Rotatory Tests

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Rotatory tests are considered to be the only adequate test for vestibular function. In other words, rotation is a physiological stimulation for the vestibular labyrinth. It is, however, a disadvantage that both labyrinths are involved together at the same time. This is in contrast to caloric stimulation, by which each labyrinth can be tested separately. At the present time, Otologists measure the nystagmus after rotating stops (postrotatory nystagmus). Its direction is opposite to that of the perrotatory nystagmus.

METHODS OF ROTATORY TESTS

a). Maximal tests.

These methods rotate subjects with ten times in twenty seconds, which was originated by Barany. The subject is placed in a rotating chair which is rotated around a vertical axis. The semicircular canal lying in the horizontal plane particularly stimulated. Therefore, the more exactly that the head of the subject is placed in a defined position, the pure the nystagmus will be elicited. According to Barany, the rotatory nystagmus is determined by the angle formed by the crossing of the spatial horizontal line and the line between the eyeballs.

In order to elicit horizontal nystagmus the subject's head is bent forwards 30 degree. During rotating to the right, nystagmus horizontal in nature is elicited to the right, and after stopping the rotating chair, horizontal nystagmus to the left is observed (postrotatory nystagmus). In this method the duration of nystagmus averages 15 to 35 seconds in normal subject. When the subject's head is bend forwards 90 degrees, rotatory nystagmus is present. In this condition the duration of nystagmus is shorter than that of horizontal nystagmus, averaging 10 to 20 seconds. When the subject's head is tilted towards the shoulder 90 degrees, vertical nystagmus lasts 5 to 10 seconds in normal subject.

Unilateral rotation test. In this test each separate labyrinth is stimulated. For the test, special designed rotatory chair was used, which has a lateral axis of rotation. The subject's head is fixed so that non-tested

labyrinth is situated exactly in the axis of rotation.

b). Minimal tests.

Grahe's method is a typical of minimal tests by which the subject is rotated one revolution around a vertical axis. The subject is placed in a rotating chair with the lags flexed. The examiner stands behind him and puts two fingers (ring and middle fingers) loosely on his closed eyelids. The subject is rotated 180 degrees, during which the examiner palpates with his fingers through the closed eyelids the movements of the eyeballs and determines the number of jerks. In my experiences, Grahe's minimal test enable to show only whether nystagmus is elicited or not.

c). Long rotating tests.

In long rotating tests rotation is begun slowly (below threshold) and is continued over a period of 3 to 4 minutes.

Veit's method.

In this method, the subject is rotated at first slowly, then accelerated. When the angular velocity reaches 180 degrees per second, angular acceleration ends, and rotation with a constant angular velocity (180°/sec) continues. After the subject no longer feels rotation sensation, the rotation is stopped 1 to 2 minutes, Now after the rotation is suddenly stopped, postrotatory nystagmus is counted.

M. H. Fischer's method.

M. H. Fischer used an electrically driven rotatory chair devised by Toennies for long rotation test. The subject is placed in Toennies's chair with the head bent forwards 15 degrees. To eliminate the optokinetic nystagmus a block cowl is used. According to his description, rotation is started with a speed of 0.3 degree seconds and is slowly increased to 1–2 degree seconds, which is considered the physiological threshold for rotation stimulation. Rotation is then continued at constant speed for 3 minutes, then suddenly stopped. The postrotatory nystagmus is counted.

d). Cupulometry.

It is to the credit of Egmond, Groen and Jengkees to have originated that cupulometry method is useful as vestibular test. In this method, duration of the postrotational nystagmus and postrotational sensation are considered and graphically recorded as cupulogram. In cupulogram. the abscissas (horizontal) show the magnitude of impulses on a logarithmic scale expressed in degree seconds, the ordinates (vertical) show the duration of postrotational nystagmus and postrotational sensations in seconds. Both responses are measured for impulses of different strength and different velocity.

The subject is placed in an electrically driven chair with inclined head, so that the plane of rotation conforms with that of one pair of canals. The subject is first rotated with a constant subliminal speed (about 10 to 20 degree seconds), long enough to make sure that every reaction has subsided. Next the chair is suddenly stopped. the subject is asked to indicate the movement when he feels no longer rotaton sensation. The examinations are repeated for different strengths and velocities until the threshold is found (about 0.75 degree seconds). The aforementioned two responses, that is nystagmus and sensation, are measured and registered for right and left movements. Cuplugram consists of four lines, two for nystagmus and two for sensation. The normal subject gives a cuplogram characteristic shape, that is a straight course.

