COMPOUND DEPRESSED FRACTURES OF THE SKULL AT THE KENYATTA NATIONAL HOSPITAL

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This thesis is submitted in part fulfilment for the Degree of Master of Medicine (Surgery) in the University of Nairobi.

1985

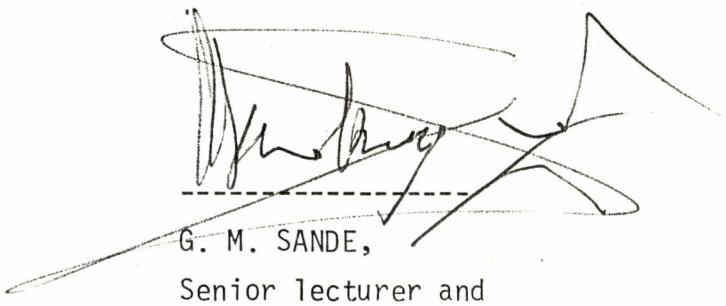
C O N T E N T S

D E C L A R A T I O N

This thesis is my original work
and has not been presented for
a degree in any other University.

MUBASHIR MAHMOOD QURESHI

This thesis has been submitted for
examination with my approval
as University supervisor.



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I am indebted to Mrs. Razwana for her valuable secretarial assistance.

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INTRODUCTION

Compound depressed fracture of the skull is one in which a depression of a vault fragment is accompanied by a laceration of the overlying scalp through all its layers. It is a common type of head injury seen at the Kenyatta National Hospital. Severe brain injury, with its attendant prolonged unconsciousness, is uncommon. The majority of those properly treated recover rapidly and completely. However, inappropriate treatment carries the risk of serious complications that often worsen the prognosis of even those whose initial injury appears trivial. The risk of intracranial infection is high in all compound fractures of the skull. Mortality rate is increased by infection, development of intracranial haematoma and brain abcess formation. Late epilepsy is a closely related complication, and inadequate management increases this risk. The injury, furthermore, affects young adults who, in most instances are sole income earners of their families.

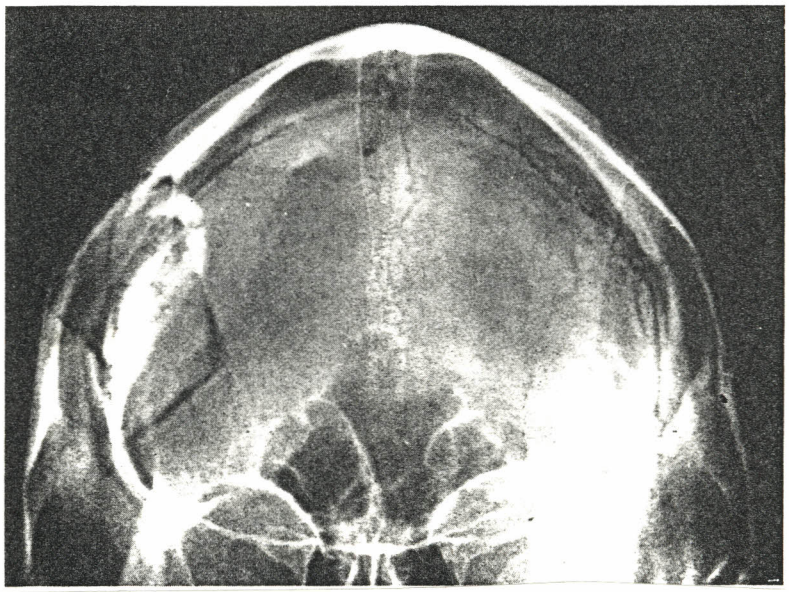
The objectives ofthis study revolve around the aforementioned problems, and are the following:

- Determine the age and sex relationship, and identify any particular risk group.
- Identify thecauses of injury and assess their relationship to severity and prognosis.
- Seek the factors that complicate the initial injury, and identify those at risk.
- Assess the status of management of this injury in our national referral hospital vis-a-vis the status in other neurosurgical centres, with particular attention to mortality, infection and final sequele of neurological disability.
- Assess the incompletely resolved controversy regarding primary replacement of bone fragments at operation in order to determine whether or not this increases the risk of infection.

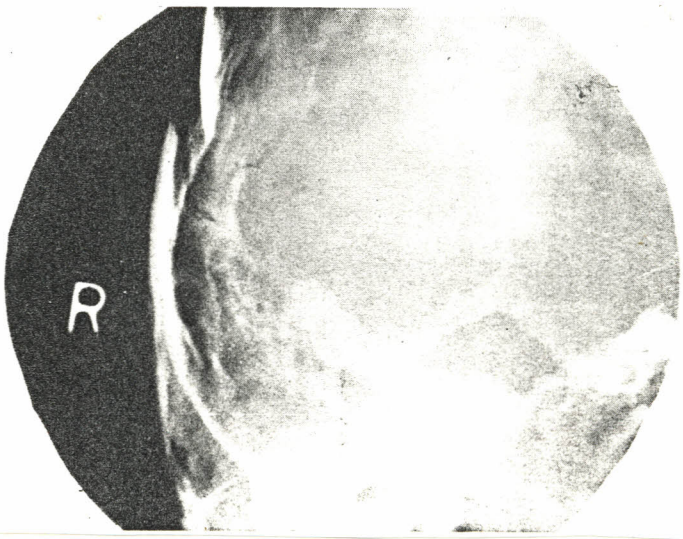
Finally it is hoped that this study will provide insight into this type of injury as seen at our hospital and prompt discussion about ways to help our patients in the best manner possible.

Plate I: Examples of Depressed Skull Fracture.

a. Involving Right Lateral Frontal Region.
b. Involving Right Parietal Region.



(a)



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MATERIALS AND METHODS

Kenyatta National Hospital serves as a national referral hospital to all government, provincial and district hospitals. It is also the only government hospital serving the Kenyan capital, Nairobi, with its population of about 1 million. In this series 60% of the compound depressed fractures presented directly while 40% of the cases were referrals from the peripheral provincial and district hospitals.

In Kenyatta National Hospital (KNH) a patient presenting with a compound depressed skull fracture is seen at the casualty by the casualty medical officer. After a general examination and institution of the initial management, appropriate radiographs are requested. The patient then receives his dose of Tetanus toxoid and the scalp wound is cleaned and sutured in the casualty minor theatre. All compound depressed fractures of the skull are admitted under the care of primary surgeons (includes general surgeons and orthopaedic surgeons) and the senior house officer (SHO) in these wards institutes other necessary management. The general surgical SHO then makes the necessary consultations, dealing with the SHO working in the neurosurgical unit. All neurological surgery required by these patients is conducted, with necessary consultation of the neurosurgeon on call, by the neurosurgical SHO.

This study is based on 100 patients admitted to the Kenyatta National Hospital with a compound depressed fracture of the skull between December 1982 to May 1984. Record files for all patients admitted with head injury were examined. These included the following 402 patients.

- Head injury with no vault fracture and no Haematoma = 168 (41.8%).
- Head injury with linear vault fracture and no Haematoma = 84 (20.9%).
- Head injury with associated Intracranial Haematoma = 15 (3.7%).

These included Extradural Haematoma - 3.
Subdural Haematoma - 4.
Unspecified - 6.
Extra + Subdural - 1.
Intracerebral - 1.

All these patients had a vault fracture.

- Fracture of the base of the skull = 21 (5.2%).
- Closed depressed fracture of the skull = 14 (3.5%).
- COMPOUND DEPRESSED FRACTURE OF THE SKULL = 100 (24.9%).

Total 402

Analysis was carried out for the compound depressed fracture and proportions presented as percentages. Where important differences occured due to a second factor, the difference was tested using the 't' test. This was calculated using the standard error of the difference, and the difference between the proportions. The 't' value was then used to get the probability value 'p'. This was categorised as follows:

- P less than 0.05 : weakly significant.
- P less than 0.01 : significant.
- P less than 0.001 : highly significant.
- N/S : not significant.

HISTORICAL INTRODUCTION

Compound depressed fractures of the skull have presented a problem in management ever since Man learnt to wield stick and stone against his fellow beings. Prehistoric skulls have shown evidence of surgery on the head. In Europe trepanning may have been performed some 10,000 years ago (47) and it was certianly done during the Neolithic period (23). The purpose, though obscure, may have been treatment for neurological complaints including depressed fractures. And the 'patients' survived: the majority of the trepanned skulls show signs of healing, saying much for the skill of the 'surgeon'.

The Edwin Smith papyrus describes a 1700 BC ancient Egyptian management of 27 head injuries of which 4 were compound depressed fractures (48). Such ailments were not to be treated. They were pasted with grease and not bandaged to allow free drainage. The trepan is not mentioned.

The Greeks were more aggressive. The Hippocratic corpus describes the trepan for skull indentations and advises great care to avoid dural damage. It was not to be used over suture lines and course of meningeal vessels (33).

Celcus (25 BC - 37 AD) used the trepan for elevation and excision of depressed fractures. His teaching remained standard textbooks until the Middle Ages.

Heliodorus (100 AD) instructed that depressed fractures be treated by removal of all bone fragments pressing on the dura. The skull was to be trepanned near the fracture and the instrument cooled by dropping water into the wound. To stop the patient hearing the sounds of the surgery his ears were stoppered.

It is of special interest to note that in Kenya there exists upto today a particular group of traditional medicine men among the Kisii tribe in Western Kenya, who perform craniotomies for reasons including elevation of depressed fractures. Meching (25) reports these observations and having reviewed photographs and X-rays of patients who have undergone this operation by 'medicine men of primitive cultures' is convinced that these trapanations have a long tradition.

For the next two thousand years from days of Helidorus there persisted the reluctance to treat wounds in which the dura was torn because of the grave outlook.

With the advent of gunpowder brought in Europe from China by Mongols, penetrating injuries became even deadlier. The devastation was attibuted to poison. Giovanne da Vigo (1460 - 1525), surgeon to Pope advised cautery using boiling elder oil to prevent the poison from spreading.

For wounds of the skull and brain Pare' recommended straining with nose and mouth closed to 'force out the sanious matter and filth'. Trepanning for depressed fractures was done to evacuate 'sanies or matter poured forth upon the membranes'.

Until the 18th century is was believed that blood accumulated in the extradural or subdural spaces eventually became pus, explaining the invariable occurence of sepsis in penetrating head wounds.

While John Hunter (1728 - 1793) surgeon to the British troops, impressed by the good health of captives injured 5 days previously, concluded that the correct approach was to delay treatment, Pare' and Baron Larrey (1766 - 1842) of the Napoleon's army recognised the need for prompt attention and developed the evacuation of the injured using ambulances.

Further advances awaited a further century, when Lister's antiseptic methods were introduced in 1867. The availability of antiseptics in the Boer War (1899 - 1902) reduced surgical infection to an unprecedented level. Meningitis and the general death rates in wounds of the head occurred less often, and operative inteference became more justified. Distrust in the methods requiring surgical debridement and reliance on antiseptics alone resulted in disaster during the War of 1914 - 1919, during which time it was considered sufficient to merely clean a wound with antiseptic and suture it. The disasters were such that in 1916 primary suture was forbidden.

Cushing (6) - 1918, advocated prompt surgical intervention to reduce infection. Under local anaesthesia the scalp wound and cranial wound were excised. Indriven bone fragments were picked up using foreceps. Clots and necrotic brain were removed by irrigation and suction. Irrigation of track using an antiseptic was performed and the dura closed where possible. The scalp was repaired in 2 layers with silk.

Cushing, Horsley, Horrax and Jafferson laid the foundations of present day management of missile injuries to the head.

During the World War II (1939 - 1945) Cushing's methods were practiced. Sulphanilamide and sulphadiazine were introduced and early operation done (within 48 hours in the majority). With advent of sodium thiopental (Penthothal) general anaesthesia became preferred. The infection rate (brain abcess rate) in the Middle East in 1941 - 1942 was 27%. By 1945 the figure was reduced to 3% using prompt casualty evacuation and increasingly thorough debridement. Rapid evacuation by helicopter was a feature of the Korean War. Penicillin was now preferred. Prompt evacuation was a feature of the Cyprus and Vietnam War and the conflict in 1974 in North Ireland.

Current practice emphasises prompt resuscitation, immediate hyperventilation with respirator to protect airway and to control raised intracranial pressure. Surgery aims at removing all bone fragments and devitalised brain tissue, repair of dura and closure of scalp without tension. Post op a high standard of nursing care and physiotherapy are important. At a later date the skull defect can be repaired by a cranioplasty.

SUMMARY

AGE AND SEX:

The majority, 91% were males. 13% were below 16 years of age. Almost two-thirds were between 16 and 40 years. Only one was below one year and one other above 60 years.

OCCUPATION:

The unemployed and casual workers formed the majority. Nearly half of those working as 'casuals' were employed as night watchmen. Skilled workers were absent from the series, perhaps because such patients seek medical treatment at private care institutions.

INCIDENCE:

The injury was commoner towards the weekend by a small percentage. Almost half occured in the last week of the month, while the last and the following first weekend of the month had 66% of all the injuries.

The overall monthly incidence for the period studied was 5.5 patients.

CAUSE OF INJURY:

Assault was the most common cause (72%). The 'panga' was the commonest weapon of assault. Iron bars, 'rungu' (club), axe, knifes and a digging fork ('jembe') were other weapons used. 'Mob justice', a local form of instant justice was the cause in 4 patients suspected of being thieves.

Road Traffic Accidents accounted for 11%, while falls were responsible in 6%. The accidental 'Fork-Jembe injury' occured in 5%. One case was due to an attack by a buffalo.

REFERRALS:

40% were referrals for other hospitals, 36% being from peripheral government hospitals and 4% from private-care institutions within Nairobi. Lack of skilled man-power and lack of operation equipment were the main reason for referral from government hospitals. Patients were referred from private hospitals as they could not afford to pay for private hospital care.

INJURY TO PRESENTATION AT KNH:

5.6% presented within 2 hours, 27% within 4 hours. The majority presented within 24 hours. 22.4% presented after a delay of 24 hours. In 11 patients the time of injury was not known.

TIME OF PRESENTATION TO TIME OF OPERATION:

81% were operated upon; 26 within 24 hours, 22 between 24-48 hours or more after admission. Delayed neurosurgical review, missed depressed fracture, postponement of surgery by the neurosurgical SHO, inavailability of blood for surgery and late availability of operating theatre were the main reasons for a delay of greater than 24 hours.

DURATION OF HOSPITALISATION:

The minimum duration was one day and the maximum duration was more than two months. The average duration of stay per patient was 13.7 days.

Of the 81 patients who were operated, 23.5% were discharged within one week, 61.7% within two weeks and 77.8% by three weeks. 6 patients were hospitalised for more than a month. 2 of these remained in hospital for more than 2 months.

LEVEL OF CONSCIOUSNESS:

86 patients were conscious upon admission; 59 of these were fully oriented while 27 were disoriented. The remaining 14 patients had more severe disturbance of consciousness level.

10 patients were recorded as smelling of alcohol.

SPEECH:

12 patients were aphasic and 7 were dysphasic. The left side of the skull was more commonly involved in these patients, the parietal region particularly so.

ASSOCIATED INJURIES:

16 patients had only a soft tissue injury, while 11 had a more severe associated injury. In all these 11 patients RTA was the cause of injury. These injuries included fracture of limb bones, mandibular fracture, fractured ribs and a cervical spine injury.

CRANIAL NERVE INVOLVEMENT:

Occured in 11 patients. The VIIth cranial nerve (9 cases), IIIrd cranial nerve (1 case) and VIth cranial nerve (1 case) were the nerves involved.

77.7% of those who had a VIIth nerve involvement had an associated intracranial mass lesion (ICML). Laceration of the dura was found in 88.8% of those who had a VIIth nerve involvement.

PUPILLARY REACTION:

Was abnormal in 9 patients. In 8 of these an associated intracranial mass lesion (haematoma or brain abcess) was present.

SITE OF INJURY:

Assault involved the left side of the skull more commonly. The other causes resulted in an even distribution of fractures on both sides of the skull. The parietal and frontal bones were the most frequently involved, together being involved in 68 cases. The fracture overlay the saggital sinus in 7 patients and over the sigmoid in one. Only one of these patients was operated upon and the sinus was not found to be torn.

LOSS OF MOTOR FUNCTION:

The contralateral upper limb was the most commonly involved limb (25 cases). Contralateral hemiparesis occured in 18 patients. The ipsilateral limbs were involved uncommonly.

EPILEPSY:

11 patients developed an epileptic fit prior to surgery, 8 grand mal in type and 3 focal in type. The grand mal fit was 4 times commoner in the group under 16 years of age, while the focal fit was 3½ times commoner in this group compared to the group above 16 years.

Late epilepsy was not assessed due to the short duration and inconsistent nature of follow up. However, one patient developed grand mal fits 4 months after the injury. He was not among those who had developed early epilepsy soon after injury.

DEEP TENDON REFLEXES:

22.8% had an abnormal reflex pattern. 2 patients had an abnormal (upgoing) plantar reflex on the contralateral side. An intracranial haematoma was present in both instances. The other reflex abnormalities did not relate to an ICML with any certainity.

GAIT:

53% had a normal gait. 3 patients had a staggering gait and one patient developed a limp. Disturbed consciousness and hemiparesis were the most common reasons for inability to walk.

PROPHYLACTIC ANTIBIOTICS:

These were routinely prescribed for all patients admitted with this injury. Chloramphenicol, Crystalline penicillin and ampicillin were the most frequently used drugs. Chloramphenicol was generally used in combination with a penicillin. Combinations varied and were often dictated by availability. The various combinations were therefore not analysed. The chloramphenicol-penicillin combination appeared to reduce the pre-operative wound infection rate. The post operative rate appeared uninfluenced.

CATEGORY OF SURGEON:

92.6% of patients were operated upon by a surgical SHO in training, 4.9% by a qualified surgeon and 2.5% by a neurosurgeon. The small numbers in the latter 2 categories prevented analysis to be carried out in order to assess the influence of the surgeons experience on the outcome.

PRE OPERATIVE (ESTABLISHED) WOUND INFECTION:

Wound infection was established in 11 patients by the time of surgery. All these patients had a trauma to operation interval of more than 48 hours. 81.8% had a delay of more than 96 hours. This appeared responsible in occurence of infection.

POST OPERATIVE WOUND INFECTION:

Occured de novo in 12 patients (14.8%). In all of these the infection was limited to the operation wound. When patients having established infection at operation were included, post op wound infection occurred in 22 patients (27.2%). No cases of meningitis were seen. One patient developed a brain abcess 2½ months after surgery : an incidence of 1.2%.

PRIMARY REPLACEMENT OF BONE FRAGMENTS:

Was done in 20 patients. In 17 of these, replacement was carried out more than 24 hours after injury. 2 cases of wound infection occurred in this group. The overall infection rate was not different from that found after primary bone replacement.

LACERATION OF THE DURA:

Dura was found torn in 39 cases (48% of operated patients). A torn dura was associated with higher incidence of disorientation and impaired consciousness. The post op duration of impaired consciousness was also prolonged when dura laceration was present. All the 4 patients who developed a brain abcess had a torn dura. Incidence of epilepsy, and neurological deficit was higher in those with a torn dura, but this did not reach significant levels. 19 of the patients with a dural tear required a dural graft. Delay in surgery did not influence the need for a graft. Type of graft wasnot analysed due to scanty information.

LACERATION OF THE BRAIN:

This was found in 25 patients. Its severity was graded as 'superficial', 'necrosed brain', 'brain oozing' through fracture site, and brain fungus. The severity was not related to delay in surgery. Level of consciousness and period of post operative unconsciousness was unfavourably affected significantly. Incidence of neurological deficit and epilepsy were increased by severe laceration, though not significantly.

Death occured in 16.6% of patients with 'oozing brain', 7.7% of those with 'necrotic brain' and 0% of those with superficial contusion.

INTRACRANIAL HAEMATOMA AND BRAIN ABCESS:

30 patients had an intracranial haematoma. An extradural was the most common. 5 patients had an intracerebral haematoma. 3 patients had an early brain abcess at operation. These resolved completely with treatment A fourth patient developed a brain abcess 2½ months after operation. Dural laceration was present in all these cases of brain abcess.

BLOOD TRANSFUSION:

54 patients (66.6%) required blood transfusion during surgery. 38% required 1 unit (500 mls.), 26% required 2 units and 2.5% required 3 units. Age did not appear to influence amount of transfusion.

BACTERIOLOGY OF INFECTED WOUNDS:

Escherishia coli was the commonest organism (43%). Staph albus, staph aureus and proteus species were cultured in 14% each. More than one organism was present in half the cultures.

Gentamycin was effective in vitro against all the above organisms. Chloramphenicol with ampicillin was effective against 43% of the organisms. Crystalline penicillin was ineffective in vitro against all the cultured organisms.

POST OPERATIVE COMPLICATIONS:

Occured in 9 patients. 4 of these died. Respiratory failure, bacteraemic shock, tetanus and severe head injury were the reasons for death. Relatively minor complications included bed sores and threatened abortion.

