PATTERN OF RADIOLOGICAL IMAGING MODALITIES FOR MAXILLOFACIAL SKELETAL INJURIES IN NAIROBI

RETROSPECTIVE DESCRIPTIVE STUDY DONE AT KENYATTA NATIONAL HOSPITAL, NAIROBI HOSPITAL AND THE AGA KHAN HOSPITAL (NAIROBI)

THIS DISSERTATION IS SUBMITTED AS PART FULFILLMENT FOR THE DEGREE OF MASTER OF MEDICINE

IN

DIAGNOSTIC RADIOLOGY
UNIVERSITY OF NAIROBI

DR. LUCY G. SENYAGWA
MD (DAR)

DECLARATION

Candidate

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

Signature: ____________ Date: 16.5.2002
DR. LUCY SENYAGWA MD (Dar)

Supervisor

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

Signature: ____________ Date: 21/5/02
PROF. JMK KITONYI MBChB (Nbi) M.Sc. (Lon.) M.Med (Nbi)
Associate Professor, Department of Diagnostic Radiology
University of Nairobi

Signature: ____________ Date: 16.5.2002.
DR. ML CHINDIA BDS, MSc, FFDRCS
Senior Lecturer Dept. of Oral & Maxillofacial Surgery/Oral Medicine and Oral Pathology, Faculty of Dental Sciences
University of Nairobi

Signature: ____________ Date: 16.5.2002
MR. P DEVANI BDS(Nbi), MScHons(Lon), FDSRCS(Eng)
Lecturer Dept. of Oral & Maxillofacial Surgery/Oral Medicine and Oral Pathology, Faculty of Dental Sciences, University of Nairobi
and
Consultant Maxillofacial surgeon, Dept. of Surgery
The Aga Khan Hospital.

ACKNOWLEDGEMENT

During preparation of this dissertation I received guidance, help and teaching from my supervisors, lecturers, colleagues, friends and many others. First and foremost I would like to thank Dr A.Rodrigues former senior lecturer in the department of Diagnostic Radiology, University of Nairobi, for his initial guidance and assistance in protocol writing. Secondly, to my current supervisors, Prof. J.M.K. Kitonyi and Dr. M.L. Chindia who have been invaluable in their positive criticism, guidance and patience. I also thank Dr. Devani for finding time in his busy schedule to supervise and encourage me during this study. I wish to thank Prof. Guthua and Dr. Ochola who gave me the basic foundation in the study of maxillofacial injuries. I also thank the Radiology Department of the Nairobi hospital for their permission to use their records as well as their cooperation. My gratitude also goes to the Administration of The Aga Khan hospital and in particular to Dr. S. Vinayak for giving me permission to utilize information in their department. I owe special thanks to my best friend Miss Caroline Outa for her invaluable secretarial work and support both technically and emotionally in my work.

Finally I am greatly indebted to my sponsor, The Ministry of Health, Government of Tanzania, for making it possible to conduct this study.

DEDICATION

I dedicate this dissertation to my beloved son, Gideon, who has given my lif a new meaning and perspective.

TABLE OF CONTENTS

ABBREVIATIONS

MFSI/T	----------------	Maxillofacial skeletal injuries/trauma
RTA	----------------	Road traffic accident
CT	----------------	Computed/computerized tomography
MRI	----------------	Magnetic Resonance Imaging
KNH	----------------	Kenyatta National Hospital
AKHN	----------------	Aga Khan Hospital, Nairobi
NH	----------------	Nairobi Hospital
OPG	----------------	Orthopantomography
PA	----------------	Posteroanterior
OMV	----------------	Occipito-mental view
SMV	----------------	Submentovertical view

ABSTRACT

INTRODUCTION: A review of 200 patients who presented in three major hospitals in Nairobi for maxillofacial skeletal trauma (MFST) imaging in a five- year period from Jan. 1998 to Dec. 2000.

OBJECTIVES: To show the pattern of radiological imaging utilization in the diagnosis of MFST in Nairobi, and to determine the number of plain films and particular projections required for the diagnosis of MFST in the different hospitals.

DESIGN: A retrospective descriptive study.

SETTING: Kenyatta National Hospital, Aga Khan Hospital and Nairobi Hospital.

SUBJECTS: 200 cases of MFST seen in these hospitals.

METHODS: Review of patients' files and radiological reports.

MAIN OUTCOME MEASURE: Variation in utilization of imaging modalities in the three hospitals.

