The Inner Ear Disturbances from Head Injury

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After head injury the majority of patients without unconciousness complains of tinnitus, hearing loss and vertigo. By studying the clinical findings in human patients and correlating them with the findings of animal experiments, it is generally accepted that the above mentioned symptoms are due, for the most part, to disturbance of the inner ear.

Generally, the auditory and vestibular symptoms following head injury enable to classify according to the following types of labyrinthine damages: 1. longitudinal fracture of the temporal bone; 2. transverse fracture of the temporal bone; 3. labyrinthine concussion.

1. A longitudinal fracture of the temporal bone is a linear fracture through the floor of the middle cranial fossa, which lies parallel and adjacent to the anterior margin of the petrous pyramid. It extends medially from the region of the Gasserian ganglion to the middle ear and mastoid cells laterally.

2. A transverse fracture of the temporal bone occurs perpendicular to the long axis of the petrous pyramid and is most likely to result from blows to the occiput.

3. Labyrinthine concussion may be described as perceptive deafness and vertigo resulting from a blow to the head without fracture of the bony labyrinthine capsule.

Apart from fractures of the temporal bone, it is of importance to study the inner ear disturbances following head injury on both clinical and experimental cases.

Takahashi in 1956[1] studied the inner ear disturbances following head injury.

a. Clinical study of the auditory disturbance.

A series of 58 consecutive patients with auditory disturbance tested at our clinic for the past four years were studied in his reports. Their ages ranged from 15 to 60 (average 52) years. A total number of 58 patients includes 24 of temporal head injury, 13 of occipital head injury, 13 of parietal head injury, 4 of frontal head injury and 4 of unknown areas.

The time span from head injury to examination varied from 10 days to two years.

In 24 patients with temporal head injury we found out 10 of perceptive type of hearing loss, 10 of mixed type, 3 of conductive type and 1 central type. In 13 patients with occipital head injury we found out 9 of mixed type, 2 of conductive type and 2 of perceptive type. In 13 patients with parietal head i njury we found out 7 of mixed type, 5 of perceptive type and 1 central type. In 4 patients with frontal head injury we found out 3 of mixed type and 1 of perceptive type. In 4 patients with head injury in unknown areas 3 of mixed type and 1 of perceptive type.

b. Experimental study of the auditory disturbance.

The following experiment was performed to provide an information on the pathological changes in the auditory system resulting from blows to the head. Twenty-two healthy adult guinea-pigs were used. After hearing tests had been obtained, a blow was delivered to the head. The head was held in a fixed position on a metal table top, and a blow was delivered to the left sided temporal area by means of 400 gram wooden mallet. Auditory response was tested by auricular reflex. Post-concussion auditory responses were classified into the following three groups: Group 1. Seven animals had complete loss for all tones in the range tested, 120 to 10000 cps, Group 2. Six animals had hearing loss which were rather sharply confined to 2000 to 10000 cps range; Group 3. Nine animals had some recovery of hearing acuity over the frequency range during the first week following the head injury.

c. Histopathological study of the cochlear disturbance.

The above mentioned 22 guinea-pigs were sacrificed after testing auditory disturbance and microscopic sections were made of the temporal bones.

The histopathological findings of animals in each group are as follows: Groups 1 and 2. The middle ear cavity contained blood. There was blood in the perilymphatic space of the scala tympani or vestibuli. The vestibular membrane (Reissner's membrane) bulged and the hair cells disappeared in all animals; Group 3. The middle ear cavity was clear except slight blood in a few animals. There was no pathological finding in the inner ear.

d. Clinical study of the vestibular disturbance.

A series of 56 consecutive patients with vestibular disturbance tested at our clinic for the past four years were studied in his report. Their ages ranged from 18 to 60 (average 49) years. A total number of 56 patients with head injury includes 20 of the temporal area, 13 of the occipital area,

12 of the parietal area, 5 of the frontal area and 6 of unknown area. The time span from head injury to examination varied from 1 month to 2 years.

