Tonic Labyrinthine Reflexes

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It is to the credit of Hoegyes of Hungary to have demonstrated in 1881 that tonic impulses emanate from the labyrinth and influence upon muscles of the body. Ewald in 1892 studied tonic influences of the labyrinth upon the musculature of the entire body. Both labyrinths produce continuous stimulations which under normal conditions maintain the equilibrium of the body. He described atonia of the extensor and abductor muscles of the extremity of the affected side with unilateral destruction of the labyrinth, whereas there occurred hypertonia of the flexors and adductors on the other side. From the aforementioned data he concluded that the labyrinth controls the flexors and adductors of the other side, and the extensors and abductors of the same side. Also he classified the various labyrinthine reflexes into two groups; 1) tonic reflexes to movement (cupular reflexs); and 2) tonic reflexes to posture (otolith reflexes). Subsequently Magmus and De Kleyn have developed the theory of the numerous reflexes, such as the tonic labyrinthine reflexes, the neck reflexes, and the righting reflexes. Tonic labyrinthine reflexes are those based upon changes of position of the head in respect to space. Neck reflexes are based upon changes of the position of the head in respect to the body. Labyrinthine reghting reflexes enalbe to bring the head from an abnormal position back into a normal one and maintain it there.

It is generally accepted that impulses discharging from the receptors on the labyrinth serve to orient head and body in space and to maintain equilibrium. The labyrinth elicits tonic reflexes via nucleus Deiters, causing the steady contraction of the antigravity muscles necessary for the erect upright position. The reflexes are further important for postural adjustment, and for the ability to return to normal posture after any change in position of head or body.

The tonic labyrinthine reflexes are identical with the "postural reflexes" of Sherrington. They enable the individual to bring parts of his body into harmonious positions and to maintain them so. The labyrinths have a direct influence not only upon the tonus of the musculature of the extremities but also upon that of the neck and trunk muscles.

Nonaka in 1958[1)] studied tonic labyrinthine reflexes in human by means of electromyography. Ninety-five normal healthy adult subjects, fifteen patients with unilateral disturbance of the vestibular labyrinth and thirty-eight deafmutes with bilateral destruction of the labyrinths.

In normal subjects, their ages ranged from 17 to 30 years. Fifteen patients were examined at our clinic between 1955 and 1957 and consisted of 4 labyrinthitis, 3 headtrauma, 3 deafness with vertigo, 2 postlabyrinthectomy, 1 acoustic tumour, 1 vestibular neuronitis and 1 Herpes zoster oticus. Thirty-eight deafmutes were tested at our clinic between 1955 and 1958. Their ages ranged from 15 to 29 years. Twentynine of thrity-eight individuals were male and nine were femals. They consisted of 33 congenital and 5 acquired in nature.