Yoneda in 1959[1)] carried out experimental and clinical studies on perrotatory nystagmus which is elicited during rotation. A round rotatory cabinet, 2m in diameter and 2m in height was used. The floor of this cabinet is made of a horizontal wooden board, 5 cm in thickness which is received by a 5 cm vertical steel shaft supported by a ball bearing. Special chairs were placed in the center of the floor in which both the subject and the examiner were rotated together. The examiner sat on the chair facing the subject. In order to observe eye movement during rotation (perrotatory nystagmus), the subject wore black contact lens with white cross mark which enable to eliminate optkinetic nystagmus occurring during rotation.

1). Experimental study.

Seventy normal healthy adult rabbits and twenty rabbits two weeks after unilateral destruction of the labyrinth were used. All rabbits were

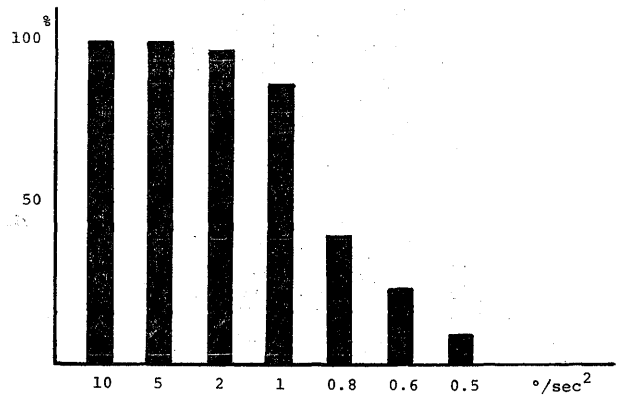


Fig. 1.

rotated one revolution (360 degrees) with 8 different angular accelerations, such as 10°, 5°, 2°, 1°, 0.8°, 0.6°, 0.5° and 0.4°/sec². In normal rabbits, rotation with 10°, 5° and 2°/sec² obtained perrotatory nystagmus in all animals (100 percent), on the other hand rotation with 1°/sec² occurred in 86 percent of all animals, rotation with 0.8°/sec² occurred in 40 percent, rotation with 0.5°/sec² obtained in 5.8 percent and rotation with 0.4°/sec² gave no nystagmus as shown in Fig. 1. In rabbits 2 weeks after unilateral destruction of the labyrinth, appearance and duration of perrotatory nystagmus decreased, compared with that in normal rabbits.

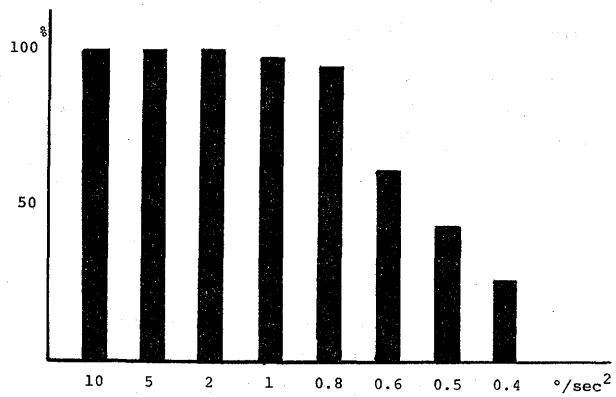
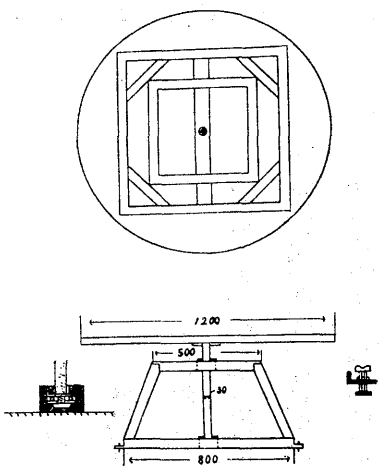


Fig. 2.



Rotation Table

Fig. 3.