RESULTS: There were 168 males and 30 females investigated (for 2 patients the gender was not indicated). The age group that was most commonly affected was 31 to 35 years. The most frequent indication for imaging was a suspected facial fracture (97%). Plain radiography was the most frequent examination performed in the primary investigation (71%). Under- utilization of CT scan as an imaging modality was demonstrated, where it was not performed in 69.3% of the cases. There was a wide variation in the use of radiographic views of the face among the hospitals with a p-value of 0.01 (the statistical measure of effect was the chi-squared test). In many of the cases an average of one to two films were used (43.5%) with an extreme finding of four patients for whom more than eight films were used. The predominant cause of injury was assault (48.7%), with mandibular fractures appearing commonest among all the facial fractures investigated (33.7%).

CONCLUSION: The variation observed among the hospitals with regard to the imaging of facial skeletal injuries require further investigation in order to determine what the basic standard radiographic images may be necessary for the average case of MFST.

CHAPTER 1

INTRODUCTION

The face is the most visible and complex architectural structure of the human body and damage to any one of its components can lead to major psychological and physical disabilities. It is made up of soft tissue structures, the bony skeleton, various cavities and neurovascular bundles and houses important organs like the eyes and tongue together with muscles of mastication and facial expression which may be disturbed by maxillofacial injuries (1,2,3). The clinician therefore expects precise and adequate information from the radiologist for planning and restoration of function and appearance of the facial structures.

It is also important for the radiologist to provide suggestions for other options of imaging modalities, which may provide better visualization of different structures and their integrity. Too often imaging of the face may be overshadowed following trauma since evaluating the brain tends to be more important (4). It has been found out that up to 33% of significant facial trauma may have associated intracranial injuries such as extracerebral haematomas, encephalocoeles and cavernous-carotid fistulae (1,2). Hence the goal of the radiological work-up should be to define the number and exact location of fractures and to determine if there are any depressions, elevations or displacement of the fractures in addition to the assessment of soft tissue complications (2,3).

Facial trauma is frequent and mainly caused by motor vehicle accidents. It can also be caused by blunt injuries like blows, a fall

Facial trauma resulting from motor vehicle accidents is often associated with serious injuries commonly involving the brain, chest or abdomen (1).

Patients presenting with facial trauma should nonetheless be clinically evaluated systematically, so as to avoid overlooking other important associated injuries, and by doing so, the clinician can accurately diagnose many facial bone fractures by inspection and palpation alone. Naturally, the patient should be resuscitated before presentation to the radiology/imaging department. Thus control of haemorrhage, maintenance of the airway and the assessment of other life threatening injuries should be done (1,2).

Maxillofacial injuries have been seen to occur frequently in severely injured patients. A 5-year prospective study done in Ontario, Canada in 1992 showed that 70% of the patients with maxillofacial injuries were involved in road traffic accidents. Men were injured at 3:1 ratio over women. The mean age was found to be 25 years (3). In Singapore, in 1998, it was found that most patients were between 20 and 29 years of age with a male preponderance of 5:1. Again road traffic accidents formed the largest proportion (61.2%) followed by industrial accidents and assaults (6).

A higher male to female ratio featured in a study done in Ibadan, Nigeria where the ratio was 14:1 but road traffic accident as an aetiological factor accounted for 81.4%. Here the second commonest source of trauma was found to have been armed robbery (7).

In children maxillofacial injuries occur with a different mode of causation. Falls account for 45.4% of facial injuries in children under 6 years of age according to a study done in Japan in 1993 (8). The mechanism of injury in adolescents has been found to resemble that of adults with regard to the fact that they are commonly secondary to road traffic accidents and assaults (8,9). Male predominance is also encountered in adolescents.

Though it has been documented that skeletal maxillofacial injuries occurring in developing countries are mainly caused by road traffic accidents, interpersonal violence has been found to be the leading aetiological factor in Kenya (10). From a study done in Nairobi Kenya, it was found that the age group most affected was 21-30 years. Males were involved more in MFST than females by a ratio of 6.6:1(11). From this study, the imaging modality that was most frequently ordered was the plain skull radiograph (most of the views were not specified including orthopantomography).

The complex composition of tissues in the face may at times cause a dense roentgenic shadow and difficulties in interpretation. The cartilaginous structures of the nose and ear coupled with oedema and haemorrhage in the soft tissues of the face may make them become radiopaque and cause confusion when studying the bony framework for a fracture.