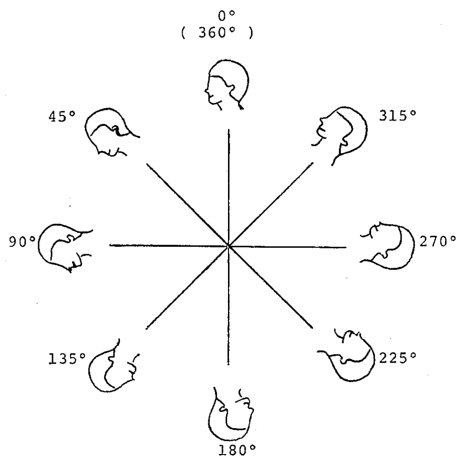

Fig. 1. Bitemporal axis

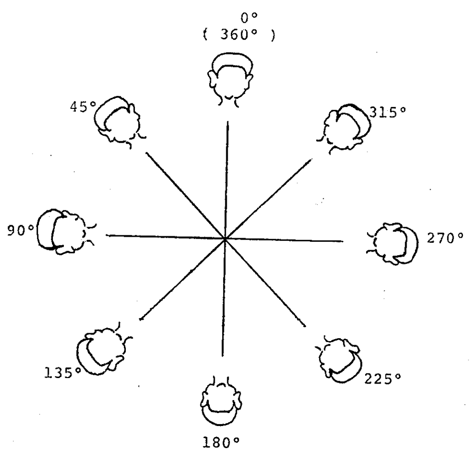

Fig. 2. Sagittal axis

The subject was placed on the tilting table (Grahe) and the head, neck and four legs of the subject were fixed completely by belts. The tilting table was first tilted over a bitemporal axis 360 degrees (Fig. 1) and then over a sagittal axis 360 degrees (Fig. 2). During tilting the table, the tonic neuromuscular unit discharge on the triceps brachial muscle (extensor) and biceps brachial muscle (flexor) was recorded by needle electrodes inserted into these muscles.

In normal subjects the following results were obtained. On tilting over a bitemporal axis 360 degrees, at 0 degree of posutre tonic neuro-

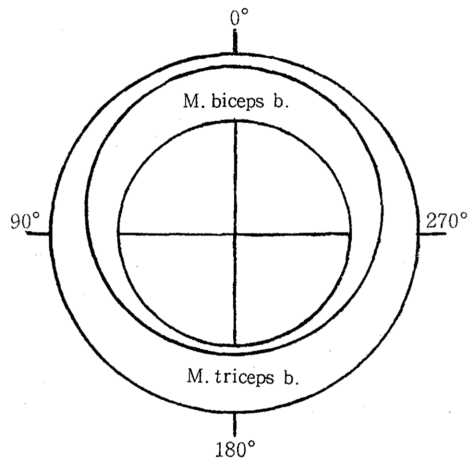

Fig. 3.

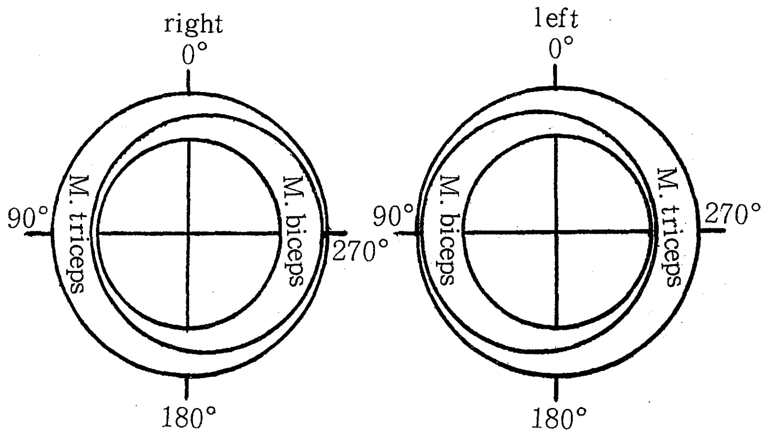

Fig. 4.

muscular unit discharge (T. N. M. U. D.) on the biceps brachial muscle (flexor) showed maximus value, whereas T. N. M. U. D. on the triceps brachial muscle (extensor) revealed minimum value. On the other hand at 180 degrees of posture, T. N. M. U. D. on the triceps brachial muscle showed maximum value, whereas T. N. M. U. D. on the biceps brachial muscle revealed minimum value as shown in Fig. 3. On tilting over a sagittal axis 360 degrees, at 90 degrees of posture T. N. M. U. D. on the right sided triceps brachial muscle showed maximum value and that on the right sided biceps brachial muscle revealed minimum value, whereas at 270 degrees of posture T. N. M. U. D. on the right sided biceps brachial

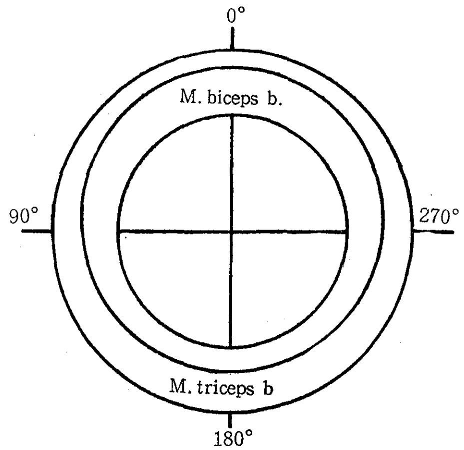

Fig. 5.