MENTAL STATUS AT DISCHARGE:

69% of patients had no mental on intellectual deficit. 24% had a residual deficit. This included disorientation, aphasia, deficit of memory. One patient was transfered to the nearest hospital in a semicomatose state.

PHYSICAL STATUS AT DISCHARGE:

22 patients had a deficit. All 22 had a monoparesis of the opposite upper limb, while 10 had a contralateral hemiparesis.

OUTCOME AT DISCHARGE:

82 patients resumed normal life, 20 of these having a mild residual deficit. 9 required assistance most of the time, while 2 required assistance all the time. Death occurred in 7 patients.

RTA accounted for 57% of the deaths while assault accounted for 28.6%. Overall the mortality from RTA was significantly higher (36.4%) than that from assault (2.8%) p = less than 0.05.

SECTION I:

GENERAL INFORMATION:

One hundred patients with a compound depressed fractures of the skull were studied. The factors studied are shown in the analysis sheet (see Appendix page 121).

1.1 AGE AND SEX:

There were 91 males and 9 females in the study, providing a male: female ratio of approximately 10:1 (see Figure 1 below).

The age distribution is shown in Fig. 2. 13% were below the age of 16 years. The majority were between the ages of 16 and 40 years. There was only one patient under the age of one year and one patient was above sixty years of age. For 10 adults, age was not specified.

Fig. 1: Sex Distribution.

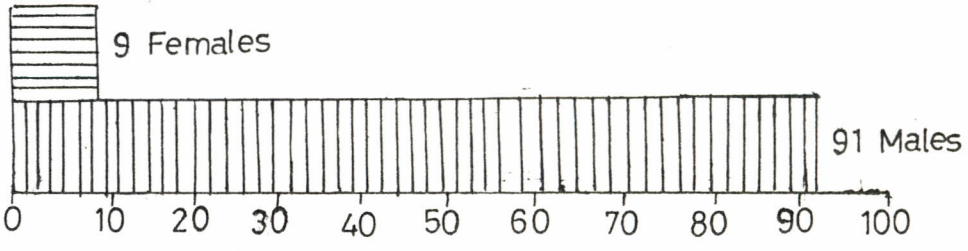
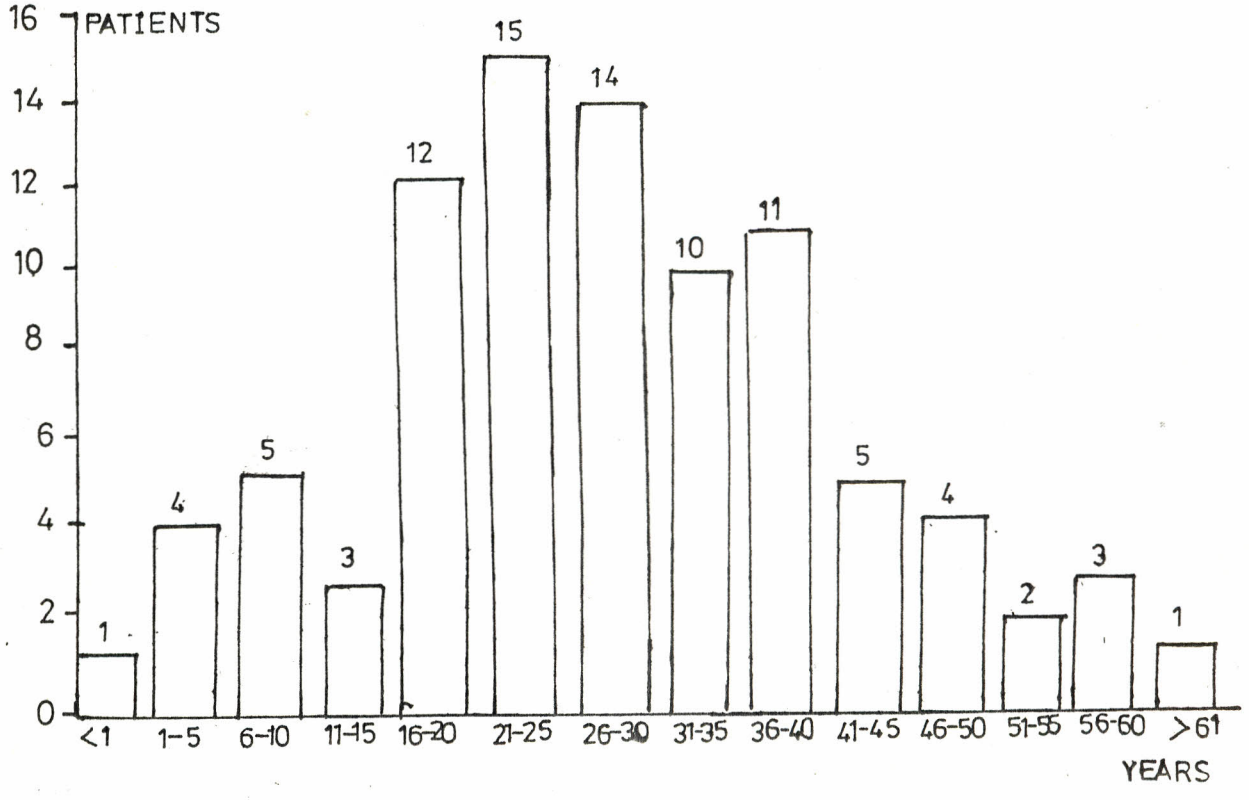


Fig. 2: Age Distribution:



1.2 OCCUPATION:

Casual labourers and unemployed persons formed the majority of the patients presenting to KNH with this injury. None of the patients were categorised as skilled labourers. 10 (47.6%) of the casual labourers were employed as security watchmen at the time of injury, highlighting a special risk group. Other occupation categorises includes Clerical (13%), Semiskilled (10%), and Small Scale Self-employed Traders (9%). The occupation was unknown in 14% of patients (see Table 1 below).

Table 1: Occupation.

Occup.	Un-Employed	Casual	Clerical	Semi-Skilled	Trader	Skilled	Unknown
No./%	20	21	13	10	9	0	14

1.3 INCIDENCE:

The injury was commoner by a small percentage towards the weekend with 18% occuring on a Friday and 17% on a Saturday. However, the incidence on other days of the week was about equal in distribution (Table 2).

Table 2: Incidence.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
14%	15%	13%	10%	18%	17%	13%	100%

The incidence per month for the period December, 1982 - December 1983 was an average of 4 patients per month (see Fig. 3a). The incidence per month for the period January, 1984, to May, 1984, was 9 patients per month. This apparent increase was due to an unexplained high incidence in March 1984 (12 cases) and April 1984 (17 cases) - see Fig. 3b. The overall monthly incidence for the period under study was 5.5 patients per month.

Fig. 3a: Incidence - Monthly for the period Dec 1983 - Dec 1983. Average - 4 patients per month.

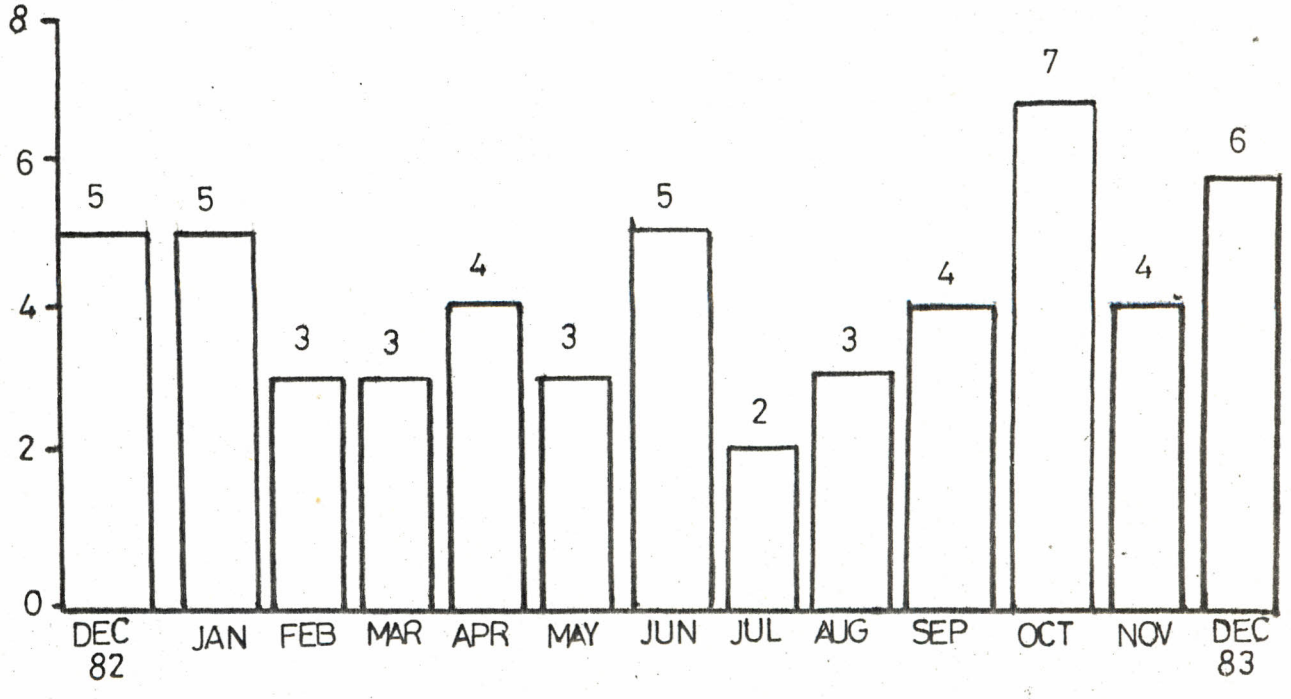
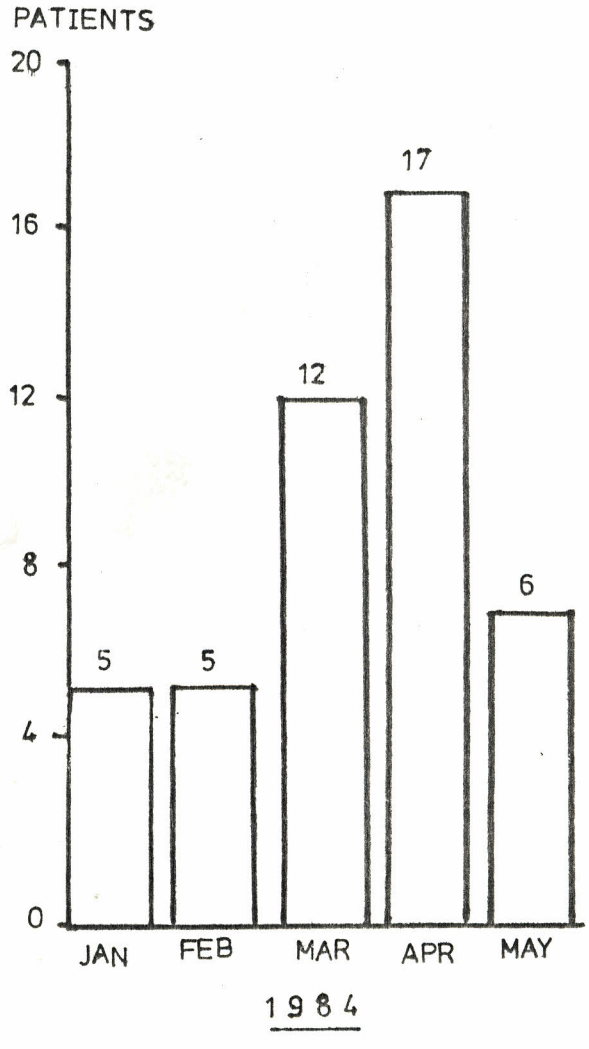
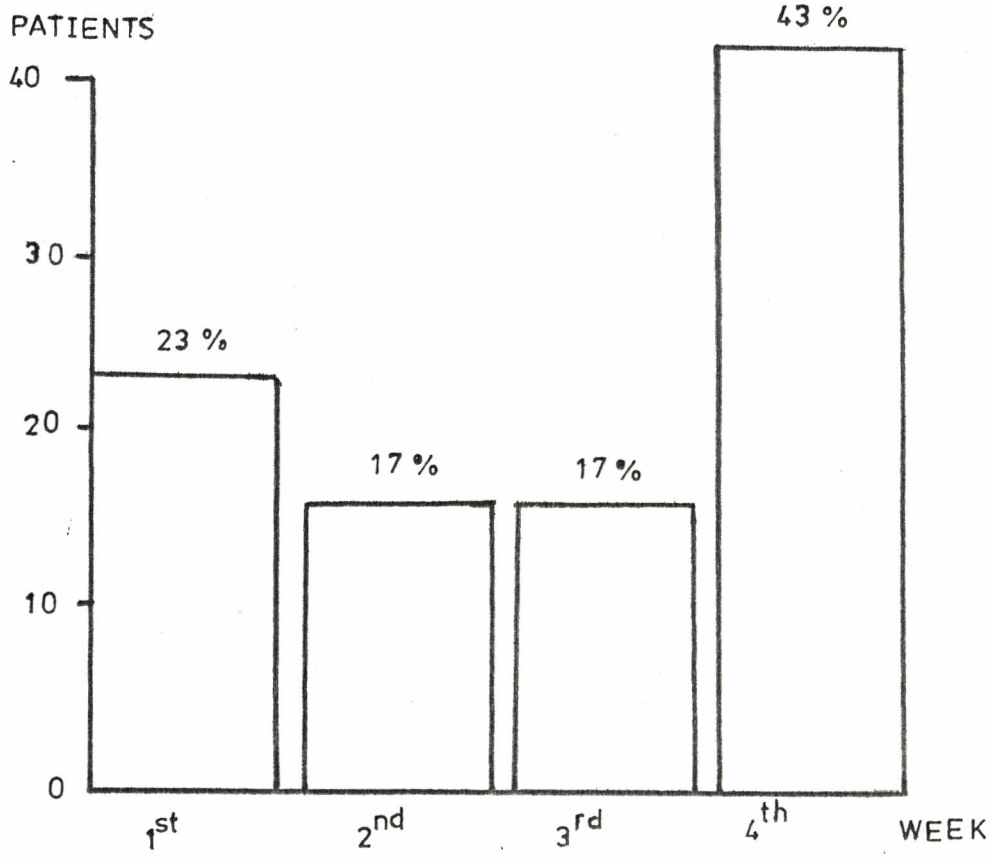


Fig. 3b: Incidence - Monthly for the period January 1984 to May 1984.
Average : 9 patients per month.



The incidence was noted to be higher in the last week of the month with 43% occurring towards the end of the month. The remaining 57% were fairly equally distributed in the 1st, 2nd and 3rd weeks of the month - see Fig. 4.

Fig. 4: Incidence - Week of the month.



1.4 REFERRALS:

40% of all the patients in the study were referred from peripheral government hospitals and neighbouring private-care institutions. The referring hospitals and the number referred by each hospital is shown in Tables 3a and 3b below.

Table 3a: Referrals.

Government Hospital	No.
Kiambu	15
Kajiado	5
Thika	5
Muranga	2
Loitokitok	2
Embu	2
Kitui	1
Tumu Tumu	1
Machakos	1
Mwingi	1
Wajir	1
Total	36

Table 3b:

Private Hosp.	No.
Aga Khan	2
M. P. Shah	1
Mater Misericordae	1
Total	4

The reasons for which these pateints were referred are illustrated in Table 4. 4 patients were referred from the privatehospitals within Nairobi, all because they could not afford to pay for private hospital care.

Table 4: Reason for referral from Government Hospitals.

Reason:	No.	%
Lack of Manpower	18	50
Lack of equipment for surgery	12	13.3
Surgeon away on leave	4	11.1
Lack of X-ray facility	2	5.6
Total	36	100

1.5 DURATION OF HOSPITAL STAY:

81% of the patients were operated upon, while 19% received primary closure of the wound in the casualty minor theatre, but were not operated upon for a more thorough debridement and elevation of the depressed skull fracture. Of the patients operated upon 23.5% were discharged within one week, 61.7% with two weeks and 77.8% within three weeks. 9.9% were hospitalised in KNH for longer than one month.

6 patients (7.4%) died despite surgical intervention - see Table 5a, overleaf.

Table 5a: Duration of hospital stay in KNH before discharge home or to the nearest district hospital.

Operated Cases - 81 patients.

Duration	No.	%
Less than 7 days	19	23.5
Between 8-14 days	31	38.3
Between 15-21 days	13	16.1
Between 22-30 days	4	4.9
More than 1 month but less than 2 months	6	7.4
More than 2 months	2	2.5
Patients who died	6	7.4
Total	81	100

Table 5b: Cases not operated - 19 patients.

Duration	No.	%
Less than 7 days	15	78.9
8-14 days	3	15.8
Patients who died	1	5.3
Total	19	100

1.5 INTERVAL BETWEEN INJURY AND PRESENTATION FOR TREATMENT.

The interval between trauma and presentation at the KNH casualty department was recorded for 89 patients. Of these 5 (5.6%) presented within 2 hours, 24 (27%) within 4 hours, 41 (46.1%) within 6 hours, 53 (59.6%) within 12 hours, 69 (77.5%) within 24 hours. 20 patients (22.5%) presented after a delay of more than 24 hours after time of injury (see Fig. 5).

1.6 ADMISSION TO OPERATION INTERVAL:

81 patients wereoperated upon. 26 of these (32.1%) were operated within 24 hours of admission, 22 (27.2%) patients between 24-48 hours, and the remaining 33 (40.7%) had a delay of greater than 48 hours before they were operated upon. (see Fig. 6 overleaf).

The reasons for the delay of more than 24 hours are tabulated in Table 6 below.

Table 6: Reasons for delay beyond 24 hours in 55 patients.

Reason	No.	%
Delayed Neurosurgical review	16	29.1
Depressed fracture missed at first presentation	11	20.9
Operation postponed by Neurosurgical SHO	8	14.5
Blood for surgery not ready	8	14.5
Theatre not available	5	9.1
Fracture missed and carotid angio done	2	3.6
Patient presented late	1	1.8
Indecision: whether general or neurosurgical to operate	1	1.8
Patient fed while awaiting surgery	1	1.8
X-rays mixed with another patient's	1	1.8
'Gelfoam' not available' quoted	1	1.8
Total	55	100

Fig. 5: Interval between Trauma and presentation at the KNH Casualty.