THE ANATOMY OF THE FACE

The face is the most anterior part of the skull. It is covered by skin, which has a number of sweat and sebaceous glands. This skin is connected to the underlying bones by lose connective tissue in which are embedded the muscles of facial expression. These muscles are innervated by the facial nerve, and have an arterial, venous blood supply with a lymphatic drainage.

The eyelids, nostrils and lips guard the orifices of the face namely, the orbit, nose and mouth respectively. The facial muscles serve as sphincters or dilators of these structures, also modifying the expression of the face (12)(Figs.1&2)

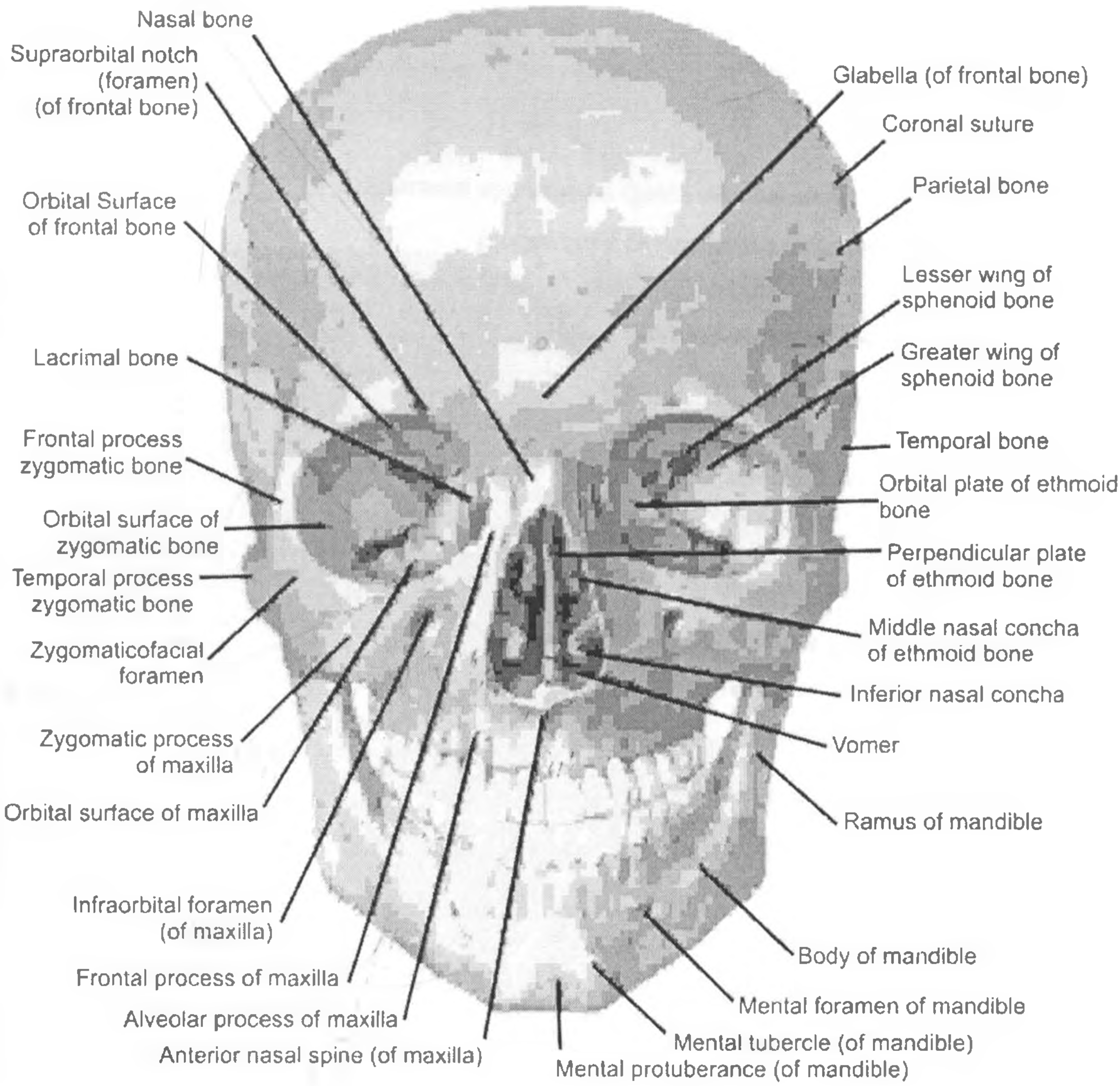

Figure 1: Anterior view of the skull showing the different facial bones.

