Skull Fractures among Head Injured Patients Attending Accident and Emergency Hospital (Teaching) in Duhok City, Iraq

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Abstract

Objectives: To study the frequency of pattern, types and anatomical location of SF, in relation to the mechanism of injury, occupation and other important social and demographic variables. Also, to assess the outcome of SF within one year.

Methods: A prospective, cross-sectional study on cases having SF attending Accident and Emergency Hospital (Teaching) (AEH) in Duhok City. This study has involved patients having a fresh SF; they were clinically evaluated, stabilized and thereafter subjected to plain skull X-ray (PSXR) and spiral computed tomography (CT) scan examination; no contrast was given; only few of them had magnetic resonance imaging (MRI) study.

Results: There were 88(62.7%) males and 52(37.3%) females. Age ranged from 4 months 70 years, mean 10 years ± 13.5 standard deviation. Patients coming from urban regions formed 85(60.7%), those from rural areas constituted 55 (39.3%). The most common causes were fall from height (FFH) 98(70%), followed by road traffic accidents (RTA) 25(17.9%), assault 4(2.86%), ceiling fan injury 4(2.86%), fall of heavy object on the head 3(2.14%), penetrating injuries by missiles 4(2.86%) and 2(1.43%) injured by unusual material (trauma by a thrown rock 1), and by sharp rotating machine –Kosara. The Glasgow Coma Scale (GCS) score was as follow: 13–15 in 110(78.6%), 9–12 in 19(13.6%) and 3–8 in 11(7.9%) patients.

Conclusion: Patients sustaining HI are mainly young age groups; males are more involved than females. The main causes were FFH, RTA, and assault. The majority of SFs are single, simple, and linear in their patterns.

Keywords: Head injury, skull fracture, neuro-Imaging, spiral computed tomography, magnetic resonance imaging

Introduction

Skull fractures (SF) are classified in three ways: Pattern: (linear, comminuted, and depressed), anatomic location (vault convexity, base), skin integrity.[1] SFs result from large energy forces applied to the head during injury. The extent and type of SF is determined by the kinetic energy of striking object, the direction of the impact force, the geometry of the striking object and the anatomic site of the impact. Forces greater than 1000 lb (454 Kg) in 1 ms are necessary to produce a fracture. Forces that are smaller or take longer to develop cause acceleration of the head rather than produce a fracture.[2] Despite these large forces, a patient with skull fracture may have no signs of brain injury, and conversely, a patient with massive brain injury may have no skull fracture.[2] Skull thickness is not uniform, and therefore, the impact of forces required to cause a fracture depends on the site of the impact. The skull is thick at the glabella, the external occipital protuberance, the mastoid processes, and the external angular process. The skull vault is comparatively thinner than the base of the skull. The skull vault is composed of cancellous bone, the diploë, which is sandwiched between the inner and outer tables and consists of the lamina external (1.5 mm) and the lamina internal (0.5 mm). The diploë does not form where the skull is covered with muscles, leaving the vault thin and prone to fracture. Skull fractures are more easily sustained at the thin squamous temporal and parietal bones, the sphenoid sinus, the foramen magnum, the petrous temporal ridge, and the inner parts of the sphenoid wings at the skull base. The middle cranial fossa forms the thinnest part of the skull and thus represents the weakest part, which is further weakened by the presence of multiple foramina. Other sites at risk for fracture are the cribriform plate, the roof of orbits in the anterior cranial fossa, and the areas between the mastoid and dural sinuses in the posterior cranial fossa. A linear fracture result first at a point of weakness when the SF fail to undergo further elastic deformation as a response to impact while comminuted fracture results when the impact force sufficient to break the bone under the point of impact and further through areas of weakness in to multiple pieces. The dura is easily torn in skull base fracture; this places subarachnoid space in direct contact with paranasal sinuses or middle ear structures providing a pathway for infection. The thickness and pliability of the skull vary among individuals and with age, as does the thickness of dura and its adhesion to the skull. These variations result in difference in the injuries that follow trauma e.g. neonates have green-stick depressed fracture because of flexibility of bone. Epidural hematomas without skull fracture occur in children and young adults because of the relative ease with which the dura strips from the calvaria.[1–4] Trauma is the leading cause of death and disability in people under 45 years of age worldwide. Up to 50% of trauma, fatalities are due to head injury (HI), but HI represents a much greater proportion of permanent disability.[5] The SF does, however, show that significant head trauma has occurred, and so a careful assessment of brain, facial structures, and cervical spine is required.[1] The main causes of HI are road traffic accidents, falls, and assaults.[5] Early definitive diagnosis and management of SF decrease morbidity and mortality as well as achieving maximal functional and aesthetic rehabilitation.[2] Improved emergency medical services and campaigns for road safety have seen a relative reduction in both the incidence of injury and the number of resulting fatalities.[6]