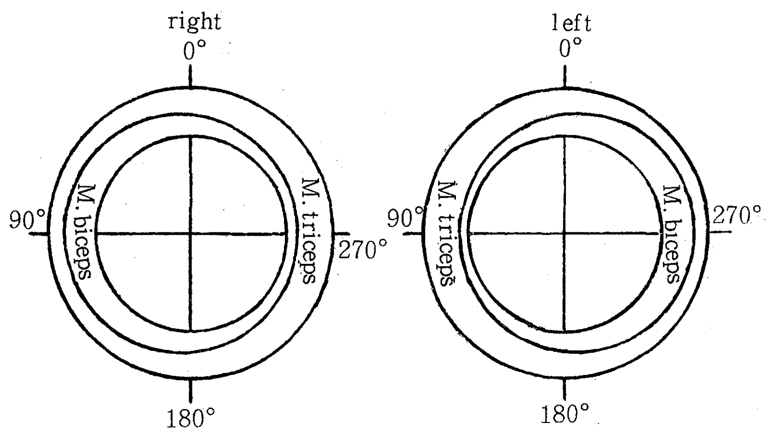

Fig. 6.

muscle showed maximum value and that on the right sided triceps brachial muscle showed minimum value as shown in Fig. 4. As illustrated in Fig. 4, as far as the left sided triceps (extensor) and biceps (flexor) muscles are concerned, condition of T. N. M. U. D. was opposite, that is bilateral symmetry. In patients with unilateral disturbance of the labyrinth, the following results were obtained. As shown in Fig. 5, on tilting over bitemporal axis 360 degrees, T. N. M. U. D. on the biceps brachial and triceps brachial muscles was almost indentical with these in normal subjects except small number of interference waves were present. On tilting over asagittal axis 360 degrees, T. N. M. U. D. on the triceps brachial muscle (extensor was present the Maximum value when the normal labyrinth holds position at 180 degrees, that is downwards. On the other hand, T. N. M. U. D. on the biceps brachial muscle (flexor) was present the maximum value when the normal labyrinth holds position at 0 degree that is upwards (Fig. 6).

In deafmutes with bilateral disturbance of the labyrinth, the following results were given. On tilting over a bitemporal axis 360 degrees, at 135 degrees of posture T. N. M. U. D. on the triceps brachial muscle showed the maximum value whereas that on the biceps brachial muscle represented the minimum value. On the other hand at 315 degrees of posture T. N. M. U. D. on the biceps brachial muscle showed the maximum value whereas that on the triceps brachial muscle revealed the minimum value as shown in Fig. 7. On tilting over a sagittal axis 360 degrees, T. N. M. U. D. on the biceps brachial muscle (flexor) showed the maximum value when the muscle is downwards, that is 180 degrees, and T. N. M. U. D. on

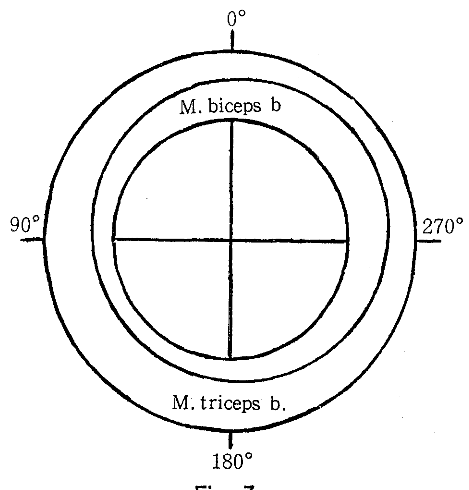

Fig. 7.