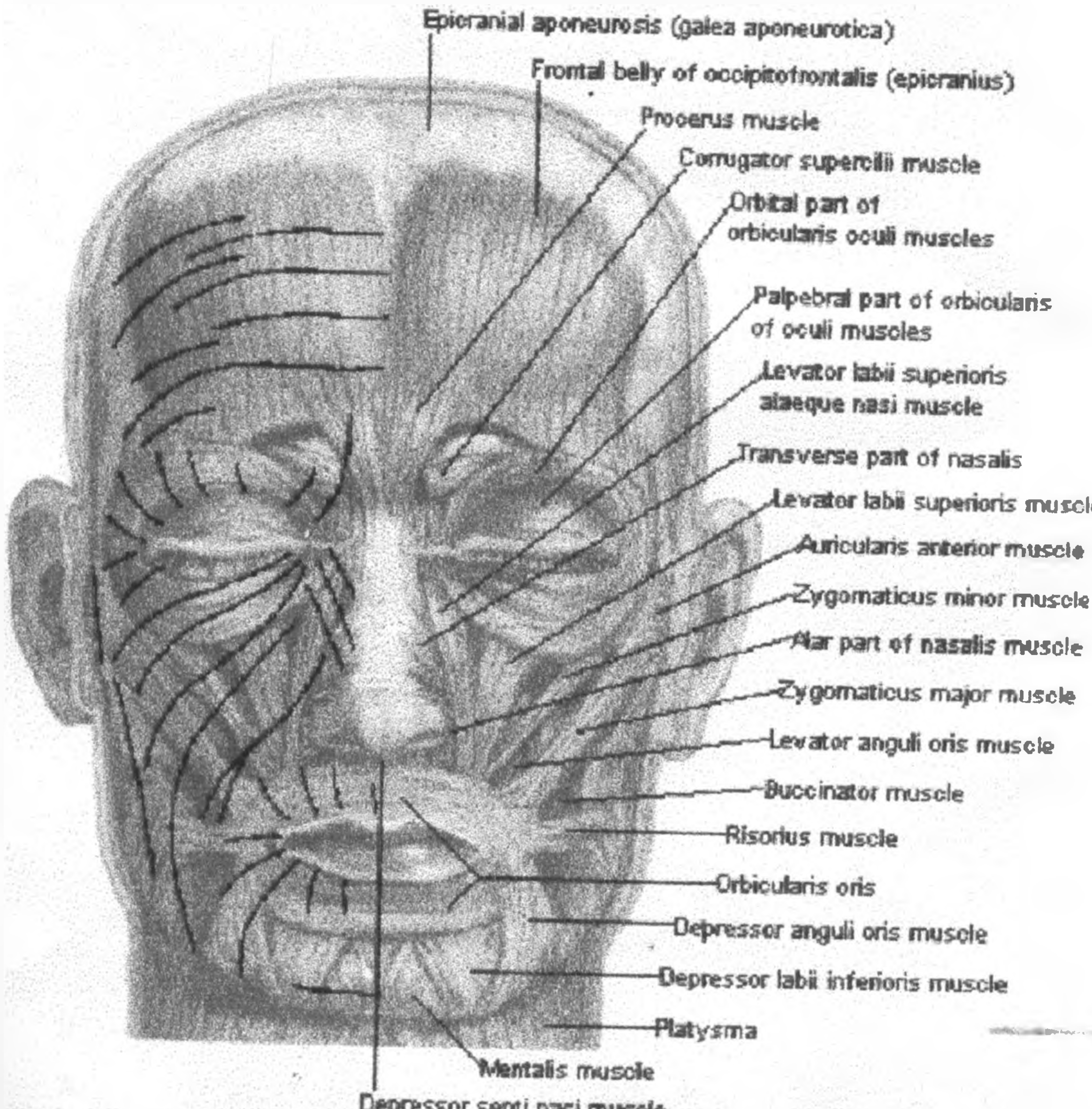

Fig. 2: Anterior view of the face showing the muscles of facial expression.

CHAPTER 2

LITERATURE REVIEW

Anatomically the nasal bones form a part of the facial skeleton, but to the radiologist a facial bone fracture implies injury to parts other than the nose. The mandible is also separately discussed (2,13). There are many ways of classifying facial skeletal injuries. Some authors describe the regional anatomy by drawing imaginary lines (Dolan's lines) using some reference point across the face for easy interpretation.

