Temporal Bone Fractures

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TEMPORAL KEMİĞİN KIRIKLARI

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Geliş Tarihi: 15 Ocak 1987

SUMMARY

This study has been done during 1980-1981 at the Johns Hopkins Hospital, Baltimore Mil., U.S.A. The purpose of this article is an attempt to familiarize the concerned medical doctors with this particular form of trauma involving the temporal bone.

In this study, four hundred and one patients with the diagnosis of the fracture of the base of the skull, which have occured from 1930 until 1981, were ret>ieu>ed. Amongst them, we found 73 blunt temporal bone fractures (18.20%) and 7gunshot injuries (1.74%),

Amongst 73 of our cases, 37 were involved in traffic accidents (S0.68%\. 25 were involved in falls (34.24%), 10 were involved in assaults or fightings (13.69%), and one in a sportive accident (1.36%).

In our material we have 48 longitudinal (60.75%), 26 transverse (32.91%), 4 combined (5.06%), and one micro (1.26%) fractures of the temporal bone.

The severity of the impacts and the complications of the temporal bone fractures attribute a great importance to them and require long-terms follow-up of the patients. Since only 50% of the temporal bone fractures are demonstrable by the classic tomography, it is obvious how important is the physical examination and long' term follow-up.

Key word*: Temporal bone fractures, skull bate fractures

OZliT

Bu çalışma, 1980-1981 yıllarında, Johns Ilopkine Hastahanest (Baltimore, A.B.D.) K.B.B. Kliniğinde yapılmıştır. Çalışmanın amacı, konu ile ilgilenen hekimlere temporal kemiği ilgilendiren kırıklar hakkında teferruatlı bir literatür bilgisi ile beraber karşılaştırmalı olarak bizim bulgularımızı sunmaktır.

Bu çalışmaya konu olan 401 hasta, 1930-1981 yıllan arasında Johns Hopkins flastahanesi'nde kafa kaidesi ktrtğt tanısı ile işlem görmüşlerdir. Unutan» arasında, 73 hastada (% 18.20) çarpmaya bağlı temporal kemik kırığı ve 7 hastada da (% 1.74) ateşli silâh ile yaralanmaya bağlı kafatası harabiyeti bulunmuştur.

Sö2 konusu 73 hastanın 3 7'si trafik kazaları (% 50.68), 25'İ düşmeler (% 34.24), 10'u darp (% 13.69) ve biri de Spor kazası (% 1.46) sebebiyle yaralanmışlardır.

Temporal kemik kırıkları arasında 48 longitudinat (% 60.75). 26 transvers (% 32.91), 4 karmaşık (% 5.06) ve bir miltro (% 1.26) hınk bulunmuştur.

Doğurduktan arıza ve komplikasyonlannın ciddiyeti dolayıstyta, temporal kemik kırıklarına önem vermek ve hastaları uzun süreli takibe almak gerekir. Temporal kemik kırıklarının ancak % 50'sini klâsik tomografi ile görüntüleyebilmek mümkün olduğuna göre, klinik muayene ve uzun sureti takibin önemi kendiliğinden ortaya çıkmakladır

Anahtar kelimeler: Temporal kemik kırıkları, kafatası kaidesi kırıkları

INTRODUCTION

The recognition of the commitments, obligations and liabilities of modern management of head injuries has long established the policy in leading cranio-facial trauma centers to involve the otorhinolaryngologist from the onset in the diagnosis and treatment of skull injuries, whenever the injury involves the temporal bone and paranasal sinuses or whenever such a possibility exists. Both, the disregard for such a multidisciplinary approach on the part of the specialist, deprive the patient of his privilege to good medical care and eventually will lead to legal complications. The purpose of this article, therefore, is an attemp to familiarize the otorhinolaryngologist with this particular form of trauma involving the temporal bone.

MATERIALS AND METHODS

Four hundred one patients with the diagnosis of the fractures of the base of the skull which have occured from 1930 until 1981, were reviewed at the Johns Hopkins Hospital in Baltimore. Among them we found 73 blunt temporal bone fractures (18.20%) and 7 gunshot injuries (1.74%).