SFs are classified according to whether there is a single fracture line (fissure or linear), several fractures radiating from a central point (stellate), or fragmentation of the bone (comminuted), and whether the edges of the fracture line had been driven below the level of the surrounding bone (depressed) or not.[7]

Aims of Study

To study the frequency of pattern, types and anatomical location of SF, in relation to the mechanism of injury, occupation and other important social and demographic variables. Also, to assess the outcome of SF within one year.

Methods

One hundred – forty consecutive head injured patients, having fresh skull fracture attending AEH having sustained head trauma, over period from Jan 2017 through December 2017, were included in the study. The patients and/or his/her relatives, guardians, or witness were asked about the cause of head injury. A simple format was designed for registering the frequency of pattern, type, site of SF, whether the fracture was simple (closed) or compound (open), single or multiple, CSF leak, other associated lesions and variables such as age, gender, occupations, residential areas, in the same event; the need for a surgical intervention was also documented. Also, in case of a child, an inquiry was made about family supervision at the time of accident. The clinical severity of the injury was assessed according to the Glasgow Coma Scale (GCS); the patients were given the appropriate GCS score. After the clinical condition of the patients with SF had been stabilized, the general and the neurological conditions were assessed. All patients had plain skull X-ray (PSXR) films (postero-anterior and lateral projections), and a complete set of cervical spine films would have been taken, and spiral CT scanning. Thin and high-resolution CT reconstruction for the diagnosis of basal skull fracture, no contrast was given; axial slices with thickness 0.5 mm for basal skull and 0.8–10 mm to the vertex were taken. Only few of them had magnetic resonance imaging (MRI) study, at the Radiology Department of the Azadi General Hospital (Teaching). Both bone and brain windows were taken for various intracranial structures, when indicated. Ethical approval no. 129 in 1-12-2016.

Results

Age and Gender

The age has ranged between 1 month and 70 years (mean 10 ± 13.5) (Table 1) 62 of them are in the paediatric age group, below the age of 14 (Table 1).

To compare the median age among cases categorized by mechanism of injury, it was significant with chi-square of 33.87 and *P*-value of 0.000 (the test is Kruskal Wallis test). As far as sex is concerned, 52 are females and 88 are males (Table 1).

Residential Area

Regarding the residential regions, most patients have come from urban 85 (60.8%), while 55 patients (39.2%) came from rural areas, Table 2.

Causes of Skull Fractures

As it is shown in Table 3, fall from height have stood for the majority of causes (70%) among the study patients, followed by RTA (17%), two of them died before any surgical intervention, one was a child, the other was a-50-year old. Four patients (3.8%) had been assaulted on their heads; two patients died, one was 70 year, the other 27 years old (no pediatric abuse noticed); 4 patients had penetrating injury, only one from rural area of Duhok. The rest were victim of blast injury from Mosul City, Nineveh Governorate; their injuries were mild and superficial. Other various causes were also responsible for HI. Unfortunately, one child died from HI by the fall of TV set on his head.