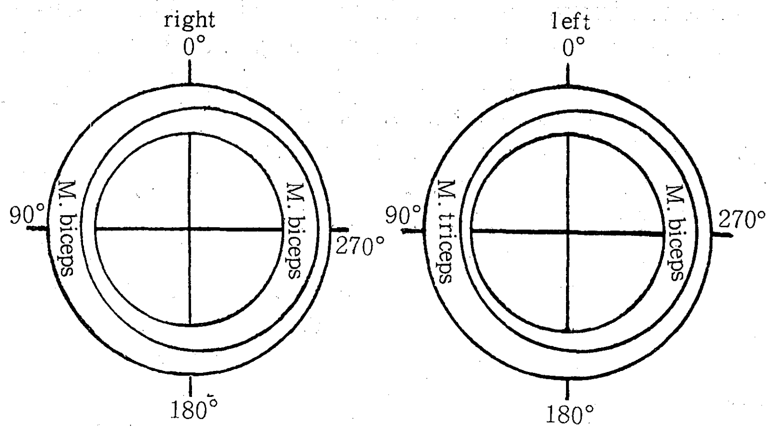

Fig. 8.

the triceps brachial muscle (extensor) showed the maximum value when the muscle is upwards, that is 0 degrees, as shown in Fig. 8.

Inokuma in 1958[2)] carried out experimental studies on the tonic labyrinthine reflexes by means of electromyography.

1) Experimental study in decerebrate cats.

Twenty decerebrate cats were used. The animal was placed on the tilting table and the head, neck, trunk and four legs were fixed completely by belts. The tilting table was tilted over two axises 360 degrees, such as bitemporal and sagittal axises. During tilting the table, the tonic neuromuscular unit discharge on the triceps brachial muscle (extensor) was

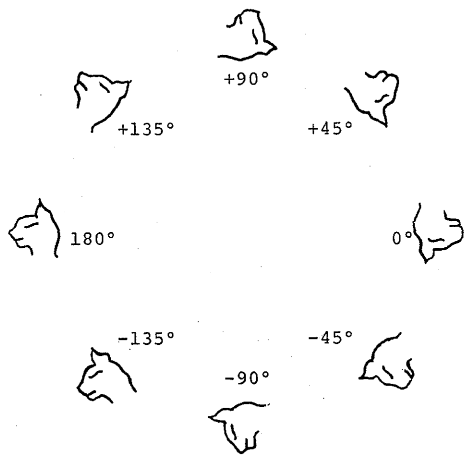

Fig. 9. bitemporla axis

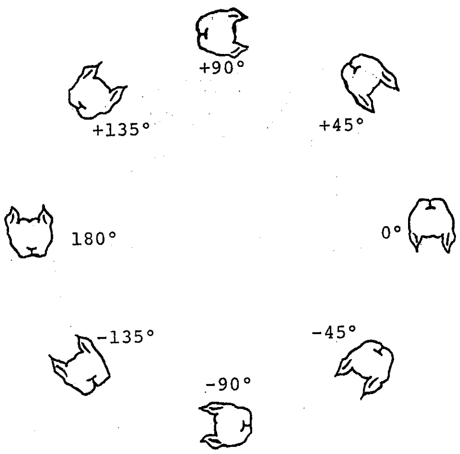

Fig. 10. Sagittal axis

recorded by means of needle electrode inserted into the aforementioned muscle. On tilting over a bitemporal axis, T. N. M. U. D. on the triceps brachial muscle was present the maximum value at 0 to -45 degrees of posture (Fig. 9). On tilting over a sagittal axis 360 degrees, T. N. M. U. D. on the same muscle showed the maximum value at 90 or -90 degrees of posture (Fig. 10).

2) Experimental study in rabbits.

a. Results from forty healthy adult animals.