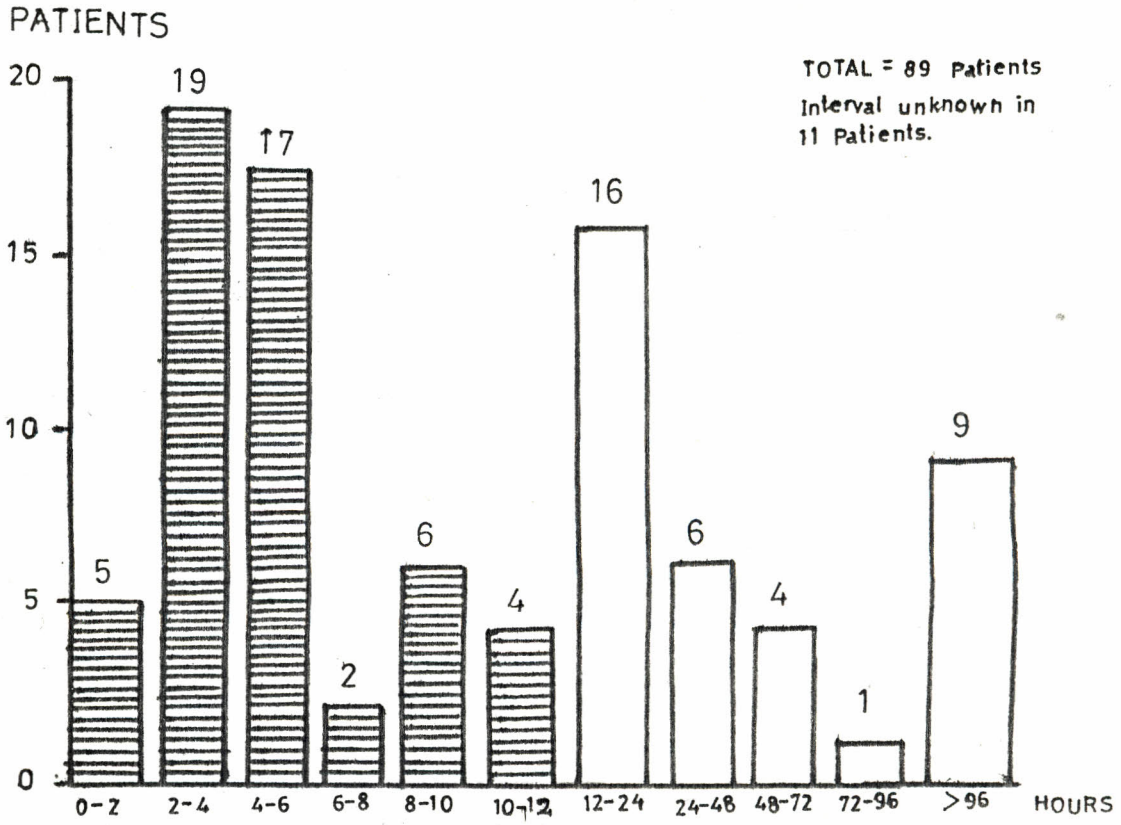
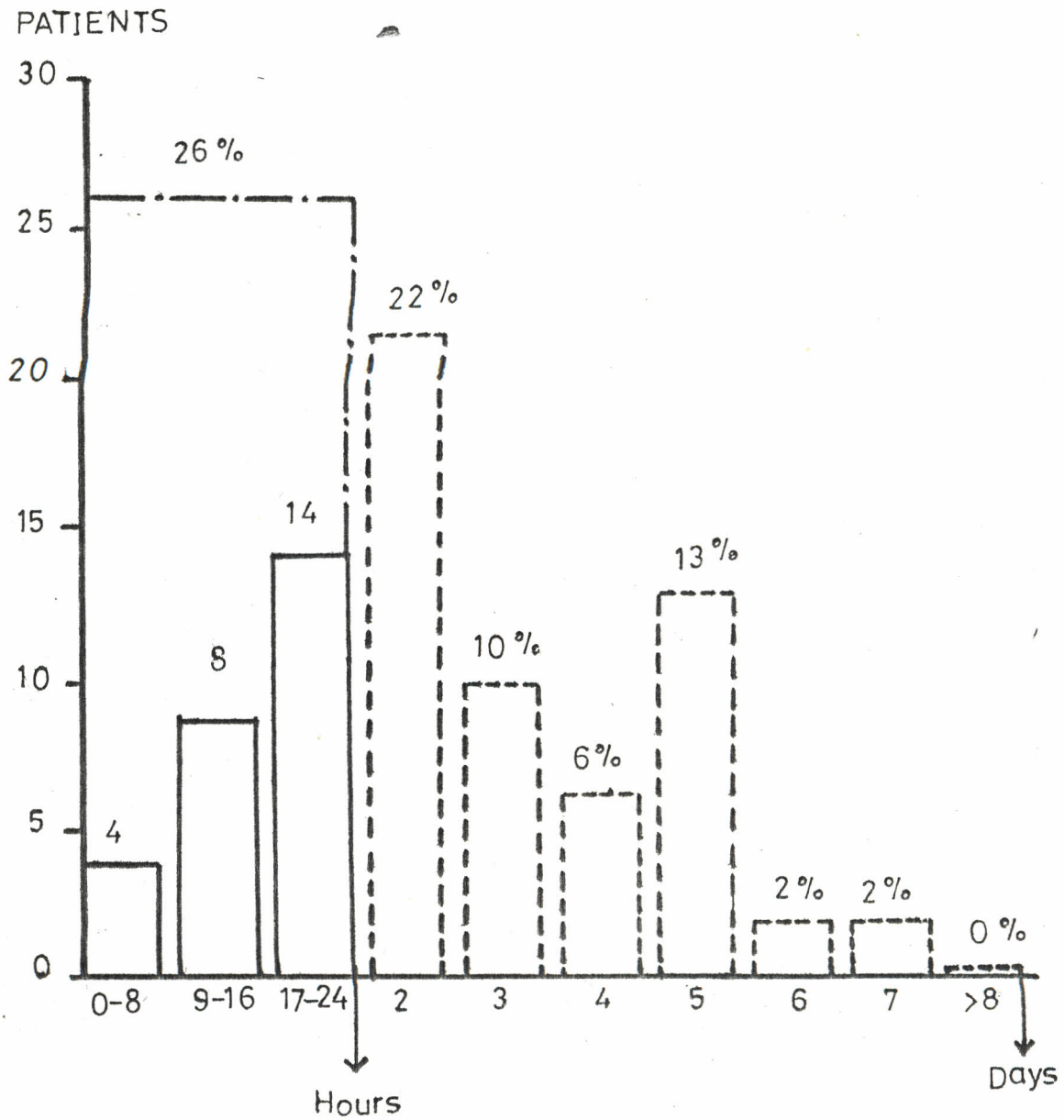


Fig. 6: Time between presentation and surgery.



1.7 CAUSES OF INJURY:

Various causes were responsible for the trauma. Assault was the most common cause of injury, accounting for 72% of all cases. Road traffic accidents, fall from a height, industrial accident, and some miscellaneous causes were other important causes of injury. Table 7a tabulates the various causes. Table 7b illustrates the various assault weapons that were used.

Falls accounted for the injury in 6 patients. Table 7c indicates the nature of fall responsible.

Table 7d indicates the other miscellaneous causes accounting for the depressed skull fracture in 10 patients.

Table 7a: Causes of Trauma.

Cause	No.	%
Assault	72	72
Road Traffic Accident	11	11
Industrial Accident	1	1
Fall	6	6
Other	10	10
Total	100	100

Table 7b: Assault weapons used (known in 27 cases).

Weapon	No.	%
'Panga'	8	29.6
Iron Bar	5	18.5
Club ('Rungu')	5	18.6
Stone	4	14.4
Axe	2	7.4
Knife	1	3.7
Traditional Sword ('Simi')	1	3.7
Fork 'Jembe'	1	3.7
Total	27	100

Table 7c: Type of Fall.

Fall	No.
Off a tree	2
High building	1
Off a bicycle	1
Unspecified	2
Total	6

Table 7d: Miscellaneous Causes.

Cause	No.
'Fork Jembe Injury'	5
Hit by stone at play	4
During Buffalo attack	1
Total	10

while causes of injury other than assault involved both sides of the skull with relatively equal frequency, assault involved the left side more commonly (see Table 7e). The reason for this may be presumed to be that an assailant would generally weild the weapon in his right hand in a face to face confrontation.

Table 7e: Comparison between injury to right and left sides of skull in relation to cause.

Cause	Right		Left	
	No.	%	No.	%
Assault	29	66	43	76.8
Road Traffic Accident (RTA)	6	13.6	5	8.9
Industrial Accident	-	-	1	1.8
Fall	3	6.8	3	5.4
Other	6	13.6	4	7.1
Total	44	100	56	100

SECTION II:

PHYSICAL EXAMINATION:

2.1 BLOOD PRESSURE:

A blood pressure recording upon admission was available in 85 patients. 3 patients had hypotension (systolic blood pressure of below 90mm of Hg.) and 1 case had severe hypertension (a diastolic blood pressure greater than 110mm of Hg.).

Of the 3 patients with hypotension, one had a compound dislocation of the right ankle and an associated fracture of the radius and ulna. This patient developed tetanus which proved fatal. A second patient sustained an associated cervical spine injury during a RTA and subsequently died due to respiratory failure. The third had no associated injury and survived.

The patient with severe systemic hypertension (170/110) was found at operation to have a subdural haematoma.

2.2 ASSOCIATED INJURY:

An associated injury was present in 27 patients. The type of associated injury is tabulated in Table 8. 16 of these patients had an associated soft tissue injury, while 11 had a more severe injury elsewhere. In all these 11 patients RTA was the cause of injuries.

2.3 LEVEL OF CONSCIOUSNESS:

86 patients (86%) were conscious at time of admission. 59 of these patients were oriented in time, place and person, while the remaining 27 were disoriented to some degree. 14 patients had a disturbed level of consciousness; of these 6 showed response to verbal command, 4 patients were able to localise a deep painful stimulus, while the remaining 4 patients responded inappropriately to painful stimulus, i.e. they could not localise the painful stimulus. None of the patients were in deep coma (i.e. no response to deep painful stimuli) - see Table 9 overleaf. 10 patients were recorded as smelling of alcohol.

Table 8: Associated injuries.

Type	No.	%
Soft Tissue Injury	16	59.3
Fracture of Limb-bone	7	25.9
Fracture Mandible	2	7.4
Fracture Ribs	1	3.7
Cervical Spine Injury	1	3.7
Total	27	100

Table 9: Level of Consciousness.

Level of Consciousness	No.	%
Conscious and Oriented	59	59
Conscious but Disoriented	27	27
Disturbed Consciousness:		
- Response to verbal command	6	6
- Appropriate response to pain stimuli	4	4
- Inappropriate response to pain stimuli	4	4
- No response to painful stimuli	0	0
Total	100	100

2.4 SPEECH:

Speech was tested and a record made in the notes in 84 patients. It was normal in 65 patients, slurred in 7 patients, while 12 patients were aphasic. Speech was not tested in 16 patients. See Table 10a.

Of the 12 patients with aphasia, 9 patients had a motor type aphasia while in 3 patients the type was not indicated (see Table 10b). With regard to the side of skull involved in the patients *with aphasia, the left side was involved in 9 (75%)* and the right side involved in 3 (25%) of patients - see Table 10c. An analysis of the patients who had a left sided skull injury and aphasia revealed the relationship between aphasia and the various sites of fracture shown in Table 10e.

Similarly Table 10d shows the relationship between site of fracture and left sided skull injury in patients having a slurred speech.

Table 10a: Speech.

Normal	Slurred	Aphasia	Unspecified	Total
65	7	12	16	100%

Table 10b: Type of Aphasia.

	Receptive	Motor	Unspecified	Total
No.	0	9	3	12
%	0	75	25	100

Table 10c: Side of skull involved.

	Left	Right	Total	P
Aphasia	9	3	12	<0.05
Slurred	6	1	7	

Table 10d: Site of fracture in patients with left side skull injury and slurred speech.

Site	No.	%
Parietal	4	66.6
Temporal	2	33.3
Total	6	100

2.5 CRANIAL NERVE INVOLVEMENT:

Cranial nerve involvement occurred in 11 (11%) patients. The VIIth (Facial) cranial nerve was the most commonly involved; (see Table 11a). Of the 9 patients with VIIth cranial nerve involvement, 4 patients had an upper motor neurone type (central) involvement, while the involvement was unspecified in 5 patients.

Table 10e: Site of fracture in patients with left sided skull injury and aphasia.

Site	No.	%
Parietal	4	44
Temporal	1	11
Temperoparietal	3	33
Frontal	1	11
Total	9	100

Furthermore, of the 9 patients with VIIth cranial nerve involvement, 2 (22.2%) had an associated subdural haematoma, 3(33.3%) were found to have an associated early brain abcess, while 1 (11.1%) had an associated extradural haematoma and one patient (11.1%) had an associated brain fungus. Hence 7 (77.7%) patients who had a VIIth cranial nerve involvement were found at operation to have an associated intracranial mass lesion - see Table 11b. Of the 9 patients with VIIth cranial nerve palsy, 8 (88.8%) patients were found to have an assoicated tear of the dura. (p less than 0.02).

Neither of the patients with a IIIrd cranial nerve and VIth cranial nerve palsy had an associated Intracranial mass lesion. However, both patients were found to have an associated tear of the dura.

Table 11a: Cranial nerve involvement.

IIIrd	VIth	VIIth
1	1	9

Table 11b: Association between Intracranial Mass Lesion (ICML) and VIIth Nerve Palsy.

Type of ICML	No.	%	p
Early Brain Abcess	3	33.3	
Subdural Haematoma	2	22.2	
Extradural Haematoma	1	11.1	
Brain Fungus	1	11.1	
Total	7	77.7	<0.001

2.6 PUPILLARY REACTION:

Pupillary reaction was recorded in all 100 patients. 91 patients had a normal pupillary size and reaction. 9 patients, had pupillary dilatation of one or both pupils. Of these 9 patients, one had an associated IIIrd cranial nerve palsy; at operation no associated intracranial haematoma was found in this patient. In the remaining 8 patients an associated intracranial mass lesion was found on the side of the dilated pupil (see Table 12).

Table 12: Association between Pupillary dilatation and a ICML on the same side.

Type of ICML	No.	%
Extradural Haematoma	2	25
Subdural Haematoma	2	25
Intracerebral Haematoma	2	25
Both Extra & Subdural Haematoma	1	12.5
Early brain abcess	1	12.5
Total	8	100

2.7 EXAMINATION OF THE SKULL:

Clinical examination of the skull:- injury was noted to be on the left side in 56 patients and on the right side in 44 patients. The comparison between clinical impression of the site of injury, the radiological evaluation and the intraoperative findings is provided in Table 13 overleaf.

2.8 MOTOR SYSTEM:

Muscle power - The contralateral upper limb was the most commonly involved in paresis or paralysis, which was found in 25 (25%) patients. Next in frequency was the contralateral lower limb, involved in 18 (18%) patients. The prilateral lower limb and upper limb were found to have reduced power in 4 (4%) and 3 (3%) patients respectively (see Table 14).

Table 13: Site of fracture - comparison between clinical impression, X-ray finding and operation finding.

Site of Fracture	Clinical				Radiologic				Operative	
	Operated		Unoperated		Operated		Unoperated			
	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.
Frontal	7	3	6	3	9	6	6	3	13	7
Parietal	21	20	3	4	19	18	3	5	16	15
Frontoparietal	3	3	-	2	3	3	-	1	1	2
Temporal	8	1	-	-	9	2	-	-	8	5
Parietotemporal	4	1	-	-	4	1	-	-	5	2
Occipital	3	1	-	-	2	1	-	-	3	-
Occipito-temporal	-	-	-	-	-	-	-	-	1	-
Fronto-temporal	-	2	-	-	-	-	-	-	-	-
Parieto-occipital	1	3	-	-	1	3	-	-	-	-
Total	47	34	9	10	47	34	9	10	47	34
Over Saggital Sinus		8				7				1
Over Sigmoid Sinus		4				1				-

Table 14: Pattern of associated paralysis/paresis of limb muscle.

Limb Involved	Power Normal	Power Reduced
Contralateral Upper Limb	75	25
Contralateral Lower Limb	82	18
Ipsilateral Lower Limb	96	4
Ipsilateral Upper Limb	97	3

2.9 EPILEPSY:

11 patients (11%) developed an epileptic fit prior to surgery i.e. early epilepsy. 8 of these were grand mal in type and 3 were focal in type (see Table 15a).

Adjusted percentage figures indicated the highest incidence of grand mal epileptic fit in the age group 6-10 years, 40% of these patients having developed a grand mal fit prior to surgery (see Table 15b).

Overall figures indicated that 23.1% of patients under the age of 16 years developed a grand mal epileptic fit and 7.7% developed a focal fit. In the adult age group (taken to be the above 16 years) 5.7% developed a grand mal fit and 2.3% developed a focal fit.

Hence the childhood group (0-15 years) had a 4-fold higher incidence of grand mal epilepsy and a 3·5-fold higher incidence of focal epilepsy when compared to the adult (above 16 years) age group (see Table 15c).

Table 15a: Epilepsy - occuring prior to surgery.

Type	No.	%
Grand mal	8	8
Focal	3	3
Total	11	11

Table 15b: Relationship between Epilepsy and age of patient.

Age Group (years)	No. in Age Gr.	Grand mal No.	Grand mal Adjusted %	Focal No.	Focal Adjusted %	p
Below 1	1	-	-	-	-	N/S
1 - 5	4	-	-	-	-	>0.1
6 -10	5	2	40	-	-	N/S
11 - 15	3	1	33.3	1	33.3	>0.1
16 - 20	12	1	8.2	-	-	
21 - 25	15	1	6.6	-	-	
26 - 30	14	-	-	-	-	
31 - 35	10	3	29.6	1	9.9	
36 - 40	11	-	-	1	8.9	
41 - 45	5	-	-	-	-	
More than 45 years	-	-	-	-	-	

Table 15c: Relationship between Epilepsy and childhood or adult status.

Age Years	No. in Age Gr.	No Grand mal fits	%	No Focal Fits	%
1 to 15	13	3	23.1	1	7.7
More than 16 years	87	5	5.7	2	2.3
Risk childhood vs. adult			4:1 ($p < 0.05$)		3.5:1

2.10 DEEP TENDON REFLEXES:

Assessment was available in 92 patients. 21 (22.8%) had an abnormal reflex. This included an exaggerated reflex on the contralateral side (9 patients), reduced reflex on the contralateral side (2 patients), bilaterally exaggerated reflexes (4 patients) and bilaterally reduced reflexes (6 patients).

2 patients had an abnormal (upgoing) plantar reflex on the contralateral side. While the other reflex abnormality was not associated with an intracranial mass lesion with any certainity, both patients with an upgoing plantar had an associated intracranial haematoma underlying the depressed fracture.

2.11 GAIT:

Gait was assessed and recorded in 81 pateints. 43 (53%) of them had a normal gait, 34 (42%) were unable to walk, 3 (3.7%) patients had a staggering gait and 1 patient (1.2%) had a limping gait (see Table 16 overleaf).

The reasons for inability to walk in the 34 patients are tabulated in Table 17 below.

Table 16: Effect on Gait - recorded in 81 patients.

	No.	%
Normal Gait	43	53
Inability to walk	34	42
Staggering Gait	3	3.7
Limping Gait	1	1.2
Total	81	100

Table 17: Reasons for Inability to walk in the 34 patients.

Reasons	No.	%
Disturbed level of consciousness	20	58.8
Hemiparesis	10	29.4
Quadriparesis	1	2.9
No neurological/physical reason	3	8.8
Total	34	100

SECTION III:

PATIENT MANAGEMENT AND OPERATIVE FINDINGS:

3.1 PREOPERATIVE MEDICATION:

Various antibiotics and other drugs were used, the choice often dictated to some extent by the availability at the particular time. The most commonly prescribed antibiotics were chloramphenicol, crystalline penicillin and ampicillin, with Gentamycin and Ampiclox being used in a few patients (see Table 18a). Paracetamol and Asprin were the analgesics commonly prescribed (see Table 18b).

The various miscellaneous medication prescribed are shown in Table 18c. Antibiotics were prescribed for all patients admitted with a compound depressed fracture of the skull.

Table 18a: Antibiotics.

Antibiotic	No. of Patients
Chloramphenicol	37
Crystalline Penicillin	34
Ampicillin	32
Gentamycin	7
Ampiclox	5
Penicillin "V" Tablets	1

Table 18b: Analgesics.

Analgesis	No. of Patients
Paracetamol	28
Asprin	11
Butazolidine	1
Pethidine	1

Table 18c: Miscellaneous.

Prescription	No. of Patients
IV Fluids	29
Dexamethasone	5
Epanutin	5
Diazepam	3
Mannitol	2
Phenabarbitone	1

3.2 CATEGORY OF SURGEON:

Category of surgeon and assistant.

The operation for the surgical debridement elevation or craniotomy was performed by a senior house officer (SHO) in 75 (92.6%) of patients. A qualified surgeon conducted the surgery in 4(4.9%) cases and a neurosurgeon did so in 2 (2.5%) cases (see Table 19a).

The primary or first-assistant was usually a theatre scrub-nurse in 44 (54%) cases, an intern in 8 (9.9%) cases, an SHO in 27 (33.3%) cases and a Neurosurgeon in 2 (2.5%) cases (see Table 19a and 19b).

Table 19a: Category of Surgeon conducting the surgery.

Surgeon	No. of Cases	%
Senior House Officer (SHO)	75	92.6
Qualified Surgeon	4	4.9
Neurosurgeon	2	2.5
Total	81	100

Table 19b: Category of Assistant.

Assistant	No. of Cases	%
Theatre Nurse	44	54
Houseman (Intern)	8	9.9
SHO (Registrar)	27	33.3
Neurosurgeon	2	2.5
Qualified Surgeon	-	-
Total	81	100

3.3 WOUND INFECTION:

Infection of the wound was already established at the time of operation in 11 cases (13.6% of operated cases). All these patients had a trauma to operation interval of greater than 48 hours; 9 had an interval of more than 96 hours (4 days).

Hence, while 9 out of 11 patients (81.8%) who developed wound infection prior to surgery had a delay of greater than 96 hours only 12 of the 58 patients (20.6%) who had no wound infection had a similar delay, indicating that delay was responsible for causing preoperative wound infection (see Table 20a.). ($p < 0.001$).

Antibiotics were prescribed routinely to all patients admitted with such an injury. The antibiotics used prior to operation were not different in the group developing preoperative wound infection as compared to the group in whom infection occurred.

Post-operative wound infection occurred in 22 (27.2%) patients in the operated group. In 10 of these patients, pre-operative infection of the wound was present. Hence 12 patients (14.8%) developed a de novo post operative wound infection.

The trauma to surgery interval was analysed in these 12 patients. Delayed surgery was not found to be the cause of the infection in these cases (see Table 20a).

3.4 PRIMARY REPLACEMENT OF BONE FRAGMENT:

This was carried out in 20 patients. In 3 patients (15%) the primary replacement was done within 18 hours after injury. In 17 patients (85%) the replacement was done after a period of more than 24 hours after injury. No wound infection occurred in the 3 patients in whom bone replacement was done within 18 hours after trauma. Of the 17 patients who had bone replacement after a delay of more than 24 hours, 2 patients (11.8%) developed a postoperative wound infection de novo (see Table 20b overleaf).

Overall wound infections rates were compared with infection rates following 1^{o} bone replacement after a delay of greater than 24 hours. This is shown in Table 20c. The results indicated that 1^{o} bone replacement of fragments when carried out even after a delay of more than 24 hours did not increase the rate of wound infection (p = N/S).