Table 1. **Distribution of patients by age and gender groups**

Age groups	Patients		Total	Percentage
	Male	Female		
4–12 months	6	3	9	6.4
1 year–9 years	57	39	96	68.6
10 years–19 years	11	6	17	12.1
20 years–29 years	8	1	9	6.4
30 years–39 years	2	3	5	3.6
40 years–49 years	2	0	2	1.4
50 years–59 years	1	0	1	0.7
60 years–70 years	1	0	1	0.7
Total (%)	88 (62.7%)	52 (37.3%)	140	100%

Table 2. **Distribution of patients by residency area**

Residency	Number of patients	Percentages
Rural	55	39.3%
Urban	85	60.7%
Total	140	100%

Table 3. **Distribution of patients by causes of head injury**

Causes	Number of patients	Percentage	Number of dead patients
Fall from height (1–4 m)	98	70	–
Road traffic accident	25	17.9	2
Assault	4	2.9	2
Ceiling fan injury	4	2.9	–
Blunt trauma by fall of fall of the TV set	3	2.1	1
Penetrating missile (bullet)	Mosul 3 Duhok 1	2.9	–
Miscellaneous	2	1.4	–
Total	140	100%	3.5%

Symptoms and Signs

Glasgow Coma Scale Score

Considering GCS score, (Table 4), most of patients, 110 (78.6%), had GCS score of (13–15), 19(13.6%) had a score of (9–12), and only 11(7.8%) had GCS from (3–8); the latter group was severely injured.

Other Symptoms and Signs

One hundred and twelve patients have suffered post-traumatic headache (80%), 22(16%) vomiting, 2(1.4%) otorrhoea, 2(1.4%) rhinorrhoea, 22(16%) had peri-orbital haematoma, 21(15%) lateralizing signs, 2(1.4%) ecchymosis over mastoid (Battle's sign). Two patients had early post-traumatic seizure, and 10(8%) showed cranial nerve palsies. Extra-cranial injuries were also present (Table 5).

Family Supervision

Most of children are below the age of 14 years, see Table 6; 69(60.5%) lack family supervision at time of accident. Only 45(39.5%) had family supervision at time of accident, Table 6.

Radiological Findings

Pattern of Skull Fractures

All patients have PSXR and CT scanning, the pattern of SF was as follow: fissure fracture 97(69.3%), depressed 23(16.4%), fracture base of skull 14(10%), 6 of which involved the ethmoid and sphenoid paranasal sinuses and 8 petrous temporal bone, and 6 patients had diastatic fractures (Table 7).

Anatomical Sites of Skull Fractures

Regarding the distribution of fractures according to their site, Table 8, the majority of vault fractures are as follow: frontal 50, parietal 36 and temporal 29. Few SF involved more one site.

Pathologies Associated with SF

As far as intracranial haematomas are concerned (Table 9), there were 27 patients with EDH, 8 SDH, 3 had combined EDH and SDH, 8 ICH (both intra-parechymal and intraventricular), 3 infra-tentorial haematoma and one with a supra- and infra-tentorial haematoma at the same time. Other CT scan findings such as cerebral haemorrhagic contusions

Table 4. **Distribution of patients by GCS score on admission**

Glasgow coma scale score	Number of patients	Percentage
13–15	110	78.6%
9–12	19	13.6%
3–8	11	7.9%
Total	140	100%

Table 5. **Distribution of patients by other associated symptoms and signs**

Symptoms and signs		Number		Percentage
Headache		112		80%
Vomiting		22		15.7%
Peri-orbital hematoma (raccoon eyes)		22		15.7%
Lateralizing signs		21		15%
Cranial nerve palsies (transient)		III nerve 5, VI nerve 1, VII nerve 4		7.1%
CSF rhinorrhoea		2		1.4%
CSF otorrhoea		2		1.4%
Early epilepsy		2		1.4%
Extracranial injuries	Fracture maxillae	2	10	7.1%
	Fracture mandible	1		
	Fracture clavicle	3		
	Fracture radius	2		
	Fracture femur	2		

III nerve, occulomotor nerve; VI nerve, abducent nerve.