On tilting over a bitemporal axis 360 degrees, T. N. M. U. D. on hte

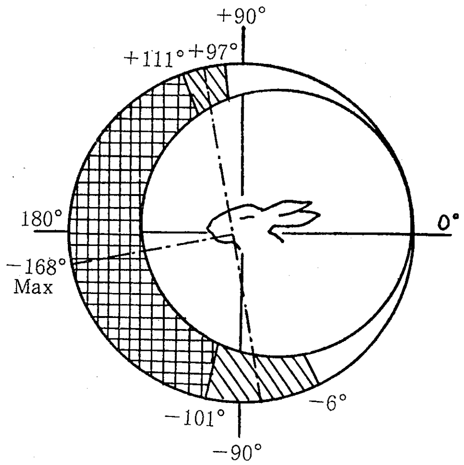

Fig. 11.

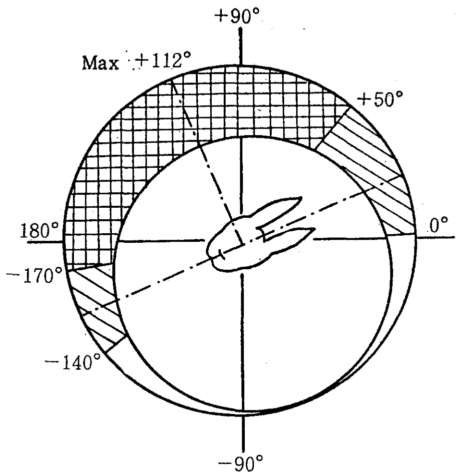

Fig. 12.

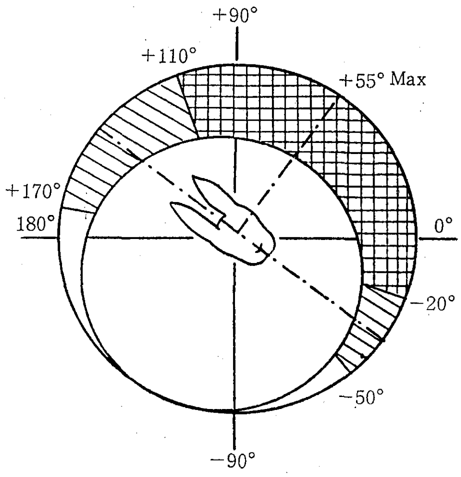

Fig. 13.

longissimus dorsal muscle was present between +111 and −101 degrees (maximum −168 degrees). On tilting over a sagittal axis 360 degrees, T. N. M. U. D. on the rig ht sided sacrospinal muscle repres ented between +50 and −170 deg rees (maximum +112 degrees), and that on the left sided sacrospinal muscle was present between +110 and −20 degrees (maximum +55 degrees) as shown in Figs. 11, 12 and 13.

b. Results from thirty-one animals over one week after destruction of the unilateral labyrinth.

On tilting over a bitemporal axis 360 degrees, T. N. M. U. D. on the longissimus dorsal muscle was present at all postures 360 degrees. On tilting over a sagittal axis 360 degrees T. N. M. U. D. on the left sided sacrospinal muscle (destructive side) was presnet at all postures, on the other hand T. N. M, U. D. on the right sided sacrospinal muscle (normal side) represented irregular pattern.

c. Results from animals over one week after destruction of bilateral labyrinths.

On tilting over bitemporal or sagittal a xises 360 degrees, T. N. M U. D. on the longissimus dorsal and sacrospinal muscles were not present at all postures.

d. Results from anesthethised animals.

Results obtained in this conditon were identical with these in normal animals.

REFERENCES

1) Nonaka, K.: Electromyographical study on the tonic labyrinthine reflexes. *Pract. Otol. Kyoto.*, 51 : 455-461, 1958.

2) Inokuma, Y.: Study on the tonic labyrinthine reflexes. *Pract. Otol. Kyoto.* 51 : 1187-1212, 1958.