Table 20a: Wound infection in the operated cases - Relationship to delay between trauma and surgery.

Trauma-surgery Interval	Nil Infection		Preoperative Infection		Denovo Post-op. Infection	
	No.	%	No.	%	No.	%
Less than 24 hrs.	16	27.6	0	0	2	16.7
24 - 48 hours	17	29.3	0	0	3	25
48 - 72 hours	9	15.5	1	9.1	2	16.7
72 - 96 hours	4	6.9	1	9.1	2	16.7
More than 96 hours	12	20.6	9	81.8	3	25
Total	58	100	11	100	12	100

Table 20b: Wound infection in relation to 1° replacement of bone fragment - carried out in 20 patients.

Trauma-operation Interval	No. of Patients	Denovo Post-op Infection No.	%	p
Less than 18 hrs.	3	0	0	Greater than 0.1
Less than 24 hrs.	-	-	-	N/S
More than 24 hrs.	17	2	11.8	-

Table 20c: Overall Wound Infection Vs. Wound Infection after 1° bone replacement.

	Overall Infection Incidence		Infection after 1° bone replacement after 24 hours.		p
	No.	%	No.	%	
Nil infection	58	71.6	13	76.5	-
Pre-op + Post-op wound infection	22	27.2	4	23.5	-
Denovo Post-op. infection	12	14.8	2	11.8	N/S >0.1

3.5 LACERATION OF THE DURA:

A tear of the dura was present in 39 pateints (48%) of the 81 operated. In 42 patients the dura was found intact. The presence of a torn dura was associated with a higher incidence of disorientation and impairment of level of consciousness (see Table 21a overleaf).

With regard to the cause of depressed fracture, assault with a 'Panga' and the 'Fork Jembe Injury' were associated dural tear, while blunt objects such as an Iron Bar, injury by a Stone while playing, road traffic accidents and falls were noted to be less likely to cause an associated tear of the dura (see Table 21b).

The post operative duration of impaired consciousness was prolonged in patients having an associated tear of the dura. Impaired consciousness of more than 24 hours occurred in 46.2% of patients with an associated dural tear as compared to 21.4% in those patients having an intact dura (see Table 21c). Similarly the number of patients who had not regained full consciousness by the time of their discharge from KNH to the nearest district hospital was higher in those who had an associated torn dura (seen in Table 21c).

Association between a torn dura and an intracranial mass lesion: A brain abcess occurred in 10.3% of patients with a torn dura, being exclusively associated with this group. The presence of an intracranial haematoma however, was less often associated with a tear of the dura, possibly because the tear allowed the collection to drain out (see Table 21d).

The incidence of epilepsy, mental deficit and physical deficit was noted to be higher when an associated tear of the dura was present (as shown in Table 21e).

Table 21a: Relationship with level of consciousness at initial presentation.

Level of Consciousness	Dura Torn No.	%	Dura Intact No.	%	p
Conscious:	30	76.9	36	85.7	-
- Oriented	(15)	38.5	(25)	59.5	N/S > 0.1
- Disoriented	(15)	38.5	(11)	26.2	-
Impaired Consciousness:	9	23.1	6	14.3	N/S > 0.1
- Response to verbal command	(3)	7.7	(3)	7.1	-
- Localising pain	(4)	10.3	(1)	2.4	-
- Not localising pain	(2)	5.1	(2)	4.8	-
- No response to pain	(0)	0	(0)	0	-
Total	39	100	42	100	-

Table 21b: Relationship of dural tear to cause of depressed fracture i.e. object.

Cause	Dura Torn No.	%	Dura Intact No.	%	p
'Panga'	5	12.8	0	0	<0.02
Club ('Rungu')	2	5.1	1	2.4	
Iron Bar	0	0	4	9.5	-

Table 21b: Relationship of dural tear to cause of depressed fracture i.e. object

Cause	Dura Torn No.	%	Dura Intact No.	%	p
*'Panga'	5	12.8	0	0	<0.02
Club ('Rungu')	2	5.1	1	2.4	-
+Iron Bar	0	0	4	9.5	-
'Jembe'	1	2.7	0	0	-
Traditional Sword ('Simi')	1	2.7	0	0	-
Axe	0	0	1	2.4	-
Stone	1	2.7	1	2.4	-
Unspecified Assault	22	56.4	20	47.6	-
+RTA	2	5.1	6	14.3	-
Fall	1	2.7	5	11.9	-
*'Fork Jembe Injury'	3	7.7	0	0	-
Industrial Accident	1	2.7	0	0	-
+Hit by Stone at play	0	0	4	9.5	-
Total	39	100	42	100	-

* More likely to cause dural tear.

\+ Less likely to cause dural tear.

Table 21c: Post operative duration of impaired consciousness vs. presence of dural tear.

Duration of Impaired Consciousness	Dura Torn No.	%	Dura Intact No.	%	p
Upto 4 hours	6	15.4	10	23.8	-
4 - 8 hours	8	20.5	14	33.3	-
8 - 12 hours	1	2.7	3	7.1	-
12 - 24 hours	0	0	2	4.8	-
More than 24 hours	18	46.2	9	21.4	<0.02
Did not regain full consciousness	4	10.3	1	2.4	-
Death	2	5.1	3	7.1	-
Total	39	100	42	100	

Table 21d: Relationship of dural tear with presence of ICM lesion.

Type of ICML	Dura Torn No.	%	Dura Intact No.	%	p
Haematoma present	10	25.6	17	40.5	N/S
Haematoma absent	29	74.4	25	59.5	-
Brain abcess	4	10.3	0	0	<0.05

Table 21e: Relationship of dural tear with epilepsy, mental deficit, physical deficit.

	Dura Torn		Dura Intact		p
	No.	%	No.	%	
Epilepsy present	7	17.9	5	11.9	N/S
Epilepsy absent	32	82.1	37	88.1	-
Mental deficit present	15	38.5	9	21.4	N/S
Mental deficit absent	24	61.5	33	78.6	-
Physical deficit present	13	33.3	8	19	N/S
Physical deficit absent	26	66.6	34	81	-

3.6 LACERATION OF THE BRAIN:

For purposes of study the laceration was categorised as 'Superficial contusion', 'Necrosed Brain Tissue'. 'Brain Oozing' through fracture site and 'Brain fungus' as a measure of severity of the laceration. 25 patients had an associated brain laceration and the number in each category is shown in Table 22a.

An associated dural tear was present in 23 of these patients and absent in 2 patients (Table 22b).

Analysis of the severity of brain laceration when related to delay in surgery indicated no relationship, except in the case, where a brain fungus had resulted (see Table 22c). This patient had a trauma to operation interval of 14 days due to a delay in seeking treatment.

The level of orientation and level of consciousness were related to the degree of brain laceration. 60% of patients having a Superficial contusion were oriented. While 46% were oriented in the more severe form of necrosed brain tissue, only 16.6% were oriented when brain tissue was found oozing through the fracture site.

None of the patients with 'Superficial contusion' were found to be in a semicomatose or comatose state, while 7.7% of those with a 'necrosed brain tissue' were in this state and 66.6% (50% + 16.6%) of patients having brain tissue oozing through fracture site were found to be in this state (see Table 22d).

With regard to the period of post operative unconsciousness, a short period was noted in the patients having a 'Superficial contusion', of whom 40% were fully conscious within 4 hours after operation and 80% were fully conscious within 8 hours after operation. In those with 'Necrosed Brain Tissue' 7.7% were fully conscious within 4 hours after surgery and 23.1% were fully conscious within 8 hours after surgery. In patients with brain oozing through fracture site, none

(0%) had regained full consciousness within 4 hours after surgery and only 16.6% had done so by 8 hours after surgery (shown in Table 22e).

While all patients in the group with 'Superficial contusion' were fully conscious by the time of discharge from KNH, 7.7% of patients with 'Necrosed brain tissue', 33.3% of those with 'Brain oozing' through fracture and the single patient (100%) with brain fungus had not regained full consciousness by the time of their discharge from KNH to the district hospital near their home (see Table 22e).

The relationship between brain laceration and epilepsy and haematoma did not indicate a direct association. However, the incidence of brain abcess, mental deficit and physical deficit was higher in thesevere forms of brain laceration than in the group with superficially contused brain (see Table 22f).

Table 22a: Types of Brain Laceration.

Types seen	No.	%
Superficial Contusion	5	6.2
Necrosed Brain Tissue	13	16.0
Brain oozing through fracture	6	7.4
Brain Fungus	1	1.2
Total	25	30.8

Table 22b: Relation of Brain Laceration with Dural Tear.

Dural Tear	No.	%
Present	23	92
Absent	2	8
Total	25	100

Table 22c: Relation to delayed surgery.

Trauma Surgery Interval	Superficial		Necrosed		Oozing		Brain Fungus	
	No.	%	No.	%	No.	%	No.	%
Less than 24 hrs	-	-	6	46.2	-	-	-	-
24 - 48 hours	1	20	1	7.7	2	33.3	-	-
48 - 72 hours	-	-	2	15.4	1	16.6	-	-
72 - 96 hours	-	-	-	-	1	16.6	-	-
96 - 120 hours	-	20	-	-	-	-	-	-
More than 120 hrs	3	60	4	30.8	2	33.3	1	100
Total	5	100	13	100	6	100	1	100

Table 22d: Relationship between Brain Laceration level of consciousness.

Level of Consciousness	Superficial No.	%	Necrosed No.	%	Oozing No.	%	Brain Fungus No.	%	p
Oriented	3	60*	6	46.2	1	16.6*	-	-	<0.05
Disoriented	2	40	6	46.2	1	16.6	1	100	
Response to Verbal command	-	-	-	-	3	50	-	-	
Localised pain	-	-	1	7.7	-	-	-	-	
Cannot localise pain	-	-	-	-	1	7.7	-	-	
No response to pain	-	-	-	-	-	-	-	-	
Total	5	100	13	100	6	100	1	100	

Table 22e: Relationship with period of post-operation unconsciousness.

Period before full consciousness regained	Superficial No.	%	Necrosed No.	%	Oozing No.	%	Brain Fungus No.	%	P
Less than 4 hrs.	2	40*	1	7.7	-	-*	-	-	<0.001
4 - 8 hours	2	40	2	15.4	-	16.6	-	-	
8 - 12 hours	-	-	1	7.7	-	-	-	-	
12 - 24 hours	1	20	2	15.4	-	-	-	-	
24 - 48 hours	-	-	1	7.7	-	-	-	-	
48 - 72 hours	-	-	-	-	1	16.6	-	-	
72 - 96 hours	-	-	1	7.7	-	-	-	-	
More than 96 hrs.	-	-	3	23.1	1	16.6	-	-	
Not fully conscious by discharge from KNH	-	-	1	7.7	2	33.3	1	100	
Died	0	-	1	7.7	1	16.6	-	-	
Total	5	100	13	100	6	100	1	100	

* Comparing Superficial and Oozing type of Laceration.

Table 22f: Relationship and other effects.

	Superficial		Necrosed		Oozing		Brain Fungus	
	No.	%	No.	%	No.	%	No.	%
Epilepsy	2	40	3	23.1	2	33.3	-	0
Haematoma	3	60	3	23.1	-	0	-	0
Brain Abcess	-	0	3	23.1	-	0	-	-
Mental Deficit	1	20	6	46.2	2	33.3	1	100
Physical Deficit	1	20	6	46.2	2	33.3	-	0

3.7 INTRACRANIAL HAEMATOMA AND BRAIN ABCESS:

30 patients (37% of operated cases) were found to have an associated intracranial haematoma. The type and number of the various types of haematoma is shown in Table 23a overleaf. NB: The diagnosis of presence of associated intracranial haematoma was subjective, no specified amount of accumulation being regarded as constituting a haematoma.

2 patients were found to have an association brain abcess at operation. In a third patient an infected haematoma was regarded as an early brain abcess. Hence 3 patients (3.7% of operated cases) had an associated brain abcess by time of operation. In a fourth patient, a brain abcess occurred $2\frac{1}{2}$ months after the initial operation (see Table 23b overleaf).

The patient who developed the brain abcess $2\frac{1}{2}$months after initial operation wasinitially admitted 5 days after an assault. The patient was put on ampicillin and gentamycin upon admission and surgical toilet carried out 3 days after admission. The site of injury was found to be infected at time of operation and the dura was torn. The brain was not lacerated. Dural closure was done after surgical debridement and the bone fragments were not replaced.

The wound became infected after operation. Daily dressing of the wound along with crystalline penicillin and gentamycin cleared the infection. No culture/sensivity of the pus was carried out. The patient was discharged in good condition with no neurological deficit. At subsequent review in the neurosurgical clinic the patient remained stable but complained of pain at site of operation and headache on and off. 2½ months after initial operation the patient presented with disorientation and a change in behaviour. Carotid angiography revealed a space occupying lesion. Haemogram showed a wbc count of 11.6 x 10 9/l. At operation a brain abcess was localised and drained. Post operative antibiotics comprising crystalline penicillin and chlorampherical were prescribed. The patient improved post operatively and was discharged in good condition.

Table 23a: Depressed Fracture vs. Intracranial Haematoma.

Type	No.	% of all cases	% of 81 operated cases
Extradural	17	17	21
Extra + Subdural	3	3	3.7
Subdural	4	4	5.0
Subdural/Intra-cerebral	1	1	1.2
Intracerebral	5	5	6.2
Total	30	30	37

Table 23b: Relationship with Brain Abcess.

Brain Abcess	No.	% of 81
De novo at operation	2	2.5
Infected Haematoma	1	1.2
3 months Post operative	1	1.2
Total	4	5

3.8 DURAL GRAFT:

The dura was found to be torn in 38 patients. 19 of these patients required a dural graft i.e. 48.7% patients with a tear of the dura required a graft. A delay in conducting surgical debridement and wound closure did not appear to influence the need for a dural graft as shown in Table 24 overleaf.

At KNH lyophilised porcine dura was frequently used as a dural graft. However, information as to whether this was used exclusively or whether periosteum of fascia was used, was not available from the case records and hence this factor was not analysed for study.

Table 24: Relationship between delayed operation and need for Dural Graft.

No. of cases of torn Dura operated in each interval	Trauma-Operation Interval	Graft Required No.	Graft Required %	Not Required No.	Not Required %
6	Less than 24 hours	3	50	3	50
9	24 - 48 hours	5	56	4	44
7	48 - 72 hours	2	28.6	5	71.4
3	72 - 96 hours	1	33.3	2	66.6
1	96 - 120 hours	0	0	1	100
3	120 - 144 hours	3	100	0	0
10	More than 6 days	5	50	5	50

3.9 BLOOD TRANSFUSION:

54 patients (66.6%) of those operated upon required to be transfused with blood during or immediately after surgery. 31 patients (38.3%) required one unit of 500ml of blood, 25.9% required two units while 2.5% required three units 1 as shown in Table 25a.

Age of patient did not appear to influence the requirement or volume of blood transfusion (see Table 25b). Being a retrospective series, it was not possible to assess correctly the factors that necessitated the need for blood transfusion.

Table 25a: Blood Transfusion in operated cases.

No. of Units	No.	%
One Unit	31	38.3
Two Units	21	25.9
Three Units	2	2.5
Total	54	66.6

Table 25b: Relationship : Age of Patient VS. Amount Transfused.

Age Group	No. of Patients in the group	1 Pint		2 Pints		3 Pints	
		No.	%	No.	%	No.	%
1 - 5	4	1	25	-	-	-	-
6 - 10	5	3	60	-	-	-	-
11 - 15	3	2	66.6	1	33.3	-	-
16 - 20	12	3	25	2	16.6	1	8.3
More than 20 years	76	22	29	18	23.7	1	1.3
Total	100	31		21		2	

3.10 INTRAOPERATIVE COMPLICATION (RESPIRATORY FAILURE):

Occurred in one patient (1.2% of operated cases). The patient, a 27 year old male was a victim of 'mob-justice', brought to casualty within 4 hours after the assault. He had no other associated injuries. He was reviewed in casualty, treated and discharged home, the depressed skull fracture having been missed. The patient presented 5 days later conscious and oriented, but found to be dysphasic and had a left hemiparesis and a right VIIth cranial nerve palsy of the upper motor neuron type. X-ray of the skull revealed a depressed fracture of the right parietal region. At operation an embedded fragment was found in association with a brain abcess. Surgical debridement and removal of bone fragments was carried out. Post operation the patient did not resume spontaneous respiration and remained comatose. He was transfered to the Intensive Care Unit where he developed grand mal epileptic fits and made no positive progress; he died 8 days later. A post mortem request was declined by the relatives.

SECTION IV:

POST OPERATIVE MANAGEMENT:

4.1 POST OPERATIVE MEDICATION:

Antibiotics - Chloramphenicol, crystalline penicillin and ampicillin were the most commonly prescribed antibiotics, being used in 49.4%, 42% and 35.8% of patients respectively. The other antibiotics used were Gentamycin and Ampicillin-Cloxacillin combination (Ampiclox), as shown in Table 26a below. The antibiotics were invariably used in combination, no particular combination being routine as this was dictated by the availability of the antibiotic at the time.

The analgesics and other miscellaneous drugs and medications prescribed are shown in Tables 26b and 26c.

Table 26a: Post operative antibiotics.

Antibiotics	No.	%
Chloramphenicol	40	49.4
Crystalline Penicillin	34	42
Ampicillin	29	35.8
Gentamycin	10	12.3
Ampiclox	4	4.9

Table 26b: Post operative analgesics.

Analgesics	No.	%
Paracetamol	15	18.5
Aspirin	2	2.5
Pethidine	1	1.2

Table 26c: Miscellaneous Drugs prescribed post operative.

Prescription	No.	%
IV Fluids	30	37
Epanutin	7	8.6
Dexamethasone	7	8.6
Phenobarbitone	1	1.2
Mannitol	1	1.2
Chloroquin	1	1.2

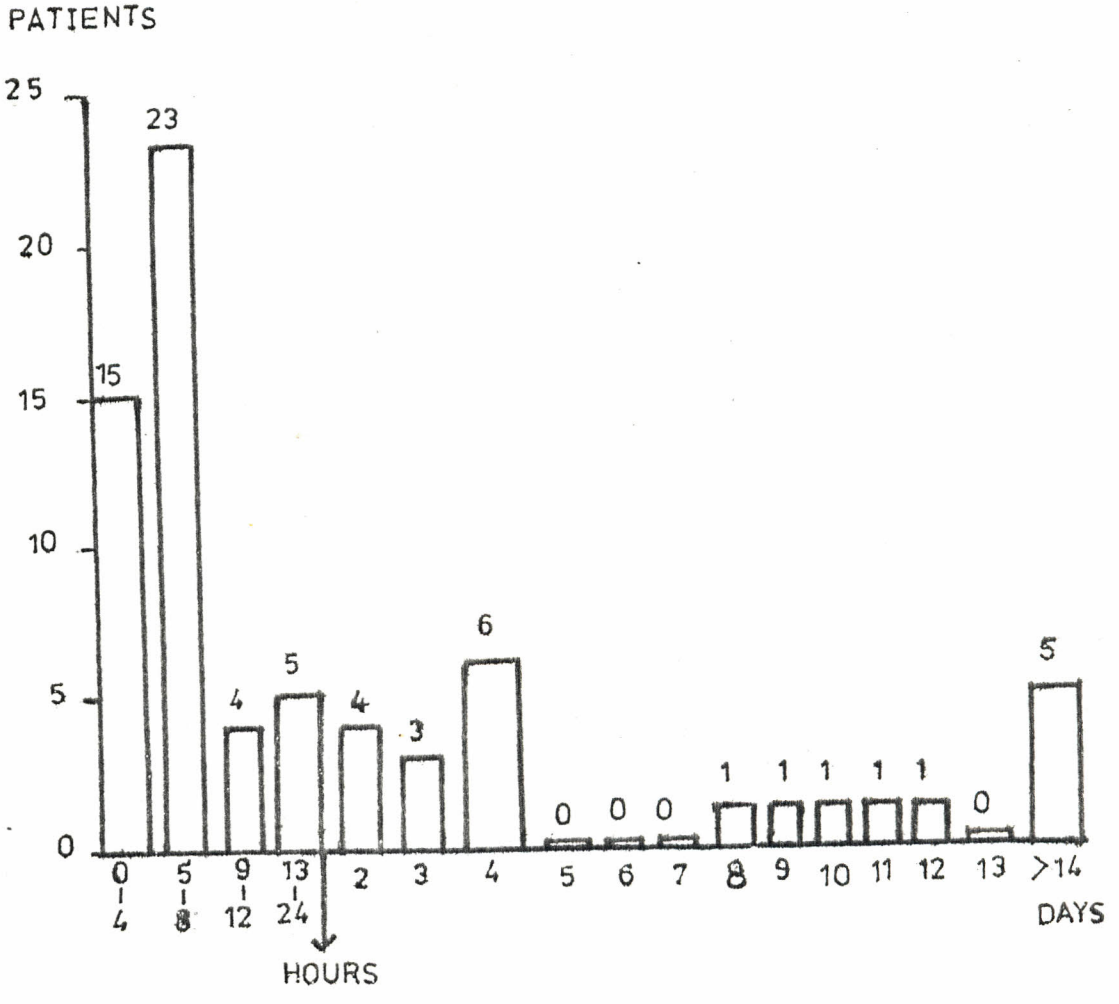
4.2 INTERVAL OF POST OPERATIVE IMPAIRMENT OF CONSCIOUSNESS:

A patient was regarded as being fully conscious when he or she answered questions put to them, appropriately and intelligently (see head injury observation chart in Appendix). Using this criteria 15 patients regained full consciousness within 12 hours. The period for the remaining patients is shown in Fig. 7.