Table 6. **Family supervision for patients in paediatric age group (9 months –14 years)**

Family supervision	Rural area	Urban area	Total number of patients	Percentage
Yes	5	40	45	39.5
No	60	9	69	60.5
Total	65	49	114	100

Table 7. **Pattern of skull fractures**

Pattern of skull fractures	Number of patients	Percentage
Fissure (linear and curvilinear)	97	69.3
Depressed fracture	23	16.4
Skull base fracture	14	10
Diastatic (lambdoid and sagittal sutures) fracture	6	4.3

Table 8. **Distribution of fractures according to their site**

Site	No. of cases
Frontal	50
Parietal (2 crossing midline)	36
Temporal	29
Occipital	10
Frontoparietal	5
Temporoparietal	2
Ethmoid	2
Sphenoid (midline)	2
Petrous temporal, basal	8

Table 9. **Computed tomography scan finding**

Type of lesion	Number of patients
Extradural hematoma	27
Subdural hematoma	8
Combined extra- and subdural hematoma	3
Intra cerebral hematoma	9
Posterior fossa hematoma	3
Cerebral hemorrhagic contusions	10
Pneumocephalus	6
Cerebral edema	5
Subarachnoid hemorrhage	5
Intracranial bullet	1

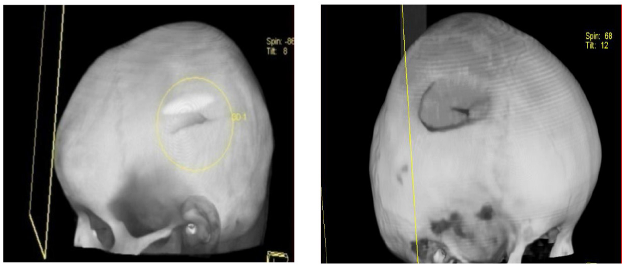

Fig. 1 **3D CT scan showing a left (picture on the left) and a right (picture on the right) parietal compound depressed fracture of two different children both of them had sustained fan injury.**

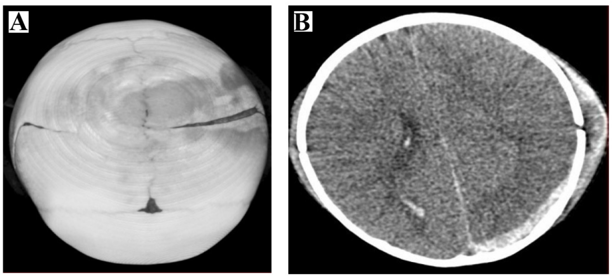

Fig. 2 **(A) 3D computed tomography scans of child with two parietal factures. (B) CT scan axial view, same child, subdural hematoma in occipital lobe.**

(10), pneumocephalus (6), cerebral oedema (5), SAH (5) and the intracranial bullet.

Discussion

In this study which has included one hundred – forty 140 consecutive patients, age range 4 months-70 year included 88 (62%) males and 52 (37%) females; the males constituted the majority of cases admitted to hospital. This result is similar to other studies who found males to be involved more than females in SFs.[8-12] This may be related to the fact that males are more exposed to dangers of work and RTA than females; Annegers et al., think that among the groups at high risk of head trauma are those who have had head trauma previously.[12] HI (among which SFs occur) affects mainly young age groups

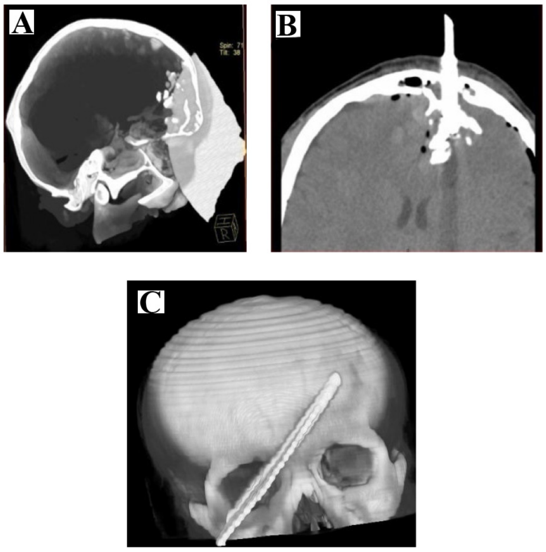

Fig. 3 **(A-C) show various head computed tomography scans of an adult, 19-year-old male with Kosarah injury. There has been injuries involving the left maxilla, orbit, frontal sinus and reaching frontal lobes of the brain.**