During the study the diagnosis was based upon one or more criteria described below:

1. bleeding from the ear
2. hemotympanum
3. laceration of the tympanic membrane
4. laceration of the skin of the external auditory canal
5. CSF otorrhea
6. facial injury (paralysis or paresis)
7. ossicular injury
8. sensorineural hearing loss
9. conductive hearing loss
10. vestibular injury (paralysis, paresis or irritation)
11. spontaneous nystagmus
12. radiological diagnosis of a fracture
13. surgical findings
14. histopathologic findings

All our cases were examined radiologically. In some cases we have audiograms, vestibular tests, EEG and facial nerve tests. In some cases all we have, is the history and physical examination. Also we have follow-ups in few cases.

In our material we have 48 longitudinal (60.75%), 26 transverse (32.91%), 4 combined (5.06%), and one micro (1.26%) fractures of the temporal bone.

Among 73 of our cases, 37 were involved in traffic accidents (50.68%), 25 were involved in falls (34.24%), 10 were involved in assaults or fightings (13.69%), and one in a sportive accident (1.36%).

The findings and complications of cases with fractured temporal bones are seen on the table number one.

DISCUSSION

MECHANISMS OF BASAL FRACTURES

The injury involving the base of the skull depends upon the severity and mechanism of the trauma. Direct and indirect fractures may be distinguished.

The direct fracture results from an impact upon a limited, circumscribed area of the skull. Such a fracture may be simple, without a dislocation, or may reveal the characteristics of a starlike impression fracture with a gap, a hole, or with one or several loose bony fragments with varying degrees of impression and dislqcation.

The indirect fracture results from an impact upon a broad surface, causing a deformity of the entire skull and producing bursting mechanisms. It does not develop at the site of impact, rather at some distance from it, in an area where the soft and bony tissues are of maximal tension and minimal elasticity. The base of the skull by nature of its irregular architectural structure becomes the predilective site for indirect fractures (10, 18, 32, 33).

Basal skull fractures may be limited to the base or occur in combination with fractures of the calvaria.

The types of basal fractures may be distinguished (20):

1. Fronto-basal fractures
2. Latero-basal fractures
3. Combined fronto-and latero-basal fractures
4. Fractures of the calvaria radiating into the base withouth involvement of the pneumatic systems.
5. Impression or ring fractures of the base

The fronto-basal fracture may result from a direct, localized impact, impression or perforating lesion in the frontal, glabellar or orbital area or from a bursting mechanism following a broad impact upon the parietal or occipital region or from a compression of the entire skull. It is primarily a fracture of the anterior cranial fossa involving the anterior paranasal sinuses, the cribriform plate and orbit, occasionally radiating into the middle and posterior cranial fossa.

The latero-basal fracture appears as a longitudinal and transverse fracture of the petrous pyramid or as a combination of both. It may result from a direct or indirect impact. Whereas, the longitudinal fracture of the petrous pyramid probably develops with equal frequency as a direct or indirect fracture, or as a

Table -1

Findings in **the** Fractures **of the Temporal Bone**

TEMPORAL BONE FRACTURES	Longitudinal		Transverse		Combined		Micro	
COMPLICATIONS	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
Bleeding from the ear	**32**	**66.66**	**11**	**42.30**	**3**	**75**	**–·**	
Laceration of the tympanic membrane	**27**	**56.25**	**5**	**19.23**	**3**	**75**		**–**
Hemotympanum	**10**	**20.83**	**9**	**34.61 1**	**–**	**–**	**1**	**100**
Laceration of the skin of the external auditory canal	**5**	**10.41**	**1**	**3.84**	**1**	**25**		**–**
CSF Liquorrhea	**8**	**16.66**	**4**	**15.38**	**3**	**75**		**–**
CN hearing loss	**2**	**4.16**	**19**	**73.07**	**3**	**75**	**–**	**–**
Conductive hearing loss	**24**	**50**	**2**	**7.69**	**1**	**25**	**–**	**–**
Facial nerve injury	**12**	**25**	**9**	**34.61**	**1**	**25**	**–**	
Vestibular injury	**3**	**6.25**	**8**	**30.76**	**1**	**25**	**–**	**–**
Ossicular injury	**12**	**25**	**1**	**3.84**	**–**	**–**	**–**	**–**
Spontan nystagmus	**2**	**4.16**	**4**	**15.38**	**1**	**25**	**–**	**–**
Menengitis	**1**	**2.08**	**1**	**3.84**			**–**	**–**

bending or bursting fracture respectively, the transverse fracture of the petrous pyramid represents with few exceptions as indirect or bursting fracture (4,15).