11 patients (13.6%)of operated cases) had not regained full consciousness by the time of their discharge from KNH and were hence discharged to the district hospital from home with some intellectual deficit.

The factors associated with a prolonged post operative period of impaired conscious have already been considered (see Laceration of Dura and Brain Laceration under 3.5 and 3.6).

Fig. 7: Duration of post operative impairment of consciousness.



4.3 POST OPERATIVE EPILEPSY:

Post operative epilepsy:- Of the 81 patients, post operative epilepsy occurred in 2 patients. None of them had epilepsy prior to surgery, nor had a fit between the interval of trauma to operation.

In one patient the epilepsy occurred while the patient was in coma after surgery (see also under Intra operative complication). This patient died 8 days after surgery whilst still comatose.

The second patient developed late onset epilepsy 4 months after the initial trauma. Hence early onset epilepsy occurring exclusively after surgery was seen in 1 patient (1.3% of operated cases) and late onset epilepsy occurred in 1 patient (1.3%), as shown in Table 27.

Table 27: Post operative epilepsy De novo.

	No.	%	Type
Number operated	81	-	-
Early epilepsy	1	1.3	Grandmal
Late epilepsy	1	1.3	Grandmal

4.4 POST OPERATIVE INCIDENCE OF PARALYSIS/PARESIS:

20 patients out of the 25 who had pre operative paresis, continued to have the weakness after surgery. 3 patients (3.7%) however, developed a weakness de novo after surgery, 2 having a weakness of the contralateral upper limb and 1 patient having a contralateral hemiparesis (see Table 28 overleaf).

Table 28: Post operative paresis/paralysis.

Involvement	All Cases	De Novo Post-op Paralysis No.	%
Ipsilateral Upper Limb	1	1	-
Ipsilateral Lower Limb	2	-	-
Contralateral Upper Limb	22	3	3.7
Contralateral Lower Limb	11	1	1.3

4.5 POST OPERATIVE WOUND INFECTION:

As discussed under Pre operative Wound Infection (see page 44 and Table 20a) post operative wound infection was seen in 22 patients (27.2%). As 10 of these patients also had a pre operative infection of the wound, de novo wound infection occurred in 12 patients (14.8% of operated cases - refer Table 20a).

Delayed operation, primary replacement of bone fragments did not appear to be associated with increase incidence of de novo post operative wound infection. However, delayed operation was responsible for increased incidence of overall post operative wound infection, since it was associated with a high pre operative wound infection rate. Pre operative wound infection contributed to 10 (45.5%) of the total 22 cases of post operative wound infection.

The use of prophylactic antibiotic did not appear to be directly related to de novo post operative infection. However, since chloramphenicol and crystalline penicillin were used in combination in 24% of patients who developed no wound infection and was used in 9.1% of those who did develop a wound infection, the combination did appear to reduce the pre operative wound infection rate (p less than 0.001) - see Table 29e.

Furthermore, as 50% of patients who developed a de novo post operative wound infection had received this combination, the high incidence in this latter group may suggest that contamination of wound during hospitalisation and/or surgery by resistent hospital organisms was responsible for de novo post operative wound infection.

4.6 BACTIRIOLOGY OF INFECTED WOUNDS:

Culture of the pus discharge was carried out in 7 out of 22 patients. The most frequently implicated organism was 'Escherichia coli' (in 42.8%) with 'Staph albus', 'Staph aureus' and Proteus species implicated in 14.3% of cases each. No growth occurred in 42.8% - as seen in Table 29a below. The culture result is tabulated in Table 29b.

The sensivity pattern indicated Gentamycin was effective in vitro against all 4 organisms, while chloramphenicol and ampicillin were effective against Escherichia coli and Staph albus, implicated together or seperately in 42.8% of infections. All organisms were resistent to crystalline penicillin (see Table 29c).

The various antibiotics prescribed singly or in combination are shown in Table 29d.

Table 29a: Post operative wound infection - Organism involved.

Organism Cultured	No.	%
Escherichia coli	3	42.8
Staph albus	1	14.3
Staph aureus	1	14.3
Proteus species	1	14.3
No growth	3	42.8

Table 29b: Cultured Organism.

Cultured Organism	No.	%
Escherichia coli alone	1	14.3
Escherichia + Staph albus	1	14.3
E. coli + Proteus	1	14.3
Staph aureus	1	14.3
No growth	3	42.8
Total	7	100

Table 29c: Sensivity Pattern.

Organism	Ampicillin	Gentamycin	Chloram-phenisol	Crystapen	Mono-cycline
E. Coli	S	S	S	R	-
Staph albus	S	S	S	R	-
Proteus	R	S	R	R	-
Staph aureus	R	S	R	R	S*

S - Sensivity
R - Resistent
* - Monocycline Sensivity checked for Staph aureus only.

Table 29d: Antibiotic prescribed for patients with wound infection (22 patients).

Antibiotic	No.	%
Chloramphenicol	9	41
Ampicillin	7	32
Crystapen	4	18
Gentamycin	4	18
Ampiclox	1	4.5
Amoxil	1	4.5

NB. Some patients received various combination of antibiotics dictated by availability at the time.

Table 29e: Association of Infection with Pre operative antibiotics.

Pre operative Antibiotics	Nil Infection (58 cases)		Pre-op Infection (11 cases)		De novo Post-op Infection (12 cases)	
	No.	%	No.	%	No.	%
Crystalline penicillin	3	5.3	2	18.2	1	8.3
Crytapen/ Chloramphenicol	14	24.1*	1	9.1*	6	50.0
Chloramphenicol	1	1.7	0	0	1	8.3
Ampicillin/ Chloramphenicol	4	6.9	1	9.1	0	0
Ampicillin	17	29.3	2	18.2	3	25
Ampicillin/ Gentamycin	4	6.9	2	18.2	3	25
Ampiclox	1	1.7	0	0	0	0
None	12	20.7	3	27.3	1	8.3

* p less than 0.001.

4.7 NEED FOR SECOND SURGICAL PROCEDURE:

A second procedure was required in three patients (see Table 30). Two required a minor procedure involving secondary wound closure. The third patient required a major operation involving a craniotomy for a brain abcess.

The details of this patient were described under Intracranial Haematoma and Brain Abcess (see pages 102/103).

Table 30: Second Surgical Procedure (required in 3 patients).

Type	Major or Minor	No.	%
2^{o} wound closure	Minor	2	2.4
Craniotomy	Major	1	1.2
Total		3	3.7

4.8 POST OPERATIVE COMPLICATIONS:

Several post-operative complications were seen. 9 patients in total developed a complication, ranging from minor ones such as bedsores to more severe ones including respiratory failure due to quadriparesis, brain abcess, bacteraemic shock and tetanus. The complications are tabulated in Table 31. 4 patients of the total 9 (44.4%) died, 3 of these (33.3%) having died due to complication. The patient who developed tetanus had an associated compound fracture of the tibia.

4.9 WOUND HEALING:

Wound healing by primary intention occurred in 69 patients, while delayed wound healing occurred in 21 patients. In 3 patients the healing was not assessed as the patients were discharged prior to removal of stitches to attend the nearest district hospital (see Table 32 overleaf).

Table 31: Post operative complications.

Complication	No.	%	Remarks
Respiratory failure	1	1.2	Died
Brain abcess	1	1.2	Reoperated, survived
Bacteramic shock	1	1.2	Died
*Tetanus	1	1.2	Died
Threatened abortion	1	1.2	Pregnancy saved
Transfusion reaction	1	1.2	Survived
Bed sores	3	3.7	One died

* Tetanus from associated compound fracture of the Tibia.

Table 32: Wound Healing - assessed in 93 patients (NB: 7 patients died).

Type	No.	%
Primary intention	69	74.2
Secondary intention	21	22.6
Not known (patient discharged to nearest hospital)	3	3.2
Total	93	100

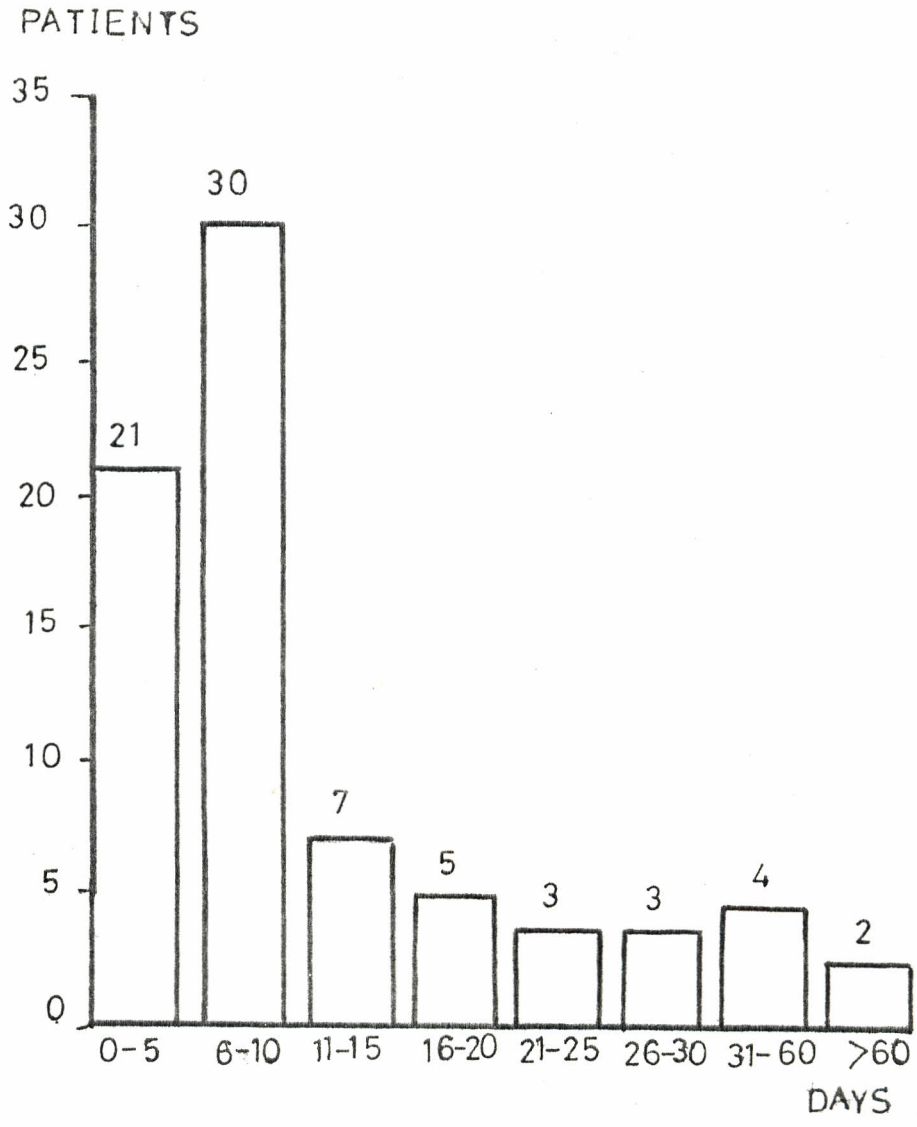
4.10 INTERVAL BETWEEN OPERATION AND DISCHARGE:

After surgery 21 patients (25.9% of operated cases) were discharged from KNH to their home or to the nearest hospital within 5 days, 62.9% within 10 days, 72.8% within 15 days. 7.4% of patients were hospitalised in KNH for more than one month, while 2.5% remaining hospitalised for more than 2 months. See Table 33 and Fig. 8.

Table 33: Interval between operation and discharge from KNH (see also Fig. 8).

Period of stay at KNH	No.	%
0 - 5 days	21	25.9
6 - 10 days	30	37.0
11 - 15 days	7	0.7
16 - 30 days	11	13.5
More than 1 month, less than 2 months	4	4.9
More than 2 months	2	2.5
Total discharged	75	92.5
Died	6	7.5
Total operated	81	100

Fig. 8: Interval between operation and discharge from KNH.



SECTION V:

DISCHARGE AND FOLLOW UP:

5.1 NEUROLOGICAL STATUS AT DISCHARGE:

Of the total 100 patients 69 (69%) were assessed as mentally normal (i.e. they had no mental or intellectual deficit) at the time of discharge. 24 (24%) patients had a mental deficit at time of discharge. The types of mental deficit, ranged from disorientation to a semi-comatose state. The latter patient was transferred to the nearest district hospital for continuation of conservative management. The various types of deficits and their frequency are tabulated in Table 34b (see also Table 34a below).

Table 34c shows the relationship between type of mental deficit and the site of injury. While no particular area was espacially involved in patients who were disoriented, the left parietal area was involved in 80% of patients with aphasia; the left parietal and parieto-temporal areas were involved in almost all patients with dysphasia and the parieto-temporal area was associated with impaired memory as shown in Table 34c.

Table 34a: Mental state/deficit at time of discharge from KNH.

Mental State	No.	%
Normal	69	69
Deficit present	24	24
Total	93	93

Table 34B: Types of mental deficit at time of discharge.

Type	No.	%
Disorientation	11	11
Aphasia	5	5
VII N. Palsy	2	2
Dysphasia	6	6
Frequent dizziness	1	1
Deficit of memory	1	1
Semicomatose (transferred to district hospital)	1	1
Total	37	37

Table 34c: Relationship between mental deficit and site of injury.

Site	Disorientation		Aphasia		Dysphasia		VII N. Palsy		Dizziness		Impaired memory		Semi-coma.	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Frontal	2	18.2	-	-	-	-	-	-	1	100	-	-	-	-
Left Parietal	2	18.2	4	80	1	16.7	-	-	-	-	-	-	-	-
Rt. Parietal	1	9.1	-	-	2	33.3	-	-	-	-	-	-	-	-
Left Temporal	2	18.2	-	-	1	16.7	-	-	-	-	-	-	1	100
Rt. Temporal	1	9.1	-	-	-	-	-	-	-	-	-	-	-	-
Temp-occipital	1	9.1	-	-	-	-	-	-	-	-	-	-	-	-
Occipital	1	9.1	-	-	-	-	-	-	-	-	-	-	-	-
Parieto-temporal	1	9.1	1	20	2	33.3	-	-	-	-	1	100	-	-
Fronto-temporal	-	-	-	-	-	-	1	100	-	-	-	-	-	-
Total	11	100	5	100	6	100	1	100	1	100	1	100	1	100

5.2 PHYSICAL STATUS/DEFICIT AT TIME OF DISCHARGE:

71 patients (71%) had no physical disability attributable to the skull injury. 22 patients had a residual physical disability at the time of their discharge from KNH. All 22 patients had a weakness of the contralateral upper limb while 10 of these 22 patients also had an accompanying weakness of the contralateral lower limb i.e. 10 patients (10%) had a contralateral hemiparesis.

Table 35b shows the relationship between site of injury and weakness of the contralateral upper limb, contralateral hemiparesis and weakness of both lower limbs. The parietal area was particularly associated with an upper limb weakness and, when involved bilaterally (ie by a midline vertex injury), caused weakness of both lower limbs.

Table 35a: Physical state/deficit at time of discharge from KNH.

Physical state	No.	%
Normal	71	71
Deficit present (due to skull injury)	22	22
Total	93	93

Table 35b: Relationship between site of injury and weakness of the contralateral upper limb, hemiparesis and lower limb weakness.

Site	Contra. Upper limb		Contra. Hemiparesis		Weakness both legs	
	No.	%	No.	%	No.	%
Frontal	3	25	3	33.3	-	-
Parietal	6	50	1	11.1	1	100
Temporal	2	16.6	3	33.3	-	-
Parieto-temporal	1	8.3	1	11.1	-	-
Tempero-occipital	-	-	1	11.1	-	-
Total	12	100	9	100	1	100

5.3 PATIENT FOLLOW UP:

64 patients (68.8% of the 93 discharged) were discharged through the neurosurgical clinic at KNH, 22 patients (23.5%) were sent to the nearest hospital for follow up. 1 patient was repatriated to a mental hospital from where he had absconded and subsequently received the injury. 6 patients (6.6%) were sent home with no instructions regarding their follow up (see Table 36).

34 of the 64 patients discharged to attend the neurosurgical clinic at KNH were recorded as having attended. 24 of these (75.6%) had made satisfactory progress, while 10 patients had not made a satisfactory improvement (see Table 37a below).

Table 37b shows the reasons for which progress was considered unsatisfactory.

Table 36: Patient follow up.

Discharged through	No.	%
Neurosurgical clinic	64	68.8
Nearest provincial or district hosp.	22	23.6
Mental hospital	1	1.1
Sent home	6	6.6
Total	93	100

Table 37a: Progress at review in Neurosurgical clinic during first month after discharge.

Progress	No.	%
Satisfactory	24	37.5
Unsatisfactory	10	15.6
Unknown	30	46.9
Total	64	100

Table 37b: Cause of unsatisfactory progress.

Reason	No.	% (of 34)
Persistent weakness	4	11.8
Persistent Aphasia	2	5.9
Wound infection present	4	11.8
Developed epilepsy	1	3.0

5.4 OUTCOME AT DISCHARGE:

62 patients (62%) had a good outcome, considered to be so when a patient resumed a completely normal life. 20 patients (20%) had a satisfactory outcome, in that they had a normal life but had a residual deficit of a nature that did not prevent them carrying out their daily activities.

9 patients (9%) had a bad outcome by virtue of the patient requiring assistence most of the time.

2 patients (2%) had a vegetative outcome, requiring assistance all the time.

7 patients (7%) died as a result of the injury or its associated complication (see Table 38 below).

Table 38: Outcome at discharge.

Outcome	No.	%
Good: Resumption of normal life	62	62
Satisfactory: Normal life with deficit	20	20
Bad: Requires assistence most of the time	9	9
Vegetative: Requires assistence all the time	2	2
Death	7	7
Total	100	100

'Bad', 'Vegetative' and fatal outcomes are all unacceptable, while return to normal life with or without a mild deficit considered acceptable.

The relationship of an unacceptable outcome to a delay in surgery (i.e. a prolonged injury to operation interval) is illustrated in Table 39 below. With a delay of less than 24 hours, and even upto 48 hours, the proportion of patients in the acceptable group was higher. Hence a delay of less than 48 hours favoured an acceptable outcome. However, this did not reach significant levels. A delay of greater than 120 hours (5 days) worsened the outlook with only 17% of such patients having had an acceptable outcome compared to 57.9% whose outcome was unacceptable (p less than 0.001).

Those who were notoperated upon appear to have had a favourable outcome at discharge (see Table 39) with a significance level of less than 0.01. This may perhaps indicate that those who were not operated upon had a mild injury.

Table 40 shows the relation between the final outcome and a complicated compound depressed fracture. Laceration of brain or dura, presence of haematoma and infection all showed a higher relative incidence of an unacceptable outcome. Although it did not reach significant levels a complicated fracture appeared to worsen the prognosis of the patient.

Table 39: Relationship between unsatisfactory outcome and delayed operation.

Injury to operation interval.	Acceptable Outcome No.	%	Unacceptable Outcome No.	%	P
Less than 24 hours	21	25.6	2	10.5	N/S
24 - 48 hours	13	15.8	2	10.5	N/S
48 - 72 hours	7	8.5	2	10.5	N/S
72 - 96 hours	7	8.5	-	-	0.05
96 - 120 hours	2	2.4	1	5.3	
More than 5 days	14	17	11	57.9	0.001
No operation	18	21.9	1	5.3	0.01
Total patients	82		19	100	

Table 40; Relationship between outcome at discharge and a complicated compound depressed fracture of the skull.

Associated Complication	Acceptable Outcome No.	%	Unacceptable Outcome No.	%	P
Lacerated Brain	18	21.95	7	36.8	N/S
Dural Tear	30	36.6	9	47.4	N/S
Haematoma	23	28.04	7	36.8	N/S
Infection	16	19.51	6	31.6	N/S
Total patients	83		29		

5.5 DETAILS OF THE PATIENTS WHO DIED:

1. Case No. 10:

A 27 year old male, was involved in a RTA brought to casualty within 3 hours of trauma. Examination revealed a patient in stable condition with a pulse of 76/min and BP 130/80. He had no serious associated injuries. CNS examination revealed a patient conscious and oriented; speech was normal, Pupillary reaction was normal. Skull examination showed a wound over the parietaoccipital region possibly overlying the sigmoid sinus.

The motor and sensory systems were normal. The gait was unsteady due to drowsiness. X-ray of the skull showed a 'small depressed fracture of the parieto-occipital region'. The patient's wound was cleaned and sutured in casualty and he was admitted for neurosurgical management. Within a few hours after admission the patient's condition deteriorated and while attempts were being made to stabilise the patient, the patient died. A post mortem was not done.