Curves of Decelerative Rotation on Each Initial Speed

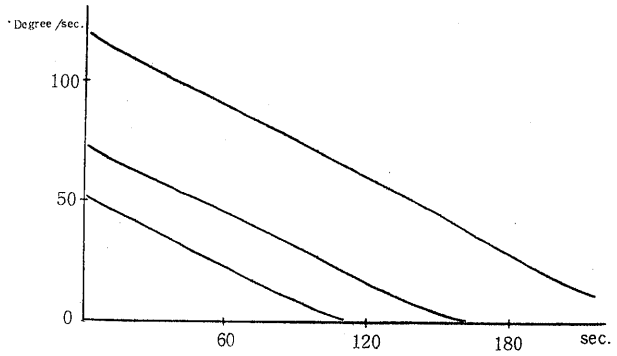
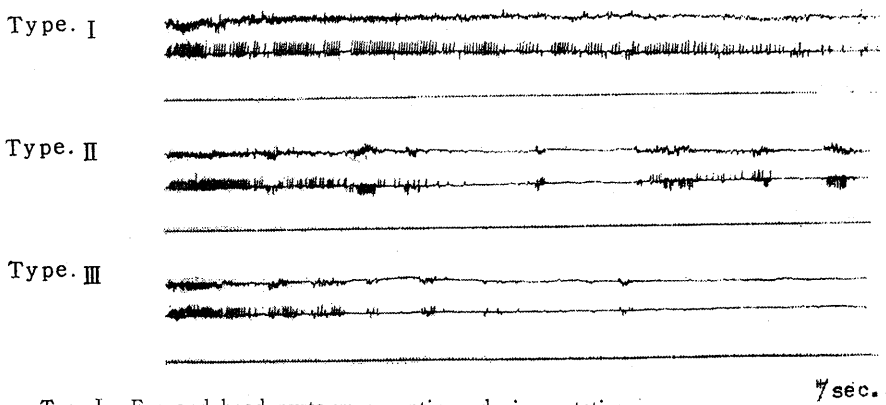


Fig. 4.

Eye And Head Nystagmus In Free Posture With Eyes Closed Elicited By Decelerative Rotation

to right

120°/sec.



Type I Eye and head nystagmus continue during rotation.

Type II In the anterior half of the course of rotation, eye and head nystagmus are regular., however, in the posterior half, they are irregular.

Type III In the anterior half of the course of rotation, eye and head nystagmus are regular, however, in the posterior half, no eye and head nystagmus.

Fig. 5.

2). Clinical study.

Thirty-four normal subjects and forty-two patients with vertigo were used. Normal subjects consisted of 13 males and 21 females, and their lages ranged from 12 to 25 (average 20) years. The patients in the study consisted of 30 males and 12 females, and their ages ranged from 16 to 67

(average 35) years. These he has examined in the course of the last three years. All human subjects, both normal and patients, were rotated by the same manner to that of animals. In normal subjects, rotation with 10°, 5°, 2°, and 1°/sec² obtained perrotatory nystagmus in all subjects (100 percent), whereas rotation with 0.8°/sec² occurred in 94 percent, rotation with 0.5°/sec² occurred in 50 percent and rotation with 0.2°/sec² gave no nystagmus as shown in Fig. 2. In the great majority of patients with vertigo, appearance and duration of the perrotatory nystagmus decreased, compared with that in normal subjects.

Miyahara in 1968[2] carried out experimental study on the eye and head movements obtained by decelerative rotation. Twenty healthy adult rabbits were used. Fig. 3 illustrates rotatory table used in the study. A round wooden table, 120 cm in diameter and 50 cm in height, is received by a 3 cm vertical steel shaft supporting with a ball bearing. The animal was rotated three different intial angular velocities, such as 120°, 72° and 51.4°/sec. Fig. 4 shows diagram of curves of decelerative rotations. Head movement was recorded by means of acceleration registrography and eye movement was measured by electronystagmography. The animal was placed in the center of the table (Fig. 3) and posture of the animal was the following three manners: 1) the animal is placed in the table with free posture, in other words the head and four legs are never fixed; 2) only four legs are fixed; 3) the head and four legs are completely fixed. Results obtained by aforementioned methods were divided into three types: Type I, head and eye movements continue through the rotation; Type II, head and eye movements continue through the rotation, but in the first half they are regular in pattern and in the latter half they are irregular; Type III, head and eye movements continue with regular pattern in the first half of rotation, but no head and eye movements is present in the latter half of rotation. In animals with free posture, the great majority of animals represented Type I or II, and a small number of animals gave Type III in the aforementioned three different rotations. In animals with four legs fixed and with the head and four legs fixed, all animals respresneted eye movement of Type III, regardless of the initial angular velocity and posture of animals (Fig. 5).

REFERENCES

1) Yoneda, S.: Study on perrotatory nystagmus. *Pract. Otol. Kyoto*, 52 : 829-856, 1959.
2) Miyahara, M : Experimental studies on head and eye movements elicited by decelerative rotation. *J. Otol. Tokyo*, 71 : 62-81, 1968.