A regional classification by Silon and Green (13) places facial bone fractures into:

I **Nasomaxillary Unit**

A Upper

1. Fractures about nasal fossa
   a) Nasal bones, frontal process of the maxilla, the anterior nasal spine.
   b) Unilateral interior wall fracture.
2. High transverse fracture
   a) Through the nasion
   b) Through the midpiriform aperture

B Lower

1. Segmental fracture of the alveolar arch and hard palate
2. Low transverse palatal – alveolar fracture.

II **Malar – maxillary Unit**

A. Confined to the zygomatic arch (single or multiple)

B. Fractures of the processes of the malar bone
   1. Undisplaced
   2. Displaced, with or without rotation

C. Fractures of the body of the malar bone.

III Total craniofacial fractures.

Clinical signs of facial bone fractures (13)

- Asymmetry of the face
- Step sign, when the infraorbital rim is palpated
- Facial ecchymosis, particularly periorbital
- Subcutaneous emphysema
- Mobility of a portion of the face
- Trismus
- Malocclusion
- Anaesthesia (due to disruption or oedema involving the infraorbital nerve
- Diplopia
- Loosened or missing teeth

Orbital Injury

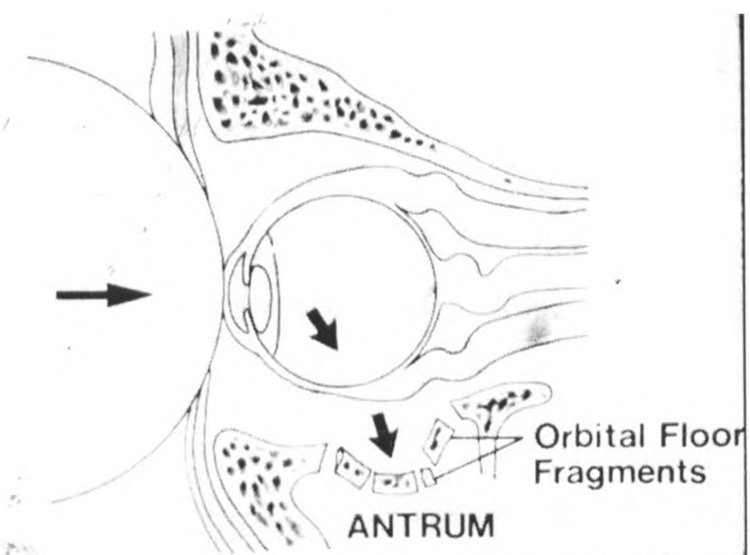

Fig. 1: Mechanism of injury in orbital blowout fracture (arrow) direction of force.

A sudden increase in intraorbital pressure may result in a blowout fracture. This may usually arise from a missile, like a baseball, whose diameter is greater than that of the orbit and transmits pressure to the soft tissues. The paper-thin orbit crumbles and displaces the bone and soft tissues downward into the maxillary sinus (2,14). The orbit is involved in a number of facial fractures including the tripod, Le Fort and nasoethmoidal complex fractures (15).

Hogg *et al.* established that the largest number of fractures of the facial bones occurred in the maxilla followed by orbital bones (3). Isolated orbital wall fractures usually involve either the medial wall or orbital floor. Recently it has been shown that when evaluating pure orbital – blow - out fractures, isolated medial wall fractures occur most commonly (55%) followed by orbital floor fractures (27%) (16). Supraorbital roof fractures have been found to be uncommon accounting for 1 to 5% of all maxillofacial fractures (4,16). In pure blow - out fractures, the orbital rim remains intact and the acutely increased pressure is relieved by a fracture in the orbital floor with herniation of the contents into the maxillary sinus, radiologically referred to as 'tear drop' deformity (17). A fluid level is often seen in the sinus secondary to bleeding. When the inferior rectus muscle is compromised patients will experience persistent, vertical diplopia (15).

Nasal Bone Fractures

Fractures of the nasal bones rarely involve the strongly reinforced upper portion. Most fractures involve the thinner portion in the lower half of the bone primarily the nasal tip and may inclu nasal fractures are due to blows, which strike the nose from the side. In such cases, both nasal bones are fractured at a horizontal level and dislocated to one side (2). When there is a severe impact, fracture of the nasofrontal angle and naso-ethmoidal complex may occur. Involvement of the perpendicular plate of the ethmoid in the region of the cribriform plate is rare and may be associated with cerebrospinal fluid rhinorrhoea. Extension of the fracture into the anterior ethmoidal cells or frontal sinuses may present with interstitial emphysema of the face.