Comment: Likely diagnosis - extradural haematoma.
: Preventable death.

2. Case No. 13:

A male aged 24 years worked as a machine operator in a wood industrial organisation. Involved in an industrial accident at work when a wooden bar he was working on got stuck in the machine and swirled and hit him across the head. Arrived in casualty within 2 hours of injury. Examination revealed a patient in poor condition with a pulse of 64/min. and BP 140/70. He had no associated injuries .

The patient was comatose, responding inappropriately to painful stimuli (being unable to localise the pain). No cranial nerve palsy detectable. The pupillary reaction was normal on the right side, but sluggish on the left side. Skull examination showed an injury over the left fronto-parietal region.

The motor system showed no lateralising weakness. The patient developed a grand mal epileptic fit prior to surgery. The X-ray was reported as '? linear fracture extending to the base of skull'. The patient was put on antibiotics (ampicillin and chloramphenicol) and a request for a carotid angiogram was made to rule out a haematoma. This was done and showed no haematoma. On the 5th day of admission the patient was taken to theatre for exploration. At operation a left frontal depressed fracture was seen with brain oozing through a tear in the dura. There was no associated intracranial haematoma. A dural graft was required after surgical debridement. The bone fragments were not replaced.

Post operative the patient received 2 units of blood (one litre) and was prescribed injection Dexamethasone 4mg. 6-hourly, IV lasix 100mg stat, and IV flagyl 500mg 8-hourly. The patient remained comatose and died 2 days later.

Comment: Cause of death likely to be diffuse brain oedema.
: Depressed fracture missed. Time wasted doing carotid angiography.
: Poor risk patient but above factors could have been avoided by early adequate management.
: Prevention of death - debatable.

3. Case No. 27:

A 44 year old female involved in a RTA. Arrived at casualty within 3 hours of injury. Examination revealed a patient in poor general condition with a pulse of 94/min. and BP 90/50. Had an associated spinal fracture of 1st - 2nd cervical vetebrae. The patient was conscious, but disoriented with aphasia of the motor type. Pupils were bilaterally small but reacting. A wound was present over the right parietal area.

The power was reduced in all 4 limbs. X-ray skull: no fracture was seen until a few days later when a depressed fracture was noted. The patient was operated 10 days after the date of admission. A depressed fracture was seen in the right frontal bone. The dura was intact and no associated haematoma was present.

Post operative thepatient regained consciousness 12 hours after surgery but remained quadriparetic. 8 days after surgery the patient went into respiratory failure and died.

Comment: Likely cause of death - Pulmonary embolism.
: Cervical fraction should have been applied to stabilise the cervical fracture.
: Ventilator support should have been considered.

4. Case No. 29:

A 28 year old male, a victim of assault through 'mob justice'. Presented to casualty within 4 hours, where he was treated and discharged. Presented again 5 days later with dysphasia and a hemiparesis of the left side. Examination revealed a patient in fair general condition, pulse of 80/min. and BP 120/80. Conscious and oriented. Speech was dysphasic. There was a left upper motor neurone type VIIth cranial nerve palsy. The right pupil was normal, the left was difficult to visualise due to haemorrhage. The skull had a wound over the right parietal region. There was hemiparesis of the left side. X-ray revealed a depressed fracture of the right parietal bone.

The patient was operated upon soon after admission. A depressed fracture of the right parietal bone was elevated and bone fragment removed. A torn dura was present. An associated intracerebral abcess which had become infected, forming an early brain abcess, was evacuated. A dural graft was required for dural closure. The patient did not resume spontaneous respiration post operatively and was transfered to the Intensive Care Unit. He developed grand mal fits and remained comatose and died 8 days later.

Comment: Diagnosis missed at initial presentation. This contributed to worsening of prognosis.
: Intra operative cause (surgical or anaesthetic), likelyto have been the cause of failure to breath and regain consciousness.
: Death - preventable.

5. Case No. 76:

A 33 year old male referred from Kiambu district hospital. Assaulted and left unconsciousness and picked by local area police and taken to hospital. Arrived at KNH about 16 hours after trauma. Examination revealed a patient in poor general condition with pulse 64/min. BP 170/110. The patient was comatose responding inappropriately to pain (unable to localise pain). He had no associated injuries. A left sided VIIth cranial nerve palsy was present. Pupillary reaction was sluggish bilaterally. A scalp wound over the right parietal region was present. There was weakness of the contralateral upper and lower limb and ipsilateral lower limb. The patient developed grand mal fits prior to surgery. An abnormal (up going) plantar reflex was present on the opposite side. X-rays revealed 'no fracture'. A carotid angiogram was done and revealed a depressed fracture and a subdural haematoma on the right side.

The patient was taken for surgery 2 days after admission. A depressed fracture of the right parietal bone was removed. The dura was intact. An associated subdural haematoma was evacuated. The patient remained comatose after surgery and died 12 days later.

Comments: Emergency surgery could have been done at the referring hospital, hence preventing delay.
: Delay contributed to death.
: Death - possibly preventable.

6. Case No. 86:

Male 44 years old admitted following an RTA. Arrived within 10 hours of injury. Examination revealed a patient in poor condition with pulse of 94/min. Had associated soft tissue injury. Was comatose responding inappropriately to pain (not able to localise pain stimulus). The right pupil was dilated and fixed, the left pupil reacting normally. There was a scalp wound over the left parietoloccipital region. X-ray was reported as showing 'a linear fracture of the left temporal bone'.

The patient was taken for surgical exploration to rule out an intracranial haematoma. A depressed fracture of the left temporal bone was elevated. The dura was found intact. An associated extradural haematoma was evacuated. The bone fragments were replaced. Post operative the patient did not regain consciousness and the patient died 30 hours later.

Comments: The side of the dilated pupil should have been explored at time of operation.
: Prevention of death - probable.

7. Case No. 90:

55 year old male admitted following a RTA. Examination revealed a patient in poor general condition with a pulse of 60/min. and hypotension. He had an associated compound dislocation of the right foot and fracture of the left radius and ulna. The patient was semi-comatose, responding to pain by localising the site of painful stimulus. The left pupil was dilated and sluggishly reacting to light. The right pupil was normal. X-rays reported as 'a linear fracture of left temporal bone'. The patient was taken to theatre for exploration. A depressed fracture of the left parietal bone was found. Elevation was done; surgical toilet of the right foot was also carried out. An associated subdural heamatoma was evacuated. Post operative the patient did not regain full consciousness. He developed spasms and infection of the leg wound. A diagnosis of tetanus was made. The patient required intubation and curarisation. He died 26 days after surgery.

Comments: Tetanus was the cause of death.
: Prevention of death - unlikely.

In patients who died RTA was a major contribution, having occured in 4 (57%) patients while assault accounted for 2 (28.6%) and an industrial accident accounting for the remaining 1(14.3%) case.

Hence assault caused a mortality in 2 out of 72 patients = 2.8% patients while RTA resulted in mortality in 4 out of 11 patients = 36.4% indicating* the severe nature of cerebral injury caused by Road Traffic Accident.

*(p less than 0.05)

D I S C U S S I O N

Depressed skull fracture results from an application of a direct force on the skull. Its shape and size depend on the impacting object (10).

The relatively thin skull in the child deforms more readily than the more rigid one of the adult. Depression in the adult requires a greater force and is therefore more likely to be accompanied by a laceration of the overlying scalp. Whether a depressed fracture is closed or compound is therefore determined chiefly by nature of trauma and the age of the patient (15).

The depression characteristically has a larger fracture of the inner table than that of the outer (32). The mechanism of this is based on the histological structure of the skull. A localised force fractures the hard outer table, and then spreads wider into the soft cancellous part. A wider force is hence transmitted to the inner table resulting in a wider fracture. Clinical and experimental studies confirms this (32).

Assault is an important causes of head injury. In this study 72% of the injuries were caused through assault. Sande (40), Mwamgombe (30) have similarly found assault a major cause in Kenyan series. Most series from industrialised centres implicate road traffic accidents as the major cause (14, 15, 28). This geographic relationship is illustrated further by a Swiss series in which 61% of such fractures result from skiing accidents (32). Industrial accidents are an important cause in these western studies, second only to traffic accidents (14, 15, 28). In this study only one patient was involved in an industrial accident.

While 4 children in this study were hit by a stone at play, this can hardly be regarded as sport. More specific type of sport including golf, cricket, horse-riding, are a significant cause in western series (14, 15, 28). Fall from a height, either off a tree or a building and some unspecified falls accounted for 6% of cases in this study. A low rate is similarly attributed to falls in other series. Sande (40), however, found falls

responsible in 36% of cases in one series. Rarer causes of compound depressed fractures have included a carpenter's nail, hammered into the skull and immediately removed (40). In this study a buffalo attack was the cause in one case. Penetrating injury of the forehead caused by a rearview mirror during a traffic accident illustrated the usefulness of wearing a seat belt (29). Tree felling accidents, blows from truck tyre rims, explosions of emery wheels have also been found as causes (15).

Assault, however, stands out not only in its magnitude in this study, but also the severity of injury it causes. Assault was the cause in 32 out of 39 (82.1%) patients with a dural tear. The 'panga' was found to be a particularly viscious weapon, causing a dural tear whenever it was implicated (p less than 0.02) .

A brain abcess occurred exclusively in patients with a torn dura. This illustrates the role of assault in causing infection and worsening the outcome. Miller and Jennett found a similar association between dural laceration and infection and also noted that infection was twice as common in assault groups than all other causes put together. Similar findings relating infection to dural laceration have been found (27, 39, 43, 46).

Assault, through its greater association with dural laceration can have further detrimental effects on outcome.

Dural laceration is associated with a higher risk of late post traumatic epilepsy (14, 17). In the KNH study, a dural laceration was associated with a higher incidence of impaired level of consciousness and prolonged post operative unconsciousness of greater than 24 house (p less than 0.02). Early epilepsy, mental and physical deficit was present more frequently when a dural tear was present, although the difference did not reach significant levels when compared to intact dura.

Various weapons of assault were implicated. The 'panga' (see appendix) a long bladed knife commonly used by rural communities to cut wood for fire, was the commonest weapon. It is often used in quarrels over a woman's love or land disputes and the aim is to maim or kill. Blood loss is usually severe (39).

The 'Rungu' (club) is a mark of distinction among several Kenya communities. In 66% of injuries caused by a 'Rungu' the dura was found lacerated. Overall the 'Rungu' was implicated in 18.6% of the assault cases. Sande (39) found injuries from this cause to be severe: 66% of patients having a residual deficit six months after the injury.

An iron bar was used in 18.5% of cases. In all cases the dura was not torn. The wider area of application of force results in a wide-based inner table. This possibly explains the low incidence of dural tear in iron bar injuries. Stones, when used as weapons of assault had a 50% likelihood of causing a dural tear. These were implicated in 15% of the assault cases.

Overall, assault injuries were a cause of greater morbidity. However, the mortality was low; 2 patients out of 72 assaulted cases died (2.8%). The mortality from road traffic accidents however was significantly higher; 36.4% of those involved in an RTA died (p = less than 0.05).

Road traffic accident formed 11% of the patient in this study. As pointed out earlier this is the most important cause in most western series. Jameison (15) in a series of 322 patients noted that traffic accidents were responsible for increased mortality, being higher in these than for all other causes of depressed fracture. The reasons for this are multiple. Raod traffic accidents are associated with higher acceleration/deceleration and rotational component of force. This results in severe concussion which in itself can result in prolonged unconsciousness (21). The magnitude of cerebral anoxia and raised intracranial pressure is higher. These are leading caused of death in head injuries (21).

The second reason for increased mortality in traffic accidents is the incidence of contre-coup haematoma, which is increased by the mechanism of forces already mentioned. Meirowsky (26) underlines the importance of exploring the opposite side if signs of raised intracranial pressure are present during surgery for elevation. Case No. 86 (see page 83) in our series illustrates this important point. The patient had an injury on the left side and a dilated pupil on the right. Despite elevation and evacuation of an extradural haematoma, the patient died. An exploratory burr hole on the opposite side may have helped (see section 5.5) Finally traffic accidents are often associated with other severe injuries, which worsen the prognosis even further. In this study 27 patients had an associated injury. 11 of these had severe injury elsewhere and in all these patients road traffic accident was the cause.

An unusal type of depressed fracture is seen at KNH. This is the 'forked jembe injury' due to a digging fork (see Appendix). This injury is commoner in peasant communities in Kenya. In this study 5 patients were injured in this manner. 2 were in the 1-5 age group, 2 in the 6-10 years group. The single patient under one year in this study sustained this injury. 3 were males and 2 female. 2 patients were not operated upon due to the proximity to the saggital sinus and the patients were in stable condition. 4 of these patients were referrals. An older sibling may accidently hit the child with the fork or a crawling child may crawl in between the legs of a mother busy digging the garden and be struck with the fork (4). The incidence of this injury was about 3 per year in this study. Mwamgombe (31) found 3 cases in 6 months in his study at KNH and Sande (40) recorded 26 children aged 2-5 years (14 boys and 12 girls) over a period of 5 years; an incidence of about 5 per year.

The injury often appears trivial, presenting as a small puncture wound. Unless the diagnosis is suspected or a history is provided by the parents the wound may be sutured and patient discharged only to return with an intracranial abcess, as did one patient in this study. Sande (40) recommends the following principles in the management of this injury:-

i. assume the presence of an intracranial clot or abcess (one out of 5 in this study)
ii. ensure adequate exposure.
iii. evacuate clot or abcess as well as in driven bone fragments and excise necrosed brain tissue.
iv. repair dura with pericranium.
v. close scalp in two layers.

The parietal area was most frequently involved in this study (38% of operated cases). The frontal area was next in frequency (24.7%), the temporal area in 16%. The fronto-parietal , pparietotemporal, occipital and occipital-temporal were involved in the remaining 17%.

Meirowsky (26) noted a similar preponderence of parietal fractures (31.5%) followed similarly by frontal and temporal fractures (30% and 19.6% respectively). Hemmon (12) in an analysis of Vietnam war injuries noted the frontal and parietal fractures formed the bulk (50%) of the total. Heiskanen (14) however, noted a preponderence of frontal fractures (45%). This is perhaps explained by a greater incidence of road accidents in his series. This is confirmed by Jameison's (15) findings, showing that in road traffic accidents the frontal area was predominantly involved. Domestic accidents in his series had a preponderence of parietal area. fractures.

The fracture was noted (radiologically) to overlie a venous sinus in 8% of cases in this study. Of these, one patient was operated upon and the venous sinus was found intact. In Miller / Jennett's (28) series the venous sinus was involved in 11.5% of cases and at operation 47.8% of these were found to be torn. Similar findings were reported by Heiskanen (14) in whose series venous sinuses were involved in 12%, and of these 37% were torn.

The difference in the rate of torn venous sinuses may reflect the willingness to operate upon such fractures in these series. In this study only one such patient was operated upon. The other reason for the difference may be that delay in presenting to hospital may have excluded those who had a severe laceration, due to higher mortality.

The left side of the skull was more commonly involved, but this did not reach significant levels. The predominance may be because an assailant generally weilds the object in his right hand in a face to face confrontation. Jameison (15)similarly noted that the left side was more commonly involved in 'sports and brawls' (p less than 0.1), and attributed it to the predominance of right handed individuals in society. With regard to road accidents, this study revealed an equal distribution on both sides of the skull. Jameison(15) in contrast found the right side more commonly involved in traffic accidents (p less than 0.1), attributing this to driving on the left side of the road. This indicates the greater number of drivers involved in accidents. In our study the majority were of low social status and pedestrian by this virtue.

Heiskenen(14) found both sides of the skull involved with equal distribution, but had a low incidence of assault. Interestingly, Hagan (11), in a war series, found the right side predominantly involved, but declined to comment about its significance.

The age group most prone to this injury was found to be the 16-40 years. 69% were in this group. 13% were below 16 years. Sande (40)found 75% between 20-40 years. Jameison (15)also noted the majority to be in the 20-40 years age group. Mwangombe (30)noted a peak in the 3rd decade. Miller/Jennet (28), Heiskenen (14), Braakman (1) however noted that almost half their patients were under 16 years. It would appear therefore that the injury in our series affects the young adult. This particular age is one upon which psychosocial pressures are strongest.

That this leads to a higher incidence of assault, traffic accident, industrial accidents is a reasonable conclusion to make. In most societies, Kenyan included, these pressures are greater upon the male. In this study the male to female ratio was 10:1 (91% males); Miller/Jennet (28)found 83% male preponderence.

Sande (40)found 73% males. Others have found a similar high male presdisposition (1, 14, 15) with figures ranging between 80-85%. That males are more accident prone is illustrated by Miller/Jennet(28) who found a male:female ratio of 2:1 (66% males) even in the age group 0-5 years.

Psychosocial factors may be implicated is further illustrated by occupation of those injured. The unemployed and the temperorily employed 'casual' workers provided the majority (41%) in this study; clerical workers 13%, semiskilled workers 10%, traders 9%, skilled workers 0% indicated an apparent reducing trend. However, this may perhaps be due to a bias, in that such patients prefer to seek treatment in the private-care institutions within Nairobi. It is of interest to note that amoung the 'casual' workers almost half were employed as night watchmen at the time of injury.

The injury was slightly more common towards the weekend, although the difference did not reach significant levels. However, there was a significantly increased incidence in the last week of each month. 43% of the injuries occurred in the first week (p less than 0.01) and 17% each occurring in the second and third week respectively (p less than 0.001). This is perhaps explained by an increased social interaction occurring during month-ends, especially over weekends when salaries have been received and theft, assault and alcohol consumption rises. Furthermore, travelling into and out of the city increases, resulting in an increased incidence of traffic accidents during this time (31) . Although only 10% of the patients in this series were noted to be 'smelling of alcohol' this is likely to be an underestimate since a large proportion (40%) presented more than 12 hours after injury. Galbraith (8) found alcohol intake was related to head injury particularly when assault was the cause.

Compound depressed fracture of the skull per se is usually followed by a *quick and total recovery provided management has been appropriate.* However, some patients develop complications, the main ones include infection, intracranial haematoma and venous sinus involvement. In this study 22 pateints developed infection (27.2% of operated cases), 30 patients (37% of operated cases) had an associated intracranial haematoma and 8% had involvement of major venous sinuses. Overall 45 patients (55% of operated cases had at least one of the mentioned complications i.e. 1 in every 2 cases was complicated.

Miller/Jennet (28) in their series of 400 patients found one or more of these complications in 26% of their patients. Compared to the uncomplicated group these patients had increased mortality, prolonged neurological deficits and late epilepsy. These factors were hence studied in this series to assess the effect on outcome.

INFECTION

The overall post operative infection rate in this study was 27.2% (22 of the 81 operated patients). All these patients had wound infection and 3 patients had an early brain abcess by the time of surgery. One patient developed a brain abcess 2½ months after the operation. One patient among the 22 developed a brain fungus and was classed as infection. Established (pre-operative) wound infection occurred in 11 patients (13.6%). The 3 patients who had an early brain abcess at operation and the patient who developed the abcess later belonged to the group with established infection. Similarly the patient with brain fungus also belonged in this group.

In all patients who developed infection de novo after surgery, the infection was limited to the wound. In this study no cases of meningitis were noted. Similarly osteomyelitis of the skull was absent from this series.

De novo post operative infection rate was 14.8%. This compares unfavourably with that of Jennet and Miller (18) who recorded an overall rate of 10.6% and a post operative rate of 4.6%. Sande (41) working in KNH found an overall rate of 11%. This was also the post operative rate as he included only clean wounds operated within 24 hours of injury. Most centres report an overall infection rate of between 2% and 10% (1, 14, 26, 27, 42). Plese (35) and Humphrey (35) have todate reported the lowest rate of infection (0%) when working on a personal series of 60 patients.

The factors responsible for this complication are several. Established infection at the time of presentation or operation contributed to 10 out of 22 post operative infections (45.5%) in this study. Furthermore, it was in this group that major intracranial infection (abcess and brain fungus) occurred.

Jennet/Miller (18) similarly noted that established infection at time of presentation was of more serious consequence. In their series, 62.5% of cerebral abcesses and meningitis occurred in this group, while the majority (78.6%) de novo post operative infections were confined to the scalp wound. It is generally accepted that infection is related to timing of surgery (5, 14, 26, 27, 42). The trauma to surgery interval was analysed in the 22 pateints who developed infection. Delay was responsible for all the cases of established infection. In all these 11 pateints a delay of more than 48 hours was present. While 9 of these patients (81.8%) had a delay of greater than 96 hours, only 12 of the 58 cases (20.6%) who had no infection, had a similar delay (p less than 0.01). The trauma to surgery interval in the 12 cases of de novo post operative infection did not appear to be related. Other factors may hence have contributed to infection in these cases. Jennet/Miller (18) found overall infection greater in those who had a delay of more than 48 hours. However, most neurosurgeons agree that a delay of more than 24 hours increases the risk ofinfection (14, 35, 41).