The combined fronto-and latero-basal fracture results primarly from compression of the entire skull. A fracture of the calvaria radiating into the base, which does not involve a pneumatic system, is of limited significance. Ring fractures of the base are indirect effects of bursting fractures, torsion, anteflexion or retroflexion of the head (33).

The bursting fractures result from protrusion of the cervical spine into the bone surrounding the foramen magnum.

INCIDENCE OF BASAL FRACTURES

The incidence of basal fractures in head injuries varies among different statistics. Among 3,230 patients hospitalized with head injuries on the neurosurgical service of Mainz University Clinic during a 10 year period, 435 or 13.5% had a basal skull fracture with 29.5% involving the fronto-basal area (7). Skoog found 370 (46.5%) skull fractures among 794 head injuries (30). According to Bauer, basal skull fractures limited to the base and combined with fractures of calvaria account for 77 percent (20).

In the past, latero-basal skull fractures have been more frequently observed than antero-basal fractures; the estimated ratio was about 2 out of 3. The structural weakness of the middle fossa obviously offers a reasonable explanation. However, the steadily increasing number of traffic accidents in recent decades may well have reversed today the relation in favor of the fronto-basal skull fracture (20).

SOURCES OF ACCIDENTS

Head injuries account for about 70% of all fatal traffic accidents (21). Traffic accidents are variously estimated to account for up to 75% of all fronto-and latero-basal skull fractures. Accidents at work may be responsible for some 10-25 percent. Whereas, accidents during sport activities, occuring at home, during birth and following anf- assault play a relatively insignificant etiological role. We found our 73 cases with the temporal bone fractures involved 50.68% in traffic accidents, 34.24% in falls, 13.69% in assaults and 1.36% in sportive accidents.

FRACTURES OF THE TEMPORAL BONE

Fractures of the base of the skull involving the temporal bone may be conveniently classified into: 1) longitudinal fractures, 2) transverse fractures, and 3) combined longitudinal and transverse fractures of the temporal bone (18, 29, 30, 31, 32).

This categorization is based upon the course and plane of the principal fracture in .relation to the long axis of the petrous pyramid. This classification, however, represents an obviously over simplification, since many of the ones considered typical fractures have roentgenological^/ unrecognizable ramifications which branch off in different planes and directions, and since there are combinations and variations of

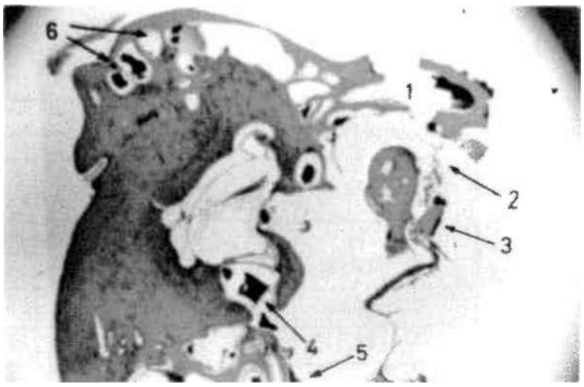

Figure-1. Transverse temporal bone fracture:

1. **Fractured tegmen tympani**
2. **Lacerated eardrum**
3. **Fractured and dislocated Malleus**
4. **Blood cloth at the round window niche**
5. **Blood cldths at the hypotympanum**
6. **Blood cloth at the pneumatic cellulae**

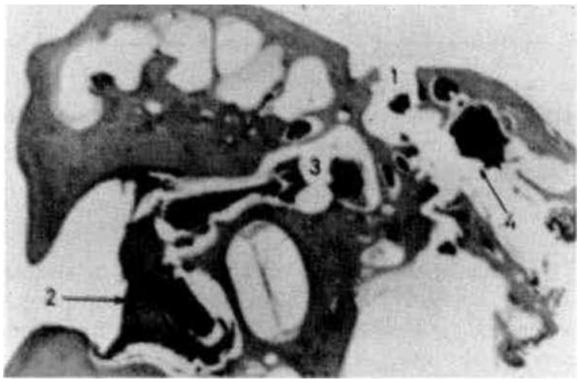

Figure-2. Transverse temporal bone fracture;

1. **Fractured tegmen tympani**
2. **Bleeding into the VHlth nerve**
3. **Bleeding into the facial nerve**
4. **Blood cloth at the epitympanum**

fractures which clearly no longer fall into one of the ones "typical" categories. Some fractures, because of their shattering pattern, obviously resemble compound fractures of the petrous pyramid (19, 24).