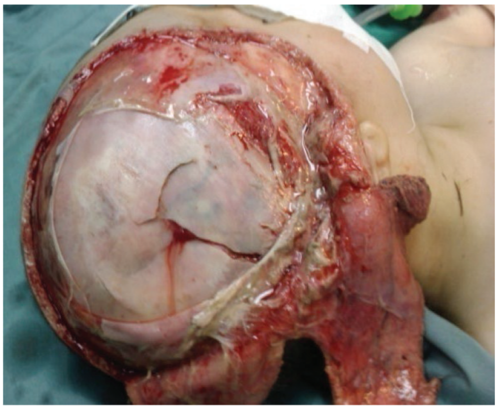

Fig. 4 **A child with compound depressed parietal fracture, also there is extensive scalp laceration.**

(Table 1); the mean age in our study was below age of 30; this is because the young are among the most active group in the community; this makes them more vulnerable to accidents than others.[13] Other researchers had found similar results.[13–16] Another factor which applies to younger children is the relatively larger head size compared to the body than in adults. Also children are more vulnerable to head trauma as a result of carelessness, lack of judgment, and battering.[17] However, in societies where the aging population is marked, head injuries do constitute a health and social problem that deserves specific consideration(s) as reported by Ohno et al., from Japan.[18] Regarding the residency, (Table 2), most of the study patients come from urban 85 (60.8%) in contrast to 55 (39.2%) coming from rural areas. Again, the former group will be exposed to the hazards of fall off higher buildings and to more road traffics, and accidents at work due to the pattern of life in the industrialized society; the author supports the idea that HI may accompany the phenomenon of urbanization. FFH as a major cause of HI as shown in Table 3 of this study is almost similar to other studies, although most had happened at domestic (residential) sites and addressing the importance of family supervision as a preventive factor, unfortunately, few occurred at school when students climbed up schools' fences; these events address the importance of school supervision as well. However, many other studies address RTA as a predominating cause.[10–12] This difference is probably due to the study size and design and to local community circumstances. It is interesting to mention that none of our RTA patients was injured in a bicycle or motorcycle accident. This is due to the fact, such sport is not prevalent in Iraq; moreover, modernly designed-attractive bicycles and motorcycles are relatively expensive and that the majority of families cannot afford to buy them. Concerning disturbance of consciousness, which is a sign of brain dysfunction, is a common sequel of HI (Table 4) and usually correlates well with the severity of the injury. GCS scores seen on admission indicate the mild profile of HI in this study. Many other studies had shown similar results.[16,19,20] Many symptoms and signs are mentioned in (Table 5) which commonly occur in HI, most of which are managed conservatively or with appropriate symptomatic drug therapy, although few of them may cause anxiety to the patient and / or his / or her family who need reassurance. However, when it becomes persistent, then it deserves further investigation(s) and may need other appropriate treatment modality.[21] Similarly, interestingly, Hugenholtz et al., addressing the problem of vomiting in HI, have concluded that post-traumatic emesis is more common following minor head injuries than following more severe head injuries. The presence of a skull fracture or the site of the impact does not influence the incidence or duration of post-traumatic emesis. Retching and vomiting generally subside within 3 h in children injured within an hour of a meal or snack. When vomiting appears in children injured more than an hour after a meal or a snack, it may be quite protracted (mean = 7.5 h).[22] Their counterparts injured more than an hour after a meal or snack are likely to remain distressed much longer and are best admitted to hospital.[20] Sharma et al., mention that one third of paediatric HI were brought to hospital with vomiting, however, the incidence of vomiting in this study is 16% (Table 9); this is probably due to the inclusion of older age groups.[20] The incidence of post-traumatic seizure by the time the HI-patients presented to the Emergency Department, is quite low, (1.4%), and is similar to other studies.[22,23] This is probably due to the mild profile of HI in this study. Table 6 shows the lack of family supervision to 69(60.5%) HI-victims at time of accident. Only 45(39.5%) had family supervision at time of accident, most of the children below the age of 14, a problem that has been addressed by many authors.[8,9] Although many accidents have taken place outside residential areas, such as on the roads while going to or coming back from school, the authors think that it is the duty of the family to provide a state of child watch in order to avoid such unfortunate events. Moreover, although this study does not report the occurrence of accident at schools, however, Hammarstrom et al., have reported HI occurring at school sites,[24] therefore, it is advisable to extend children supervision to school premises. According to the pattern and site of the fractures (Table 7), there were fissure fracture 97(69.1%) outnumbering other types of SF; this is probably due to the more diffuse distribution of the biomechanical energy input rather than to the localized injury site that results in the depressed and comminuted SF. Most of the patients who had the fissure SF were children. Older patients had mainly the depressed comminuted SF probably due to the inter-personal violence (physical assault). The majority of SFs in this study has involved the frontal, parietal and temporal bones, probably because these sites are most prominent (apparent) and not protected. Regarding the association of intracranial haematomas with the presence of SFs, since this study involves patients selected for having SFs, evidently, all intracranial haematomas were associated with one or more SF. It is a well known fact in neurosurgical practice that the occurrence of intracranial haematomas is accompanied by a higher incidence of SFs. Kaye et al., analyzing a consecutive series of 200 cases of EDH, mention that a fracture overlies the haematoma in nearly all (95%) adults and most (75%) children and that 66% of EDH are in the temporal region, 11% in the frontal region and 7% in the parietal region.[25] Other CT scan findings are concerned, e.g., pneumocephalus, intracranial contusion, SAH, and other lesions (Table 9), their presence is similar to the huge studies mentioned in the neurosurgical literature, though the incidence of various lesions may differ, some substantially. For example, while this study reports a low incidence of intracranial pneumocephalus. Steudel et al, found pneumocephalus in 40 out of 49(82%) of head injury patients within 6 hours of the accident. They think that while injuries associated with a pneumatocele or a single intracranial air bubble have a good prognosis, as do frontobasal lesions, injuries associated with multiple air bubbles have a bad prognosis.[26] Some of such findings may represent a serious threat to the patient and should prompt the neurosurgeon to adopt active appropriate clinical measures that may include surgical intervention.[24,27] However, in certain circumstances, the neurosurgical services department may take a social action e.g. in case of a child abuse.[28,29]