Laceration of dura is accepted generally to be related to infection (21, 28, 38, 42, 44). A tear of the dura was present in 39 of the 81 operated pateints (48%). Intracranial infection occurred in 4 patients and all these had a lacerated dura. No intracranial infection occurred in the group with intact dura (p less than 0.05).

Furthermore, as mentioned earlier, assault, especially with a 'panga' has an increased incidence of torn dura. Miller/Jennet (28) further indicated that in their series infection was twice as common in the assault group.

In the cases who had established infection at operation and in patients developing cerebral abcesses, delay was an important feature. While a few pateints presented late, several other reasons were attributed to a delayed surgical debridement. They were analysed and found to include:

a. Delayed review by the neurosurgical team. Both delay in requesting a consultation and delayed review after the neurosurgical team had been consulted were responsible for the delay.

b. Depressed fracture missed at first presentation. This occurred in 11 patients (20.9% of operated cases). In most instances a pateint presented himself at the casualty and was reviewed and mistakenly managed as a scalp wound and discharged, the depressed fracture having been missed. An analysis of causes of missed diagnosis revealed the following reasons.

- Low incidence of loss of consciousness. Due to localised brain laceration especially in assault cases, loss of unconsciousness is uncommon. A negative history of unconsciousness deceived the casualty officer into avoiding to request skull X-ray. Jennet/ Miller (18) and Robinson (38) noted that adequate X-rays including a lateral and an anteroposterior view and a tangential view if necessary were essential for diagnosis. The practice of finger palpation alone, during primary wound suture is unreliable as the inner table frequently seperates from the outer table, leading to a missed fracture (18).
- Even when an X-ray was requested, the fracture was missed in some instances and noted after a delay. This calls attention to the need for casualty officers to be well versed in reviewing X-rays.
- Drunkenness of a patient was not confirmed to have caused a delay in diagnosis in this study. However, drunkenness leads to camouflage of disturbed mental function which is then attributed to the alcohol. The injury may hence be underestimated (18).

c. Postponement of operation by the neurosurgical SHO was responsible for delay in 14.5% cases. At KNH, all emergencies are operated upon in one theatre, resulting in overloading. There is a further tendency to postpone the surgery to the next day if theatre becomes available very late in the night. A combination of these factors results in overall delay in operation.

d. Blood not available for surgery. Along with the factors mentioned in (c) above, this was a reason in 14.5% of patients delayed beyond 24 hours after admission. The blood bank in the hospital is constantly in low supply of blood and often contributes to a delay in surgery.

e. Theatre inavailability was responsible for delay in 9% of the cases delayed beyond 24 hours after admission. The reason for this has been mentioned earlier.

f. Several avoidable factors (see table 6 on page 24) were the cause for delay in the remaining 12.6% of cases.

ROLE OF PROPHYLACTIC ANTIBIOTICS IN PREVENTING INFECTION

All patients with a compound depressed fracture admitted to KNH were routinely prescribed antibiotics while awaiting surgery. No fixed regime was followed, and the prescription was dependent upon the availability at the time. Chloramphenicol, often in combination with crystalline penicillin or ampicillin was the most common regime.

In this study it was difficult to analyse the effect of all antibiotics used due to their inconsistent prescription. However, the crystalline penicillin/chloramphenicol was associated with a 24.1% nil infection rate and only a 9.1% pre operative infection rate. Hence the combination was effective in reducing the rate of established infection ($p < 0.01$). The other antibiotics did not show such a difference. The same combination, however, was ineffective in reducing the de novo post operative wound infection rate. The post operative infection rate was high even when this combination was used. This may be due to reasons not clear in a retrospective study. An infection by resistent hospital organism could possibly be one cause.

Overall, therefore, prophylactic antibiotics (particularly crystalline penicillin and chloramphenicol combined) reduced the overall infection, but this was due to reduction in the pre operative rate. The de novo post operative rate remained uninfluenced. There exists disagreement as to the usefulness of prophylactic antibiotics. Mendelow (27) recommends a sulphonamide/ampicillin combination, stating that this had reduced the overall infection rate from 6.3% to 1.9%. Jennet and Miller (18) suggested that the use of prophylactic antibiotics reduced infection rate, but warned that they do not reduce the need to apply surgery early. Similarly, Hagan (11), Cairns (3) and Coleman (5) have recommended their use. Robinson (38), however, notes that antibiotics 'are seldom necessary'. Plese/Humphreys (35) after a prospective series state that antibiotics hadno influence on incidence of infection. Similarly Braakman (1) showed that antibiotics had no influence on infection incidence. It has been noted that the widespread use of antibiotics

antibiotics carries the risk of opportunistic infection (36).

Miller and Jennet (28) however, reaffirm that the most important procedure is adequate surgical debridement and note that with antibiotics there is a smaller risk of infection and delay is justified if patients need to be referred for an adequate debridement.

ROLE OF PRIMARY BONE REPLACEMENT OF FRAGMENTS

Most neurosurgeons are presently in agreement that in non-missile injuries replacement of bone fragments after surgical debridement has no risk of increased infection (1, 4, 5, 14, 18, 20, 24, 35, 41).

However, there still exists controversy as to the type of wound and the time limit beyond which primary replacement is not recommended. Coleman (5) suggested that bone replacement should be limited to clean wounds operated less than 12 hours after injury.

Lyerly (24) similarly recommended that primary bone replacement be done only when the wound is clean, the dura intact and operation is within 12 hours of injury. He accepted a delay of 24 hours if antibiotics were prescribed.

Sande (41) recommends that primary bone replacement should be done in all clean cases operated within 24 hours, and recommends cleaning the fragments with hydrogen peroxide or normal saline.

Kriss (20) however states that bone can be replaced even in presence of gross contamination, dural and brain laceration provided dura can be closed and operation is within 24 hours. He found an infection rate of 2.5% using this technique.

Plese and Humphreys (35) produced a 0% infection rate with and without bone replacement whether antibiotics were used or not. They maintain that meticulous surgery carried out within 24 hours was the cardinal point. Contamination, dural laceration was of no consequence.

Jennett and Miller (18) after reviewing 400 cases conclude that bone may be primarily replaced even when wound and bone are contaminated, and dural laceration cannot be closed and surgery delayed beyond 48 hours. They state that a clean wound, early surgery, intact dura are good to have but are not essential. The only absolute contraindication is presence or suspicion of infection.

In this study primary bone replacement was carried out in 20 patients (within 18 hours in 3 patients and after 24 hours in 17 patients. Bone was not replaced in presence of infection). No infection occurred in the first 3 patients. The de novo post operative infection rate in the 17 patients was 11.8%. This rate was lower than the overall de novo post operative infection rate of 14.8% (p = N/S). In effect therefore, no significant risk of infection was noted even when bone fragments were replaced after 24 hours. This slightly reduced infection rate after replacement has similarly been noted by Braakman (1), Heiskanen (14), Jennett and Miller (18). The reduction is not significant and may be because bone fragments are left out in heavily contaminated wounds.

In contrast, in missile injuries such as those encountered in civil disturbances and war, there appears unanimous agreement that bone fragments should be removed and not replaced (11, 26).

It is of value to know the benefits of primary bone replacement. These include:

i. Cranioplasty is avoided. Cranioplasty in itself has a risk of infection (18).
ii. Potentially dangerous and unsightly defects avoided.
iii. Prosthesis in children tend to loosen or fracture as child grows (20).
iv. Cerebral atrophy has been attributed to the pulsation of brain against a defect, leading to neurological deficit (4).
v. Epilepsy rate may be lowered (4). Jennett and Miller (18) however, found no influence on epilepsy rate.
vi. The cosmetic result is better, especially for fractures involving the supra-oribital ridge (20).

BACTERIOLOGY OF INFECTION

In this study 22 patients developed infection. A pus swab to culture the organism was taken in 7 patients. Escherichia coli was cultured in 3 patients (42.8%) and staph albus (Staph epidermis), staph aureus and proteus species, each occurred in one patient (14.3% each). A mixed growth occurred in 3 patients (see tables 29a, b). Sande (42) in Glasgow found staph aureus, Escherichia coli, clostridium welchii in infected wounds in a ratio of 2:1:1 respectively.

Hagan (11) cultured staph epidermis, Escherichia coli, aerobacter, pseudomonas aeruginosa in wounds sustained in the Vietnam war. Even in brain abcessess around bone fragments staph epidermis and Escherichia coli were cultured in 63% of cases.(11).

Mendelow (27) in Edinburgh cultured infected wounds, abcesses and CSF of meningitis patients (all as a result of compound depressed fractures) in 11 patients. He recorded Escherichia coli in 54%, staph aureus in 27% and no growth in the remainder.

Escherichia coli, staph aureus, staph epidermis appear to be incriminated universally, both in missile & non-missile wounds. These form the majority in this study. If prophylaxis is to be considered or treatment started prior to culture results being available, it would appear reasonable to use a combination that would cover at least these three organisms. In this study such an antibiotic would have been effective in all except one case in which proteus species was implicated i.e. 85.7% of the infections. The choice of antibiotics would vary with the local sensivity pattern and assistance of the laboratory would help. The sensivity pattern of these organisms in this study is shown in table 29c.

BRAIN ABCESS

The incidence of brain abcess in this study was 4% (5% of operated cases). 3 were present at the time of surgery and were a result of delayed operation and established infection. One developed a brain abcess after operation. All 4 patients had delayed surgical debridement. In all of them a torn dura was found. Sande (42) in Glasgow found 2 cases of intracranial abcess in 216 patients (0.9%) both due to missed diagnosis and delayed surgery.

It is of interest to note that the brain abcess rate in the Middle East war of 1941 - 1942 was 27%. Early surgical debridement has largely been responsible for its reduced incidence (47).

Brain abcesses usually develop around a bone fragment, especially those retained in brain tissue. In compound depressed fractures 90% have been shown to develop around a retained bone and these take upto 3-5 weeks to present (11). An X-ray showing a retained fragment which changes its position on subsequent X-rays suggests a brain abcess (11).

The clinical picture is a combination of neurological deficit, raised intracranial pressure and sepsis (9). The patient who developed the abcess 2½ months later in this study showed such a presentation.

The prognosis after a brain abcess is determined by the extent of mental and physical deficit and epilepsy. Garfield (9) found a mortality of 40%, and severe deficit preventing return to normal life in 7%. 53% made a full recovery and returned to normal life.

INTRACRANIAL HAEMATOMA

In this study 30 patients had an intracranial haematoma. These comprised 17 extradural haematomas, 3 extra + sub-durals, 4 sub-durals, 1 intracerebral + subdural and 5 intracerebrals.

i.e. Extradurals.....56% of all haematomas.
Extra + Subdural.....10% of al haematomas.
Subdural.....13% of all haematomas.
Intracerebral + Subdural..3.3% of all haematomas.
Intracerebrals.....16.6% of all haematomas.

Divided into the 3 main types these included:

Extradurals.....66%.
Subdurals.....16.6%.
Intracerebrals.....20%.

As has been pointed out earlier, no particular amount was regarded as a haematoma and the diagnosis was subjective. Hence small collections may also have been included.

Miller and Jennett (28) regarded more than 20ml as a haematoma, found an intracranial haematoma in 7%. Of these 60.7% were intracerebral, 28.6% were extradural, and 10.7% were subdural.

Heiskanen (14) found an intracranial haematoma in 11% of his patients. 50% were extradurals, 15.4% subdurals and 34.6% intracerebrals. These figures tally more with those found in this study. It is noteworthy that Heiskanen did not state what amount he regarded as constituting a haematoma.

Jameison (15) found 24% extradurals, 27% subdurals and 48% intracerebral haematoma.

An intracranial haematoma in this study was found more commonly with an intact dura, but did not reach significant levels. Meirowsky (26) making a similar observation suggested that due to this high incidence in intact dura, the dura should be opened in every case. Lyerly (24) however, prefers to open the dura only when a bluish discolouration suggest a subdural. The lower incidence in torn dura may be due to decompression of the haematoma (5, 15).

An injury having a blunt acceleration/deceleration component (such as a RTA) was found in this study to be less likely to cause a dural laceration. An increased association with subdurals may be due to this factor. Miller and Jennett (28) found a higher incidence of subdurals in such injuries. There is a further increased incidence of coutre coup haematoma in injuries comprising an acceleration/ deceleration component. Raised intracranial pressure persisting after elevation despite conservative measures should alert one about this possibility, and an exploratory burr hole on the opposite side is advised (26).

There exists the possibility of a delayed traumatic intracerebral haematoma developing after elevation of compound depressed fractures (19). It was not a recognised feature in the patients in this study. It has been reported sporadically in literature (16), but is now recognised more frequently in centres using computerised-assisted tomography (7). The pathophysiology is unclear. Use of controlled ventilation leading to increased venous pressure and a venous ooze may cause the haematoma (2). Hypertonic solutions, by decreasing intraparenchymal pressure, may contribute by removing any tamponade effect (2). While the CT scan is of merit, the possibility should be considered if a patient's clinical conditions fails to improve or deteriorates following adequate surgical therapy.

In this study intracranial haematoma was present in five of the seven patients who died. Hence, of the 30 patients who had an associated intracranial haematoma, 5 died; a mortality 16.7%. Of the remaining 70 patients who had no haematoma, 2 died (2.8%) (p less than 0.05). Heiskanen (14) found 30% of haematomas died. Lewin (21) similarly had found intracranial haematoma among the three major killers in head injuries, and recommends the use of CT scan in order to attain early diagnosis. Most investigations presently in use in KNH detect haematomas at a stage in which signs of

impaction of cerebral tissue have already become established, a feature resulting in increased mortality of haematoma (21).

Miller and Jennett (28) similarly found mortality significantly increased in haematomas. They have also noted a prolonged neurological deficit associated with intracranial haematomas. The follow up in this study prevented assessment at 6 months. However, 48% of those who had a haematoma and survived, had a residual neurological deficit at time of discharge, as compared to 17.6% who did not have a haematoma (p less than 0.01). How many improved completely over the next 6 months could not be assessed in this study.

Late onset epilepsy could not be satisfactorily assessed due to nature and duration of follow up. However, 20% of the haematoma group developed a fit in the first week after injury, while only 8.5% of those without a haematoma had a fit. The difference however did not reach significance (p=greaterthan 0.1). Jennett (17) found a significant association between late onset epilepsy and intracranial haematoma, noting that late epilepsy was four times more common when a haematoma was present.

Overall therefore intracranial haematomas contributed significantly to mortality and a poor outcome. Their relationship to prolonged neurological deficit and epilepsy could not be assessed in this study.

LACERATION OF THE DURA

A dural tear was found in 39 cases (48% of operated patients). It was more commonly associated with assault though the difference did not reach significance. However in the assault group those assaulted with a 'panga' (see Fig 9) had an increased risk of dural laceration (p less than 0.02). It would appear that sharp objects in which the concentration of force was greater per area of vault resulted in greater depression of bone fragment and a resultant dural laceration. Heiskanen (14) found a torn dura in 61.6% of cases, while Plese (35) encountered a tear in 57%. Miller and Jennett (28) found it torn in 52%. Jameison (15) who noted a tear in 60%, found more tears in depressions that were narrow and 'gutter' shaped and less in broad smooth depressions.

Laceration of the dura was found more likely to be associated with dis-orientation and impaired level of consciousness at time of initial presentation, but the difference was not significant (p less than 0.1). Similarly the duration of post operative impairment of consciousness was greater when dura was torn. Hence while 46.2% of patients with a dural tear had not regained full consciousness by 24 hours after surgery, only 21.4% of those with intact dura were similarly affected (p less than 0.02).

Jameison's (15) claim that dural laceration was associated with a higher mortality was not confirmed by this study. There was no difference in the mortality rates in the group having a tear as compared to the group having an intact dura (5.1% compared to 7.1% respectively p = N/S).

The association between intracranial infection (brain abcess) and dural laceration has been noted earlier. All the brain abcesses occurred in association with a dural tear (p less than 0.05). Mendelow (27) similarly noted such an increased association between infection and dural laceration. Similarly findings have been reported by others (39, 43, 46).

The single patient with brain fungus in this study had a dural laceration The risk of brain fungus is great when a torn dura is left unclosed (11, 24). Regarding closure of dura, there appears unanimity that tight closure, with graft if necessary, should be done (4, 11, 24, 26, 28, 28,41).

This would certainly be the opinion from this study where a tear, through its contribution to infection led to a brain fungus. Jennett and Miller (18) however, noted no difference in infection rate whether dura was closed or left open, provided a good scalp closure was done.

The IIIrd, VIth and VIIth cranial nerves when involved were found to have an associated dural tear. 8 out of 9 patients with a VIIth nerve palsy had an associated dural tear (p less than 0.02). The presence of a dural laceration was associated with a higher risk of mental and physical deficit as well as early epilepsy. The difference between the groups with a torn dura and an intact one did not, however, reach significance (p less than 0.1 = N/S) - see Table 21e page . Heiskanen (14) and Jennett (17) have noted an increased risk of late epilepsy if the dura is torn.

Closure of dura is an essential step. When primary closure cannot be achieved, a dural graft should be employed. Pericranium, temporalis fascia may be used (26, 41). In this study 19 of those with a dural tear required a graft. A delayed surgical debridement did not influence the need for a graft. In KNH porcine cyophilised dura is frequently used. However, as details regarding type of graft used were inadequately available, this factor was not analysed. Jennett and Miller (18), however, noted that in their series artificial dura was used only once and in that case became infected and required to be removed.

LACERATION OF THE BRAIN

Reliance upon the operation notes was necessary to assess the presence and serverity of laceration. Descriptive terms being subjective, the reliability of results is subject to verification. However, the type of laceration was categorised for purposes of study according to the description in the various surgical notes in the record files, and defined as superficial when injury to brain tissue was minimal and necrosis absent. 'Necrosed brain' tissue was considered more severe. When brain tissue was noted to be fluid in nature at site of injury and 'oozing out' of a dural tear or fracture site, this was considered more severe than 'necrosed brain'. Finally the case of brain fungus was considered a neglected and extreme case of brain laceration. Thus there were 5 'superficial contusions', 13 'necrosed brain' tissue lacerations, 6 cases of 'brain oozing' through fracture, and 1 case of brain fungus, a total 25 patients (30.8% of operated cases). Meirowsky (26) described these lacerations as 'localised encephalomalacia' and found them in 39% of missile injuries. Jameison (15) grouped cerebral lacerations with intracerebral haematomas. Together these constituted 50% in his series.

All except 2 brain lacerations were associated with a dural tear. Superficial contusion was found underlying an intact dura in the 2 cases. Delayed surgery was not related to the degree of severity, except in the case of brain fungus. This patient had a trauma to operation interval of 14 days due to delay in seeking treatment.

The level of consciousness at time of presentation was related to the severity of laceration. 60% of those with superficial contusion were oriented while only 16.6% of those with 'brain oozing through fracture site were oriented ($p < 0.05$). Jameison (15) similarly found extensive cortical damage with increased frequency in patients unconscious for more than 24 hours.

The duration of post operation period unconciousness was also related to severity of laceration. 40% of patients with a superficial contusion regained full consciousness within 4 hours after surgery. In the 'necrosed brain' group 7.7% were fully conscious within 4 hours (p greater than 0.1=N/S) while in the group with 'brain oozing' through fracture site 0% were fully conscious within 4 hours (p less than 0.001). The mortality was higher in the severer forms of laceration (see table 22e) but the difference did not reach significance.

No direct relationship was noted between severity of laceration and epilepsy or neurological deficit. With regard to final outcome, an unacceptable outcome was present with higher frequency when brain laceration was present. The difference did not reach significance (p greater than 0.1 = N/S) see table 40.

Heiskanen (14) however found a significant relationship between presence of neurological deficit and severe brain injury.

With regard to brain injury and brain damage, the period of post traumatic amnesia (PTA) is a more useful index than duration of unconsciousness (17). It is defined as the time of injury to appearance of continuous memory. In this study reliance was placed on level of consciousness when assessing effects of brain injury, as the PTA was not specifically recorded in the files.

IMPAIRED CONSCIOUSNESS

Diffuse brain injury is an uncommon accompanyment of compound depressed fractures of the skull. It is associated with causes that have an acceleration/deceleration or rotational component such as traffic accidents. The resultant increased intracranial pressure complicates a compound depressed fracture and increases mortality (15).

In this study 86 patients were conscious at time of presentation, 27 of these disoriented. 14 patients showed impaired consciousness levels ranging from response to verbal command to inability to localise pain. 5 of the total 11 cases of traffic accidents (45.5%) were in this group while 8 out of the total 72 assault cases (11%) were in this group. The single case of industrial accident was also in this group. RTA was hence more frequently involved in causing a generalised brain injury (p less than 0.05).

The mortality in this group was 4 out of 14 (28.6%), while 3 out of the remaining 86 (3.4%) died from the group who were conscious at admission. Hence an impaired level of conscious was related with an increased incidence of mortality (p less than 0.05).

Jameison (15) similarly found mortality increased in patients who were concussed compared to those who had remained conscious throughout.

Heiskanen (14) found no deaths in those unconscious for less than 15 mins.

