patients (53 per cent), increasing significantly with increasing tumor size (Table VIII). In only two cases was the tumor less than 25 mm. In Table IX, the affection of the optokinetic nystagmus is

TABLE VII

RELATION BETWEEN AFFECTION OF OPTOKINETIC NYSTAGMUS AND TUMOR SIZE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

	Tumor size				
Optokinetic nystagmus	Intrameatal no = 1	1–25 mm no = 27	26–40 mm no = 12	> 40 mm no = 19	All tumors no = 59
Decreased			1 (8%)	6 (32%)	7 (12%)
Abolished				3 (16%)	3 (5%)
Decreased or abolished			1 (8%)	9 (47%)	10 (17%)
			$p < 0.01$		

χ^2-test

TABLE VIII

RELATION BETWEEN TUMOR SIZE AND PATHO-ANATOMICAL FINDINGS IN THE CEREBELLO-PONTINE ANGLE IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

	Tumor size				
Tumor impression in pons	Intrameatal no = 1	1–25 mm no = 27	26–40 mm no = 12	> 40 mm no = 19	All tumors no = 59
Impression		2	10	19	31 (53%)
No impression	1	25	2	0	28 (47%)
		$p < 0.01$			

χ^2-test

TABLE IX

RELATION BETWEEN AFFECTION OF OPTOKINETIC NYSTAGMUS AND TUMOR IMPRESSION IN PONS IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

Impression in pons	Optokinetic nystagmus		
	Normal		Decreased/ abolished
No impression	28		0
		$p < 0.001$	
Impression present	20		10

χ^2-test

related to the presence of anatomical impression in the pons at operation. All patients with a defective optokinetic nystagmus had an anatomical impression in the pons while, among the remaining 48 patients with normal optokinetic nystagmus, 20 had such an impression in the pons. There was thus a significant correlation between the pathology of the optokinetic nystagmus and the impression in the brain-stem.

f. Post-operative optokinetic nystagmus

Only two patients had a defective optokinetic nystagmus post-operatively. In both cases this was a defective horizontal optokinetic nystagmus, with decreased function towards the operated side, without accompanying defects of the vertical optokinetic nystagmus. In both cases the tumor was larger than 40 mm in diameter, and in both cases a suboccipital operation had been performed.

g. Post-operative symptoms after translabyrinthine and suboccipital surgery

Fifty patients had only translabyrinthine surgery, while nine patients had an additional suboccipital removal of the tumor (Table X). In this table the occurrence of affection of the trigeminal nerve, of the cerebellum and of the optokinetic nystagmus are pooled.

Thirty-nine patients with only translabyrinthine surgery had tumors smaller than 40 mm in extra-meatal size, mean 23 mm. A total of 13 of these patients had pre-operative symptoms, while only one had post-operative symptoms. This patient had decreased corneal sensibility after removal of a neuroma measuring 26 mm.

There were 11 patients with only translabyrinthine surgery in whom the tumor was larger than 40 mm, with a mean of 47 mm in extrameatal diameter. Eight of these had pre-operative symptoms, while only two had symptoms one year after the operation.

The nine patients who had an additional suboccipital operation had a mean tumor size of 51 mm. Seven patients had pre-operative symptoms from the trigeminal nerve, cere-

TABLE X

COMPARISON BETWEEN TRANSLABYRINTHINE AND COMBINED TRANSLABYRINTHINE/SUBOCCIPITAL REMOVAL OF ACOUSTIC NEUROMAS WITH REGARD TO PRE-OPERATIVE AND POST-OPERATIVE AFFECTION OF EITHER THE TRIGEMINAL NERVE, THE CEREBELLUM OR THE OPTO-KINETIC NYSTAGMUS

Operation	Group no	Tumor size Mean (mm) (range)	Symptoms Preoperative +	÷	Postoperative +	÷	
Translabyrinthine	≦ 40 mm 39	23	13			13	
		(0–40)		26	1	25	
	< 40 mm 11	47	8		2	6	
		(41–55)		3		3	$p < 0.01$
Suboccipital	9	51	7		6	1	
		(30–70)		2	1	1	
	59	32	28	31	10	49	

χ^2-test

bellum or optokinetic nystagmus, and six of these patients still had symptoms post-operatively.

The frequency of post-operative symptoms from the trigeminal nerve, the cerebellum and the optokinetic nystagmus was significantly lower among patients operated only via the translabyrinthine approach and with a tumor size larger than 40 mm in diameter, compared with patients who had a supplementary suboccipital operation and in whom the tumor size did not deviate significantly from that among the 11 patients with only translabyrinthine surgery (Table X).

Discussion

As a rule, acoustic neuromas arise from the vestibular part of the VIIIth cranial nerve. The growth usually begins in the internal acoustic meatus, which gradually becomes filled. With few exceptions the tumour thereafter grows through the porus into the cerebello-pontine angle. Considering the anatomical conditions and relations in the meatus and in the cerebello-pontine angle, it is understandable that the first symptoms from the tumor are acoustic and vestibular. Theoretically, the facial and intermedius nerves should be affected at the same time, while the cerebellum, the trigeminal nerve and the brain-stem, in that order, should be affected when the tumor begins to press upon these regions.