Abnormal rotatory response represented 12 of 20 patients with temporal head injury, 2 of 13 patients with occipital head injury, 5 of 12 patients with parietal head injury, and 2 of 6 patients with head injury in unknown area.

Abnormal caloric reponse represented 11 of 20 patients with temporal head injury, 6 of 13 patients with occipital head injury, 6 of 12 patients with parietal head injury, 2 of 5 patients with frontal head injury and 4 of 6 patients with head injury in unknown area.

e. Experimental study of the vestibular disturbance.

In order to provide an information on vestibular disturbance resulting from blow to the head, thirty-nine healthy adult rabbits were used. After vestibular tests had been obtained, a blow was delivered to the head by means of the same procedure mentioned in Chapter b.

After blow to the head, spontaneous nystagmus represented in 30 of 39 animals. In 16 of 30 animals with spontaneous nystagmus direction of the nystagmus was towards the opposite side, and in 10 of 30 amimals direction of the nystagmus was towards the disturbed side. In the remainders no spontaneous nystagmus was present, but in 2 animals vertical nystagmus was present.

After blow to the head, post-rotatory response was tested. Abnormal rotatory nystagmus, that is decreased duration period of nystamgus, represented in all animals without exception.

Ogata in 1953[2] studied histopathological changes in the inner ear of contrecoup. After blow to the left sided temporal area, animals (rabbits) were sacrificed and microscopic sections were made of the temporal bones. In the right sided inner ear (opposite side to the head injury), blood was found in the soft tissues of the modiolus, nerve fibers of the N. cochlearis and vestibularis, and internal auditory meatus.

Ogata in 1958[3] performed on experimental study on treatment for vestibular disturbances following blow to the head. Twenty healthy adult rabbits were delivered to the head. The head was held in a fixed position on a metal table top, and a blow was delivered to the left sided temporal area by means of 400 gram wooden mallet. Postrotatory nystagmus following blow to the head was always of much short duration than that of pre-head concussion A total number of 20 rabbits was performed on a fenestration operation on the left sided lateral semicircular canal in order to drain the perilymph. Ten days after fenestration operation,

postrotatory nystagmus was tested in all animals. Postrotatory response after fenestration represented much greater duration than that before operation in all animals except in only 2 with increasing duration.

Magnus and De Kleyn have developed a theory of tonic labyrinthine reflexes which is based upon changes of position of the head in respect to space. Ogata in 1958[3] studied tonic labyrinthine reflexes of rabbits by means of technique of electromyography. Twenty rabbits were used in this study. The animal was fixed on a table and the head was rotated about a vertical axis as shown in Fig. 1. In order to record spike discharge, a needle electrode was inserted into the Saculospinal muscle on the neck.

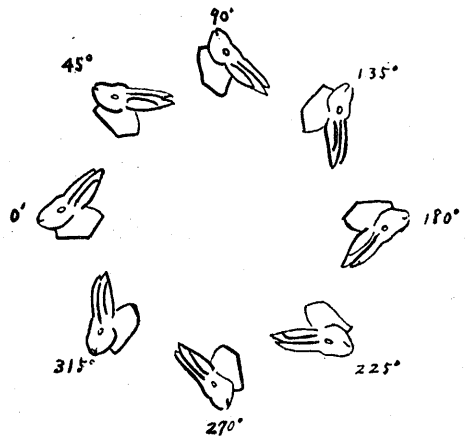

Fig. 1.

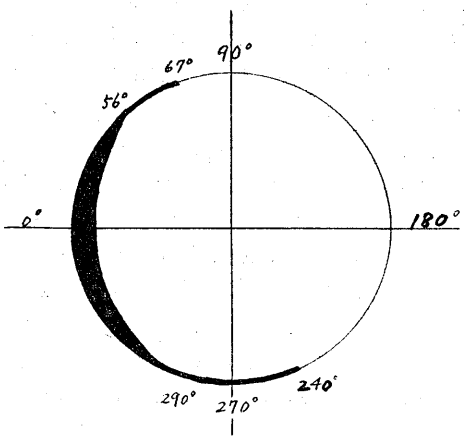

Fig. 2.