Inspite of its short comings it is, at present, for diagnostic purpose convenient to maintain the original classification.

Longitudinal fractures of the temporal bone are basically middle fossa fractures (17,18,23,29,30,32).

Longitudinal fractures occur more frequently than transverse or combined fractures (13, 20, 30, 31, 32). In many studies involved in the temporal bone fractures percentages are not similar. They vary between 80 and 94.5 percent for the longitudinal fractures and between **2.8** and **20** percent for the transverse fractures **(17, 18, 29, 31, 32).**

In our material, we have **48** c^ses with longitudinal fractures (60**.75%), 26** cases with transverse fractures **(32.91%), 5** cases with combined fractures (**5**.06%), and only one with microfractures (**1**.26%). The percentage may change regarding the structure **of** the neighborhood and industrial development. **In** industrial, agricultural, metropolitan or rural areas, the types of injuries should be different

OTHER FORMS OF TEMPORAL BONE FRACTURES

It has already **been** mentioned that the original classification of the temporal bone fractures is **no** longer satisfactory since it does **not** include **a** number **of** other fracture forms, which are occasionally **ob**served.

For instance, **a** longitudinal fracture through the petrous pyramid **can assume a** horizontal rather than **a** vertical plane, **and a** transverse fracture may bisect the petrous pyramid in an oblique rather than a perpendicular plane. **The** fracture which shatters the petrous pyramid and **follows no** particular plane **must be** considered as **a** compound fracture. This particular form of fracture is more frequent than hitherto **re**cognized. Its accurate **incidence** will eventually be determined by histologic examination **of a** sufficient number **of** such fractured temporal **bones.** Another less frequent group **of** temporal bone fractures, not mentioned above, includes:

1. The isolated fracture through the **lower** portion of the mastoid process which does not involve the middle ear but may involve the external auditory canal and the Fallopian canal **(6, 27).**

2. A fracture resulting in separation of the petrous pyramid from the framework of the temporal bone.

3. A fracture resulting in evulsion of the entire temporal bone from the surrounding base and calvaria of the skull.

4. The shattering or compound fracture involving the temporal bone caused by bullets or traveling missiles. In our study, we encountered seven temporal bone injuries due to bullets. Among them, there are no similar two incidences or clinical pictures. But all of them had sensorineural and/or conductive hearing loss to some degree. Two of them had both cochlear and vestibular functions extinguished.

5. The microfractures involving one of the cochlea or vestibule or both of them.

6. Fractures of still other etiologies.

COMPLICATIONS

MENINGITIS:

Early meningitis occurs more frequently after transverse fractures **(50%)** than after longitudinal fractures (2%) **(4).** A delayed otogenic meningitis may develop weeks, months or up to several decades after the original head injury, during an upper respiratory tract infection. The etiology of the potentially delayed, lethal otogenic meningitis **is** directly related to the biological behavior and response of the bone of the petrous pyramid to a given fracture. The endosteal and periosteal layers of the otic capsule are able to produce fibrous tissue and new bone during the process of a fracture repair. The endochondral layer of the otic capsule, however, in general generates very little connective tissue and new bone (26). And for that reason a potential pathway for the spread of infection from the middle ear to the internal ear or subarachnoid space persist for the rest of the patient's life. A wide open fracture cleft with ingrowth of mucoperiosteum may also contribute to the maintenance of a permanent avenue for the development of a potential endocranial complication.

A persistent CSF otorrhea may be caused by a dural tear kept open and require appropriate surgical closure.

In one of our cases with a transverse fracture of the temporal bone, there was a constant CSF otorrhea. The patient developed a meningitis and was operated. During the operation, a fracture line was discovered running parallel to the floor of the middle ear and extending posterior-superioriy to involve the round and oval windows. Due to the purulent labyrinthitis, labyrinthectomy was done.