In previously cited series (Table I) it was suggested that, next to the VIIIth cranial nerve, the trigeminal nerve was the nerve most frequently affected in patients with acoustic neuromas. In evaluating the facial nerve function, these authors have evaluated the motor part alone and have not included the intermedius nerve. As mentioned in a previous publication (Thomsen *et al.*, 1981), it has been established both in animal experiments and in investigations in humans, that the motor (facial nerve) fibres are less sensitive to pressure than the sensory fibres (intermedius nerve). This notion is supported by more recent studies (Pulec and House, 1964; Sheehy, 1968; Thomsen and Zilstorff, 1975), in which it was found that the intermedius nerve function was more frequently affected than the function of the trigeminal nerve. This is also in accordance with the results from this material, which showed (Table XI) that the nervus intermedius was significantly more frequently affected than the trigeminal nerve, optokinetic nystagmus and motor facial function. There is a tendency towards a more frequent affection of the intermedius nerve than of the cerebellum.

The corneal and/or facial sensibility was affected in 29 per cent of all patients, and in 53 per cent of patients with tumors larger than 40 mm (Table II), while the motor part of the trigeminal nerve was not affected in any case. These findings reflect the same relation as between affections of motor and sensory function in the facial-intermedius nerve, and they indicate that the motor fibres are more resistant than the sensory fibres. This has also been proposed by Cleveland and Garvey (1953). In addition, it must be stressed that the motor fibres of the trigeminal nerve (in the trigeminal root in the angle) are protected by the sensory part, rendering an affection of the motor function even more unlikely.

Corneal sensibility was more frequently affected than facial sensibility. The reason for this might be that the cornea has a very limited nuclear representation in the brain-stem compared with the sensory innervation of the face (Rasmussen, 1965).

The majority of patients with pre-operative affections of the trigeminal nerve had normal function post-operatively, indicating that affection by pressure from the tumor is usually a reversible process.

Cerebellar function, which is that of co-ordination in the human motion pattern, is examined with Romberg's test, gait examination and examination for dysdiadochokinesis. None of the patients had an isolated affection by Romberg's test, and only in one case did simultaneous gait disturbances not occur (Table VI).

These affections occurred particularly in patients with tumors larger than 40 mm in diameter, but altogether cerebellar symptoms occurred in 32 per cent of the patients.

TABLE XI

COMPARISON OF FREQUENCY OF PRE-OPERATIVE AFFECTION OF THE INTERMEDIUS NERVE, FACIAL NERVE (MOTOR FUNCTION), TRIGEMINAL NERVE, CEREBELLUM AND THE OPTOKINETIC NYSTAGMUS IN 59 PATIENTS WITH ACOUSTIC NEUROMAS

	no.	Affection %		p-value			
Intermedius	30	51					
			n.s.				
Cerebellum	21	36		< 0.02			
			n.s.				
Trigeminal	17	29			< 0.01		< 0.001
			n.s.			< 0.05	
Optokinetic nystagmus	11	19		< 0.01			
			n.s.				
Facial motor function	6	10					

Only six patients out of 55 had cerebellar affection one year after operation, and all of these had very large tumors, more than 40 mm in diameter. Five of the patients were also operated suboccipitally and four of these had cerebellar symptoms before surgery. One patient who did not have symptoms pre-operatively developed cerebellar symptoms after the suboccipital operation, but this also occurred in one patient who had a trans-labyrinthine removal of a 50 mm large tumor. In all six cases the affection consisted of gait disturbances.

Optokinetic nystagmus can be defined as an eye movement pattern induced by repetitive visual stimuli. The pattern is characterized by slow following movements in the direction of the stimulus and fast movements in the opposite direction. According to Bender and Shanzer (1964), the slow following movements of horizontal optokinetic nystagmus are regulated from the occipital cortex. The efferent pathways run from an optomotor center in the parietal lobe (Broman's zone 18) through the posterior part of the internal capsule, and most of them cross at the level of the superior colliculus. The pathways cross again just above the abducens nucleus (Daroff, 1970) and run thereafter to the horizontal gaze center in the pontine paramedian reticular formation (Cohen *et al.*, 1968). The right occipital lobe directs following movements to the right; the fast phase eye-movements are controlled from area-8 in the frontal lobe (Sanders and Bird, 1970). The descending cortico-fugal pathways run through the internal capsule to the brain-stem. They run ipsilaterally and cross cranially to the abducens nucleus and end likewise in the contralateral pontine paramedian reticular formation. The fronto-bulbar system thus crosses only once. The right frontal lobe directs the fast phase to the left.

The pathways for vertical optokinetic nystagmus are less certain, but are probably organized in a way similar to those for horizontal optokinetic nystagmus. The center for vertical gaze is situated in the mescencephalon (Sanders and Bird, 1970).