Conclusion

Patients sustaining HI are mainly young age groups; males are more involved than females. The main causes were FFH, RTA, and assault. The majority of SFs are single, simple, and linear in their patterns. Also, lack of family supervision was seen in children with FFH. HI can be responsible for many of avoidable domestic events. Although the majority of cases had high GCS scores indicating a mild degree of trauma, however, a proper management and skilled care needed in order not to miss a serious complication that may complicate aSF, as well as, to effect recovery.

References

1. Rengachary SS, Ellenboqen RG. Principle of Neurosurgey (2nd ed.). Traumatic skull and facial fracture. Edinburgh London New York Oxford Philadelphia St. Louis Sydney Toronto Elsevier Mosby 2008: 329–360.
2. Wilkins R H, M.D, Setti S Rengachary. Neurosurgery (2nd ed.). Head trauma and spinal trauma, skull fracture. New York: McGraw-Hill, 1996.
3. Biros MH, Heegaard WE. Head injury. In: Marx JA, ed. Rosen's Emergency Medicine: Concepts and Clinical Practice (7th ed). Chap 38. Philadelphia, Pa: Mosby Elsevier, 2009.
4. Leveque JC. Hoff JT. Neurosurgery. In: Greenfield LJ, Mulholland MW, Oldham KT, Zelenock GB, Lillemoe KD, eds. Greenfield's Surgery: Scientific