Fracture, separation and dislocation of the middle ear ossicles often accompany temporal bone fractures but may also be observed without them. They cause a persistent conductive hearing loss which may be amendable to surgical correction. In our study we discovered **16.45%** ossicular injury among all of the temporal bone fractures.

A perilymph fistula at the oval or round -vindow may be observed with or without a temporal bone fracture (11, 12).

A certain number of hearing losses are associated with an injury in the conductive system, in the labyrinth, in the eighth nerve or in the brain. In some cases there is a sensorineural hearing loss without any certain damage in the cochlea, eighth nerve or brain. One explanation for the sensorineural hearing loss is that a blow to the head, presumably induces a pressure wave within the skull which, when transmitted to the cochlea, causes an injury similar to the one of intense acoustic traumas (27). Makishima proved his-

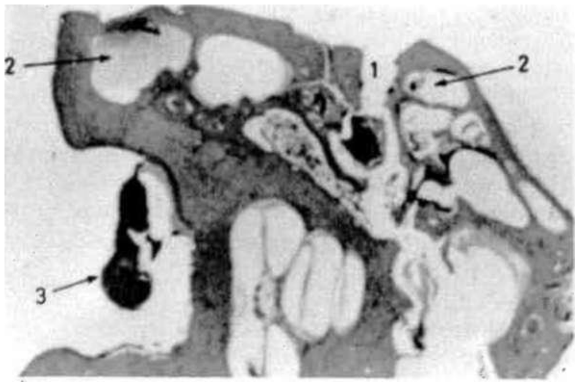

Figure-**3.** Transverse temporal bone fracture:

1. Fractured tegment tympani
2. Blood cloth and serous fluid collection at the pneumatic cellulae
3. Bleeding into the VEIIth nerve

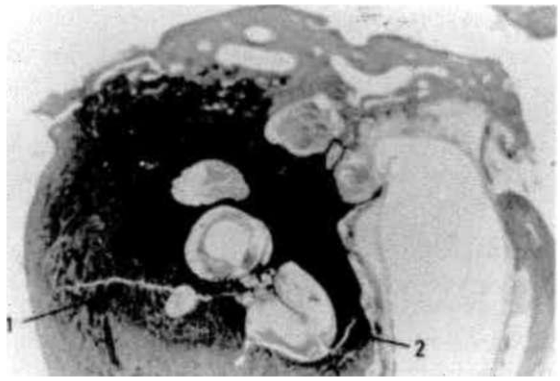

Figure-4. Microfracture of the tomporal bone:

1. and **2.** Microfracture lines at various locations

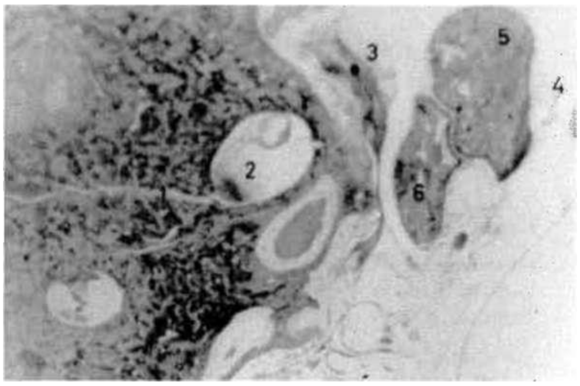

Figure-5. Microfracture of the temporal bone and hemotympanum:

1. **Microfracture line**
2. Blood in the labyrinth

3. and **4.** Blood at the epitympanum

5. Malleus
6. Ineus

tologieally bleeding into the acoustic nerve in head injured guinea pigs without any other visible labyrinthine damage (22).

A vestibular dysfunction may be result of a fracture of the labyrinth, a bleeding into the labyrinth or obvious destruction of the membranous labyrinth. The most common form of dysequilibrium encountered after a head injury is persistent vertigo of the benign paroxysmal type (2, 9) more recently recognized by Schuknecht as cuppulolithiasis. An impact to the temporo-parietal and occipital area is most likely to produce the symptom. The symptom may persist for months, but usually is self-limiting. The phenomenon is reproductible in head hanging position with the involved ear in the downward position. It is presumably caused by disruption of the otolithic membrane, resulting in detachment and free-floating of the otoconia (29).

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