Optokinetic nystagmus thus has extensive cerebral connections and may be affected by lesions in the hemispheres, mescencephalon, pons or cerebellum (Frisén, 1973). Lesions in the pons will cause a defective optokinetic nystagmus to the same side as the lesion, while more extensive lesions in the pons and lesions in the mescencephalon will cause a decrease towards both sides (Tos *et al.*, 1972). In this series there was no patient with a defective horizontal optokinetic nystagmus towards both sides.

A defective optokinetic nystagmus has a lower amplitude and/or frequency, and is often irregular. Frequently a combination of these changes is encountered, or there is abolition of optokinetic nystagmus from one stimulus direction and a completely normal response from the opposite. It is therefore rarely a problem to recognize a defective optokinetic nystagmus (Frisén, 1973).

To affect both the horizontal and the vertical optokinetic nystagmus, there must be a diffuse lesion in the brain-stem involving the mescencephalon.

In this material a defective optokinetic nystagmus was a relatively rare and late symptom, though it occurred in 47 per cent of patients with tumors larger than 40 mm in diameter; this accords with the findings of 50 per cent by Tos *et al.* (1973). All patients had a defective horizontal optokinetic nystagmus towards the affected side, and only two patients had in addition a defective vertical optokinetic nystagmus. Both of these two patients had very large tumors, which is also necessary in order to influence the vertical gaze center localized in the mescencephalon.

It should be emphasized that it is a late symptom and that impressions in the pons may occur without causing defective optokinetic nystagmus. A negative finding does not exclude a large tumor with impression in the pons, and subsequent difficulties at surgery. But in all cases in this series, a defective optokinetic nystagmus was accompanied by a large anatomical impression in the pons.

Considering all symptoms from the trigeminal nerve, the cerebellum and the optokinetic nystagmus collectively, we found that these symptoms were present post-operatively in considerably fewer patients undergoing translabyrinthine surgery than in those who had also had a suboccipital operation. However, the tumor size in patients who had only translabyrinthine surgery was only about half the size of that in the patients who also had suboccipital surgery, so a direct comparison cannot be made (Table X). However, 11 tumors among those operated only by the translabyrinthine approach were larger than 40 mm, and their mean diameter was no different from that in the nine patients who also had a suboccipital operation. Two of the eleven patients with only translabyrinthine surgery had post-operative affections of the trigeminal nerve, the cerebellum or the optokinetic nystagmus, whereas seven patients in the group with suboccipital surgery had symptoms. This difference between the two surgical approaches is significant ($p < 0.01$). Therefore, with regard to the occurrence of post-operative symptoms from the trigeminal nerve, cerebellum and optokinetic nystagmus, the translabyrinthine approach is more lenient to the patient.

Conclusion

In patients suspected of having an acoustic neuroma, the occurrence of affections of the trigeminal nerve, cerebellum and optokinetic nystagmus predicts the presence of a large tumor and, consequently, difficulties at operation. In patients with hearing impairment greater than 80 dB, tests that are independent of hearing threshold must be applied. In these cases examination of the function of the trigeminal nerve, cerebellum and optokinetic nystagmus is particularly valuable.

In the majority of cases the symptoms are reversible, and post-operative affections persist only in patients in whom the tumor is very large and difficult to remove.

The investigations are simple and easy to perform. They demand no expensive special equipment and can be performed both in private otological practice and in the hospital. These examinations should still be included in the routine investigation of patients with unilateral acoustic or vestibular symptoms in the search for tumors in the cerebello-pontine angle.

Summary

The involvement of the trigeminal nerve, cerebellum, and optokinetic nystagmus in patients with acoustic neuromas, as well as the methods of investigation, are described. The corneal and/or facial sensibility was found to be reduced in 29 per cent of the whole series and in 53 per cent of tumors larger than 40 mm. There was a significant correlation between reduced corneal and/or facial sensibility and the findings of pressure at the trigeminal root at operation. Only three patients had a persistent reduction of trigeminal function post-operatively.

Cerebellar dysfunction was found in 32 per cent, but significantly more frequently (58 per cent) in patients with tumors larger than 40 mm. Post-operatively, six patients had cerebellar symptoms in the form of gait disturbances; five of these patients had a supplementary suboccipital removal performed, after the initial translabyrinthine approach. A defective optokinetic nystagmus was found pre-operatively in 10 patients, nine of whom had tumors larger than 40 mm in diameter. All patients with a defective optokinetic nystagmus had a large anatomic impression in the pons at operation.

In patients suspected of having an acoustic neuroma, symptoms from the trigeminal nerve, the cerebellum and the optokinetic nystagmus predict the presence of a large tumor and subsequent difficulties at operation. The symptoms were completely reversible in the vast majority of cases and post-operative symptoms persisted only in patients in whom tumor removal was difficult and the tumor very large.

Testing of the trigeminal nerve, the cerebellum and the optokinetic nystagmus still deserves its place in the diagnostic work-up of patients with unilateral acoustic or vestibular symptoms, especially in cases with severe hearing impairment, which necessitate the use of tests that are independent of acoustic function.

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