Principles and Practice (4th ed.). Chap 114. Philadelphia, Pa: Lippincott Williams & Wilkins, 2005.
5. Beaumont A, Marmarou A. Response of the brain to physical injury. In: Alan Crochard, Richard Hayward and Julian T. Hoff eds. Neurosurgery The Scientific Basis of Clinical Practice. Blackwell Science 2000;460–478.
6. Jennett B (1996). Epidemiology of head injury. J Neurol Neurosurg Psychiatr. 1996;60:362–9.
7. Tyson GW (1987). Basic concepts. In: Head Injury Management for Providers of Emergency Care ed. Baltimore London Los Angeles Sydney: Williams and Wilkins, 1987:24–26.
8. Teasdale G., Jennett B. Assessment of coma and impaired consciousness: A practical scale. Lancet 1974;2:81–4.
9. Moore RS, Summers CL, Jackson M, Tesfayohannes B. Paediatric road accidents in two health districts.JAccidEmerg Med Jun 1994;11(2):109–11.
10. Al-Rawi WWH, Kadhem S. Head injury admission to Basrah Teaching Hospital: outcome and financial implications. The Iraqi Journal of Medical Sciences 2001; Vol I (3):333–9.
11. Mlay SM, Sayi-EN (1993). The management of depressed skull fractures in children at Muhimbili Medical Centre, Dar es Salaam, Tanzania. East Afr Med J May 1993;70(5):291–3.
12. Annegers JF, Grabow JD, Kurland LT, Laws ER Jr. The incidence, causes, and secular trends of head trauma in Olmsted County, Minnesota, 1935–1974. Neurology Sep 1980;30(9):912–9.
13. Berney J, Favier J, Froidevaux AC. Paediatric head trauma: influence of age and sex. I. Epidemiology. Childs NervSyst Nov 1994;10(8):509–16.
14. Adeloye A, Al – Kouka N. Acute head injuries in Kuwait .A paper of prospective survey of acute head injuries from Kuwait submitted to the 9th International Neurosurgical Congress in Delhi, India 1989.
15. Sarsam Z.D. Craniocerebral Injuries : A study of the pattern of head injury in a neurosurgical unit in Iraq. A thesis submitted to the Iraqi Commission for Medical Specializations 1993.
16. Lyie D.M., Pierce J.P., Freeman E.A., Rushworth. Clinical course and outcome of severe head injury in Australia . J. Neurosurgery 1986;65:5–8.
17. Jennett B. Medical aspects of head injury. Medicine International 1987;1595–1601.
18. Ohno K, Suzuki R, Masaoka H, Matsushima Y, Inaba Y, Monma S, Asano T. A clinical study on head injuries in the aged. No Shinkei Geka 1987 Jun; 15(6):607–11.
19. Tyson GW. Treatment of head injuries. In: Head Injury Management for Providers of Emergency Care ed. Baltimore London Los Angeles Sydney: Williams and Wilkins 1987; 183–4.
20. Sharma M, Sharma AK. Mode, presentation, CT findings and outcome of pediatric head injury. Indian Pediatr 1994 Jun; 31(6): 733–9.
21. Hodgkinson DW, Berry E, Yates DW. Mild head injury - a positive approach to management. Eur J Emerg Med. 1994 Mar;1(1):9–12.
22. Hugenholtz H, Izukawa D, Shear P, Li M, Ventureyra EC. Vomiting in children following head injury. Childs NervSyst 1987;3(5):266–70.
23. Annegers JF, Grabow JD, Groover RV, Laws ER Jr, Elveback LR, Kurland LT. Seizures after head trauma: a population study. Neurology Jul 1980; 30(7 Pt 1):683–9.
24. Hammarstrom A, Janlert U. Epidemiology of school injuries in the northern part of Sweden. Scand J Soc Med Jun 1994;22(2):120–6.
25. Kaye AH. Traumatic intracranial haematomas. In: Kaye AH ed. Essential Neurosurgery. New York Edinburgh London Madrid Melbourne San Francisco and Tokyo: Churchill Livingstone 1996;81–91.
26. Steudel WI, Hacker H. Prognosis, incidence and management of acute traumatic intracranial pneumocephalus. A retrospective analysis of 49 cases. ActaNeurochir Wien 1986;80(3–4):93–9.
27. Al-Rawi WWH, Ameen AA, Al-Ta'ee MA. Computerized tomographic scan findings in patients with persistent acute post-traumatic headache. Basrah Journal of Surgery 1995 March; Vol 1 (1):74–8.
28. Tsai FY, Zee CS, Apthorp JS, Dixon GH. Computed tomography in child abuse head trauma. J ComputTomogr Dec 1980; 4(4): 277–86.
29. Cohen RA, Kaufman RA, Myers PA, Towbin RB. Cranial computed tomography in the abused child with head injury. AJR Am J Roentgenol. Jan; 146(1): 97–102.