Hammon (12) similarly noted comatose status was associated with increased mortality.

Impaired consciousness results from severe generalised concussion (21), increased intracranial pressure, cerebral hypoxia and haematoma, and these constitute the major killers in head injuries (21). Intracranial haematomas have been discussed earlier (page 103).

Increased Intracranial Pressure (ICP):

The mechanism is two fold:

- Immediate oedema is a result of vasoparesis often due to hypoxia. It thus responds well to artificial ventilation. Hyperventilation leads to a hypocapnia resulting in constriction of cerebral vessels. The reduced blood flow reduces the ICP (21).
- Late oedema is due to excess extracellular fluid and intracellular fluid. Thus the use of, intravenous hypertonic agents such as urea, mannitol, hypertonic plasma, sucrose and glycerol is effective in reducing this oedema (22).
- Volatile anesthetics such as halothane are avoided as they increase intracranial pressure (21).
- Hypothermia has been used to reduce ICP and has helped reduce mortality (21).

The use of controlled ventilation has its hazards (21) and its use is restricted to cases where simpler measures fail to raise arterial oxygen. The main indications include a raised ICP greater than 30mm of Hg. not responding to simpler measures and uncontrolled fits (21).

MORTALITY

Of the seven patients who died 5 died as a result of the head injury - 5%. The details of these patients are provided in section 5.5 on page 80 . Missed diagnosis and subsequent delay occurred in two patients. Prolonged raised intracranial pressure from a haematoma and cerebral oedema was the likely cause in 3 patients. Lewin (21) has pointed out that Haematoma, cerebral hypoxia and increased brain bulk (from brain oedema) are the 3 main killers in head injuries. Diagnosis of raised intracranial pressure clinically depends on signs that occur when cerebral impaction has already progressed. In KNH arteriography is limited to patients who develop lateralising signs, pupillary changes, or are comatose and show no signs of improvement. At this stage the outcome is already jeopardised. Early diagnosis is essential to reduce mortality. The CAT-scan offers this early diagnosis (19, 21, 38) and reduced mortality.

Heiskanen (14) has reported a mortality of 8% and noted no deaths in those unconscious for less than 15 minutes. This study confirmed that mortality was significantly higher in the group of patients who were unconscious (p less than 0.05). Hammon (12), Jameison (15), similarly noted a higher mortality in comatose patients.

The presence of an intracranial haematoma in this study was another determined of mortality (p less than 0.05). Heiskanan (14) noted a high mortality in patients with a haematoma; 30% of the patients who had a haematoma died. Road traffic accidents were associated with higher mortality; 36.4% of patients involved in RTA died while 2.8% of the group who were assaulted had a fatal outcome (p less than 0.05). Jameison (15) similarly found mortality was increased in road traffic accidents; his rate of 14.5% from RTA was higher than from all other causes. Not only is the brain injury more severe due to the mechanism of forces, but an increased association of other injuries worsens the outcome.

Infection per se did not appear to increase mortality in this study. This is in contrast with findings of other series (18). While mortality was mainly due to infection in First world war (47), improved surgical technique, early operation and, possibly, antibiotics have reduced the severity. A reduced mortality is hence explainable. However, a closer and longer follow up is required to assess the effects of infection on mortality.

Sande (42) in Glasgow recorded a 0% mortality rate from infection, a finding in line with this study. A reason for this may be the reduced incidence of brain abcess. While this rate was 27% in the Middle East in 1941 improvement of treatment have reduced this rate worldwide (47). In this study 4 patients developed an abcess; early in 3 patients and one 2½ months after surgery. Mortality is high in de novo brain abcesses reaching 40% in some series (9).

SEQUELE

62 patients (62%) in this study had a good outcome in that they resumed normal life. 20% were considered satisfactory in that they had a residual deficit that did not prevent them from leading a normal life. Thus 82% had an acceptable outcome.

9 patients required assistence most of the time while 2 required assistance all the time. 7 patients died. Hence 18% had an unacceptable outcome.

There was a relationship between unacceptable outcome and delayed surgery (see table 39 page 78). A delay of less than 48 hours from time of injury favoured an acceptable outcome. The difference however, was not statistically significant. Beyond 48 hours an unfavourable outcome was likely. A delay of greater than five days, as occurred in 25 patients was particularly significant (p less than 0.001).

The incidence of laceration of dura and brain, presence haematoma and infection was higher in the group who had an unacceptable outcome. These factors were therefore contributory to the morbidity and mortality. The difference did not reach statistical significance however (see table 40).

24% had a mental deficit at time of discharge. This included disorientation (11%), Aphasia (5%). Dysphasia (6%), VIIth Nerve palsy (2%), Giddiness (1%), deficit of memory (1%). 1 patient was in semi-comatose state at time of transfer to the nearest district hospital.

Relationship of mental deficit to site of injury was evident with regard to aphasia and dysphasia. In these patients a higher incidence of injury to parietal and parietotemporal areas was noted. No particular area was associated with disorientation, giddiness, memory deficit or prolonged unconsciousness.

22% had a physical deficit due to the head injury. This included a contralateral upper limb paresis in all 22 patients. 10 of these had hemiparasis. 1 patient had weakness of both lower limbs.

The site of injury showed a wider distribution in patient having a hemiparesis. In those who had an upper limb monoparesis, the parietal region was involved more frequently (see table 35b).

The injury showed a high incidence of focal neurological deficit such as hemiplegia, aphasia and disphasia, cranial nerve palsy. The incidence of generalised deficit such as memory deficit giddiness, prolonged unconsciousness was low. This has similarly been noted by Meirowsky (14) who showed a high incidence of focal neurological deficit in depressed fractures, while closed injuries had a higher incidence of 'post concussional syndromes' (i.e. memory deficit, irritability, emotional instability, unsteadiness, giddiness and apathy). Heiskanen (26) found Hemiparesis in 15% Dysphasia in 9.8% and cranial nerve involvement in 18%. He noted that the IIIrd, VIth, VIIIth cranial nerves were usually involved, a finding confirmed by this study. In his series the cranial nerve usually recovered. The other deficits also recovered completely in 76% of cases during the follow up period of 6 years. This could not be confirmed in the KNH study, as the period of follow up was brief.

EPILEPSY

Jennett (17) distinguished early epilepsy from late onset epilepsy. He defined early epilepsy as that occurring within one week of trauma and the late onset as one occurring after this period.

11 patients (11%) developed an epileptic fit prior to surgery i.e. early epilepsy. Post operative fits occurred in 2 patients, within a week in one and 4 months later in the second. Thus early epilepsy occurred in 12% of patients in this study. Late epilepsy was recorded in 1 patient. Due to short duration of follow up only early epilepsy could be analysed.

Percentages adjusted for age showed a high incidence in the 6-10 years age group. This was statistically not higher than any particular age group (p greater than 0.1 = N/S) - see table 15b. However, when the age group below 16 years was compared to the group above 16 years, epilepsy was noted to be 4 fold commoner in the childhood group. This difference was statistically significant (p less than 0.05). This is in contrast to Jennett's (17) finding who found the incidence the same for the under 16 years group and the adult group. However, Jennett was referring to late onset epilepsy and this is perhaps the reason for the difference. A long term follow up is necessary to check the finding in the KNH study. 8 of the epileptic fits were grandmal (72.7%) and 3 were focal (27.3%). No cases of temporal lobe epilepsy were noted. Heiskanen (14) reported a 6.3% early epilepsy rate, 86% of these occurring within 24 hours of injury. He recorded 57% grandmal, 32.5% focal and 10% temporal.

Although the single patient who developed late onset epilepsy in this study did not have early epilepsy, early epilepsy is associated with late onset epilepsy (14, 17). Jennett found it to be the single most important factor contributing to late epilepsy. The view of Carrington (4), however, is contrary. He indicates that epileptic fits in the immediate post operation period are generally focal and do not necessarily reoccur. He considers these as representing acute cerebral injury and of little significance. He does not however, say the same for preoperative fits which are also due to acute cerebral injury.

Riddock (37) similarly believed that early fits were not related to late epilepsy. Symonds (44) indicated that they were. Overall evidence however favours the view that early fits are a determinant of late onset epilepsy. This study could not contribute to this assertion. However, it is important to discuss the risk of late onset epilepsy in compound depressed fractures of the skull. The following points are of significance:

- The overall risk of late epilepsy is reported as between 7-20% (14 , 18).
- The risk of late onset epilepsy is greater after depressed fracture than after any other type of head injury (17 , 34).
- The risk is increased if infection complicates the injury (5 , 18).
- Laceration of dura increases risk of late epilepsy (17 , 20). If this is associated with a prolonged post traumatic amnesia (PTA greater than 24 hours) or with an early fit the risk is greatly increased (17).
- Risk of epilepsy is doubled in patients unconscious for more than 24 hours (14).
- The site of depressed fracture has no influence on epilepsy (17).
- A fracture complicated by a haematoma has increased association with epilepsy (17).
- Laceration of brain has been noted to have a higher association with late epilepsy (20 , 45).
- Dural closure reduces incidence of epilepsy by reducing adhesions between brain and superficial tissues (26).
- Carrington (4) suggests that primary replacement of bone fragments may have reduced the incidence of epilepsy in their series which had a follow up of 7-9 years. Jennett and Miller (18) however, found the incidence of epilepsy unaffected by primary bone replacement.
  Walker (45) indicated that the craniectomy defect may contribute to late epilepsy by altered haemo-hydro-dynamics of the unsupported brain.
- Between 47-66% of the patients have been found to have their first fit within one year of injury (14 , 17 , 45). 65-75% have been found to have their first fit within 2 years.
  Jennett (17) found 77% of the fits developed within 3 years, and 25% occurred after 4 years. More children than adults had their first fit after 4 years in Jennet's (17) series.

- Onset of epilepsy upto 11 and 19 years has been recorded (14).
- Epilepsy is likely to be more severe (more than one attack per month) if it begins in the first 3 months after injury (17).

In this study 7 patients were commenced on anticonvulsant medication and this was stopped in all cases by the time of their discharge. Jennett (17) offers the following guideline. Prophylactic anti-convulsants are given in case of compound depressed fracture associated with:

- Presence of intra cranial haematoma.
- Early fit.
- Prolonged post traumati amnesia (greater than 24 hours)
- Dural laceration.

The medication should be continued for at least one year, and longer if the risk is considered to be high.

CONCLUSIONS AND RECOMMENDATIONS

1. Compound depressed fracture of the skull comprises about a quarter of all head injuries seen at the Kenyatta National Hospital. Of the patients who require surgical intervention, those with this type of injury form the majority (87%). Patients with a closed head injury complicated by an intracranial haematoma form the remaining 13%.
   A thorough knowledge about this injury is important therefore for all those involved in its management.

2. The injury predominantly affects those between 16 and 40 years of age. Males are predominantly affected. The low-income social groups are more involved perhaps because of a greater incidence of assault amongst this group. Psychosocial pressures and abuse of alcohol possibly contribute to this injury.

3. Assaulted cases form the majority. Although the mortality is lower in the assault group, the morbidity is still significant. A lot of man-hours are lost due to the morbidity from this injury.

4. Road traffic accidents cause a high mortality and increased morbidity due to the higher incidence of haematoma, increased intracranial pressure and other associated injuries.

5. Delay in adequate managementof this injury is often due to avoidable causes. It is responsible for worsened outcome. The factors involved have been discussed and should be looked into and corrected.

6. A scheme of management should be followed. This should include:
   a. All patients must be operated unless specifically indicated by the neurosurgical consultant in charge of the patient.
   b. An antibiotic regimen for prophylactic use should be chosen and alternatives decided upon. This should be regularly reviewed with discussion with the laboratory.

c. The policy of primary replacement of bone fragments should be discussed and its indications and contraindications outlined.

d. Artificial dura be limited to patients with clean wounds operated within 24 hours of injury. In all instances autogenous graft should be advised.

7. The following factors complicate a compound depressed skull fracture:
   a. Infection.
   b. Intracranial haematoma.
   c. Laceration of dura or brain.
   d. Increased intracranial pressure due to cerebral oedema.
   e. A fracture overlying a venous sinus.

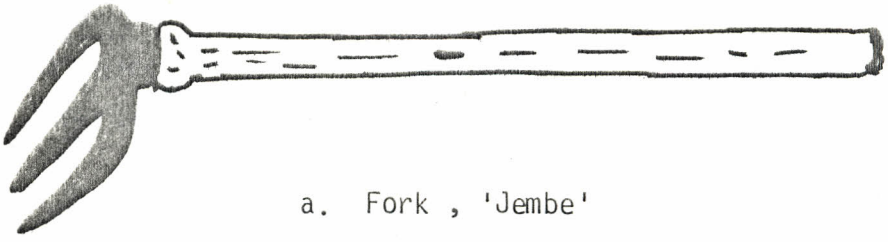
8. Patient follow up should be re-enforced. All patients who have an injury complicated by any of the factors discussed earlier should be followed up in the neurosurgical clinic. The uncomplicated cases may be followed up at their nearest district hospital. A 6 monthly report about these patients should be expected in order to maintain a follow up record in KNH.

9. Anticonvulsant should be prescribed in accordance with suggestions outlined by Jennett (see page 118).

10. Artificial ventilation should be used in those patients who present with signs of increased intracranial pressure. All such patients need to be given oxygen by mask as the initial measure to reduce raised ICP.

APPENDIX

Fig. 9: Objects causing Trauma.



a. Fork , 'Jembe'

b. 'Rungu'

c. 'Panga'

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STUDY ON COMPOUND DEPRESSED FRACTURES OF THE SKULL AT KENYATTA NATIONAL HOSPITAL

PERSONAL DATE: Case No. _____ I.P. No. _____

Sex: Male _____ Female _____

AGE:

Upto 1 Year	_____	31 to 35 Years	_____
1 to 5 Years	_____	36 to 40 Years	_____
6 to 10 Years	_____	41 to 45 Years	_____
11 to 15 Years	_____	46 to 50 Years	_____
16 to 20 Years	_____	51 to 55 Years	_____
21 to 25 Years	_____	56 to 60 Years	_____
26 to 30 Years	_____	61 or above	_____

OCCUPATION:

Unemployed _____

Casual _____

Clerical _____

Semi-skilled _____

Skilled _____

Date of Admission _____

Date of Discharge _____

Period of Stay in Hosp. _____

Referral: Yes _____ No. _____

If yes, reason for referral _____

Time between Injury and arrival at Casualty _____

Time between arrival and Surgical Intervention _____

CAUSE OF INJURY:

Assault _____ Specify Weapon _____

RTA _____

Industrial Accident _____

Domestic Accident _____

Fall _____

Other _____ Specify _____

CLINICAL EXAMINATION:

Smell of Alcohol Yes _____ No. _____

Pulse _____ B.P. _____

Associated Injuries: Spinal _____
Chest _____
Abdomen _____
Pelvic _____
Limb _____

CNS FINDINGS:

Conscious _____
Oriented _____
Disoriented _____
Disturbed Consciousness _____

i.e. Coma Grade 1 (Response to Cerbal command) _____
Grade 2 (Appropriate response to pain) _____
Grade 3 (Inappropriate response to pain) _____
Grade 4 (No response to pain) _____

SPEECH:

Normal _____
Slurred _____
Aphasia _____ Receptive _____
Motor _____
Unspecified _____

CR NERVE PALSY:

Present _____ Absent _____
Specify _____

Fundoscopy _____
Not Done _____

Pupils: Right _____ Left _____

Skull: Site of Injury: Frontal _____
Parietal _____
Temporal _____
Occipital _____

Over Venous Sinuses: Yes _____ No _____
If yes, specify _____

Neck Injury: Present _____ Absent _____

Specify if present. _____

MOTOR SYSTEM:

Power: Ipsilateral Upper Limb Normal _____

Reduced _____

Ipsilateral Lower Limb Normal _____

Reduced _____

Contralateral Upper Limb Normal _____

Reduced _____

Contralateral Lower Limb Normal _____

Reduced _____

Fits present pre operative: Yes _____ No. _____

Type _____

Reflexes: Normal _____ Abnormal _____

Specify _____

Sensory Loss: Present _____ Absent _____

Gait: Normal _____ Abnormal _____ Unable _____

Specify _____

Radiological Findings: _____

Pre op treatment prescribed: _____

_____

_____

Premedication: _____

_____

OPERATION NOTES:

Date of Operation _____

Site of Fracture _____

Frontal _____

Parietal _____

Temporal _____

Occipital _____

Over saggital sinus _____

Over sigmoid Sinus _____

Type of operation _____

Surgeon: SHO _____ Assistant: Paramedical _____
Qualified Surgeon _____ Houseman _____
Neurosurgeon _____ SHO _____
Qualified Surgeon _____
Neurosurgeon _____

Site infected at time of operation: Yes _____ No. _____
Dura torn: Yes _____ No. _____
Brain tissue lacerated: Yes _____ No. _____
Specify _____
Associated Extradural Haematoma: Yes _____ No. _____
Associated Subdural Haematoma: Yes _____ No. _____
Associated Intracerebral Haematoma: Yes _____ No. _____
Dura closed: Yes _____ No. _____
Reason _____
Dural graft required: Yes _____ No. _____
Bone Fragments replaced: Yes _____ No. _____
Blood transfered: Yes _____ No. _____
Units _____
Intra operative complications: Yes _____ No. _____
Specify _____
_____
_____
_____

POST OPERATIVE NOTES:

Post op treatment prescribed: _____
_____
_____
_____
_____

Period before full consciousness regained: _____
Post operative fits: Yes _____ No. _____
Specify _____
Treatment _____
Post operative paralysis: Present _____ Absent _____
Specify _____
Post operative wound sepsis: Present _____ Absent _____

If present, culture done: Yes _____ No. _____

Organism cultured: _____

Treatment prescribed: _____

Any surgical procedure required after initial surgery: Yes _____ No. _____

Specify _____

Other post operative complications: Yes _____ No. _____

Specify _____

AT DISCHARGE:

Condition of wound: Primary Healing _____ Secondary Healing _____

If 2^{o} organism cultured: Yes _____ No. _____

Period between operation and discharge _____ Days.

Mental State: Normal _____ Residual deficit _____

Specify deficit _____

Temperory _____ Long term _____

Physical State: Normal _____ Residual deficit _____

Specify deficit _____

Temporary _____ Long term _____

Discharged to: Neurosurgical Clinic _____

Nearest Hospital _____

Psych. Clinic _____

Mental Hospital _____

Review at NSC: Satisfactory Progress _____

Unsatisfactory _____

Specify _____

Needs Cranioplasty: Yes _____ No. _____

Re-admitted for Cranioplasty: Yes _____ No. _____

MANAGEMENT:

Satisfactory _____

Inadequate _____ Specify No. _____

Unsatisfactory _____ Specify No. _____

Satisfactory: No major mistakes made - less than 3 minor mistakes.

Inadequate: No major mistakes made - more than 3 minor mistakes.

Unsatisfactory: Major mistakes made.

Major Omissions/Actions	Non-major Omissions/Actions
1. Replacement of bone pieces after 18 hours post trauma.	1. Observation chart inadequately filed.
2. Delay of more than 24 hours between arrival and surgery.	2. Wound infection accurral.
3. Dura not closed.	3. Culture not done if wound infection present.
4. Intraoperative complication occurred.	4. Delay of more than 8 hours occurred between arrival and surgery.
5. Antiepileptics not given at discharge in cases of fits occurring at any time during hospitalisation.	5. No instructions about follow-up given.
6. Operation not performed at all.	6. _____
7. _____	7. _____
8. _____	

OUTCOME AT DISCHARGE:

Good _____ - Resumption of normal life.

Satisfactory _____ - Normal life with deficits.

Bad _____ - Needs assistance most of the time.

Death _____ -

HEAD INJURY AND CRANIOTOMY CHART

This chart to be started in Casualty and continued in the ward.

Underline the observations that are required

DATE	SURNAME	OTHER NAMES	REG. No.

½ 1 or 2 HOURLY CHART*													
PULSE													
BLOOD PRESSURE													
RESPIRATION													
TEMPERATURE													
1. FULLY CONSCIOUS (answers questions intelligently)													
2. CONSCIOUS BUT CONFUSED (answers simple questions only)													
3. SEMI-CONSCIOUS (only responds to pain)													
4. COMA (no response to pain)													
PUPILS (draw circles indicating relative size.) — SIZE R													
SIZE L													
REACTION TO LIGHT + R													
REACTION TO LIGHT + L													
FITS — PRESENT													
FITS — ABSENT													
SPONTANEOUS MOVEMENT (write "yes" or "no") — R. ARM													
R. LEG													
L. ARM													
L. LEG													
PARALYSIS (if conscious write "yes" or "no"; if unconscious write "ext" or "flex" to pain) — R. ARM													
R. LEG													
L. ARM													
L. LEG													

OTHER INJURIES CIRCLE IF INVOLVED CHEST ARM NECK ABDOMEN LEG SPINE

DATE OF ADMISSION .....

TIME OF ADMISSION .....

*WHEN TIME FREQUENCY IS ALTERED A NEW CHART MUST BE STARTED

GPK (L)