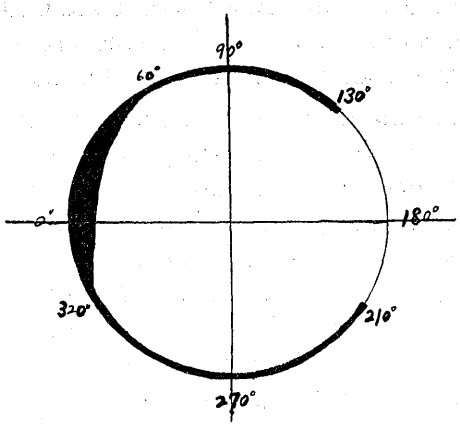

Fig. 3.

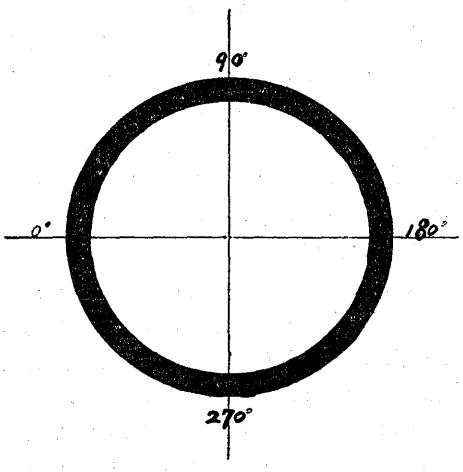

Fig. 4.

In normal animals, as illustrated in Fig. 2, spike discharges represented from 67° to 240°. On the other hand, in animals with temporal bone injury spike discharges represented from 130° to 210° (Fig. 3) or in all space (Fig. 4). However, after fenestration operation, in those animals with temporal bone injury spike discharges represented from 67° to 240° and from 130° to 210°.

In order to provide an information on the histopatological change in the labyrinth performed on fenestration operation, the above mentioned rabbits were sacrificed 30 days after operation and microscopic sections

were made of the temporal bone. Blood was found in the lymphatic space in 8 of 29 rabbits, degeneration of the crista was present in 5 of 20 rabbits and degeneration of the macula was found in 13 of 20 rabbits.

Furukawa and Takahashi in 1953[4] studied vestibular disturbance in patients with vertigo following head injury. Spontaneous nystagmus was shown in 12 of 22 patients, abnormal caloric response represented in 16 of 22 patients, abnormal rotatory response was present in 15 of 22 patients. Goniometer test showed abnormal response in 17 of 22 patients, pastpointing test revealed abnormal response in 10 of 22 patients, walking test was present abnormal response in 11 of 22 patients. The degree of unbalance in 22 patients was as follows: 1. high degree disturbance in 3; 2. middle degree disturbance in 6; 3. mild degree in 13.

Yoneda and Takahashi in 1953[5] carried out experimental study on vestibular function following blow to the head. 39 healthy adult rabbits were used. A blow was delivered to the left sided temporal area by means of 400 gram wooden mallet. One week after blow to the head, the head deviated to the left side (disturbed side) in 8 of 39 animals, the head deviated to the right side in 24 of 39 animals, and the remainders (7 animals) showed no deviation of the head. Spontaneous nystagmus was present in 28 of 39 animals. Of 28 animals, 11 represented the nystagmus towards the disturbed side, 15 occurred the nystagmus towards the normal side, and 2 showed vertical nystagmus. Postrotatory test revealed abnormal response in the majority of animals.

Ogata and Takahashi in 1953[6] carried out experimental study on the labyrinth after blow to the head, and made a comparison of vestibular responses with histopathological findengs. 5 healthy adult rabbits were used. Results obtained were as follows: 1. Vestibular hyperfunction is induced by vestibular shock; 2. Vestibular hypofunction is caused by either bleeding in the cochlear bone or bleeding in the Ganglion Scarpa.

SUMMARY

In this paper, the results obtained by clinical and experimental studies on the inner ear disturbances due to the head injury were reviewed. In the majority of patients and animals with head injury, abnormal vestibular responses and histopathological findings on the labyrinth were present.

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