Fractures of the Zygoma

The zygoma or cheekbone is one of the commonest sites of injury among fractures that involve multiple facial bones (2,15). The mallar prominence of the zygomatic bone makes it more susceptible to injuries involving the zygomaticomaxillary complex (17). Fracture of the zygoma may occur as an isolated finding or as part of a zygomaticomaxillary complex (tripod, quadripod or trimalar) fracture (Fig. 2).

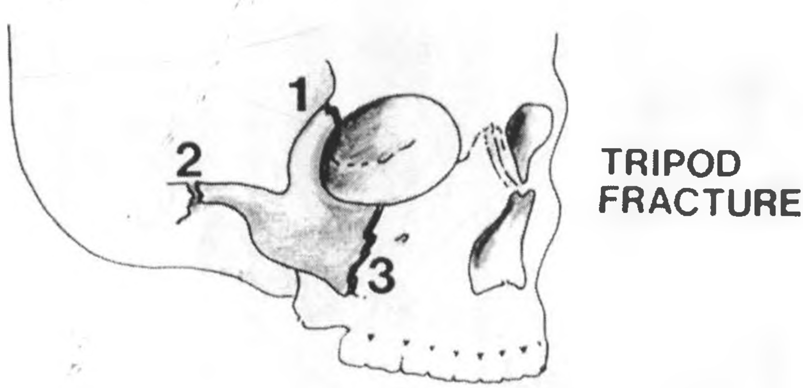

Fig. 2: Tripod fracture — consists of:

1. Separation of the zygomaticofrontal suture;

2. Fracture of the zygomatic arch;
3. Fracture of the inferior orbital rim extending through the anterior and lateral walls of the maxillary antrum.

Many of the fractures associated with this injury can be seen both on plain films and CT scan. Associated findings on plain films include opacification of the ipsilateral maxillary antrum and posterior displacement of the body of the zygoma on the submentovertical view with overlying soft tissue swelling (2,13,15).

Fractures of the Midface (Le Fort fractures)

These were categorized by Le Fort at the turn of the 20th century and describe the basic patterns of injury (Fig. 3a,b,c).

A. The Le Fort I or floating palate

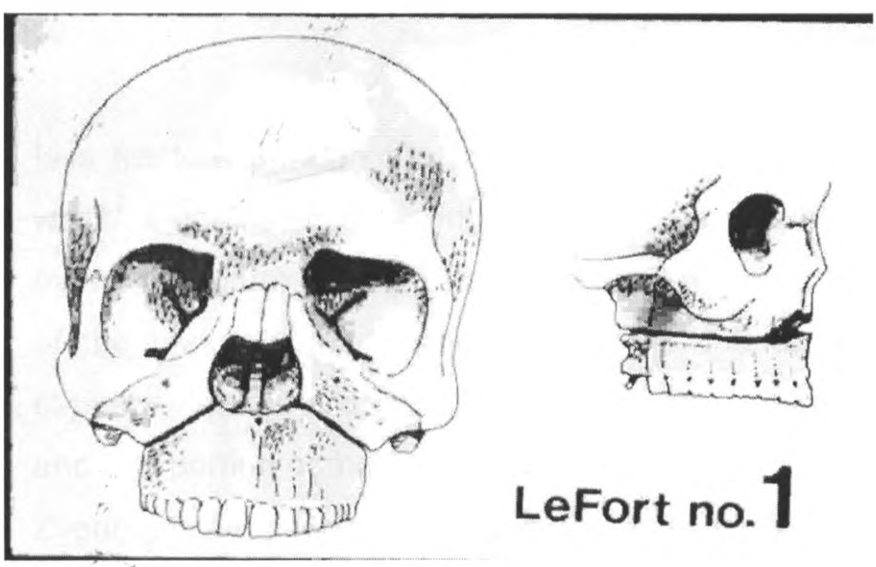

Fig. 3a: A Le Fort I fracture — there is separation of the alveolar process of the maxilla.

- Is a horizontal fracture through the maxillary sinuses. It extends through the nasal septum and walls of the maxillary sinus into the inferior aspect of the pterygoid plates.
- Occasionally it may be accompanied by a unilateral zygomaticomaxillary complex fracture.

B. The Le Fort II or pyramidal fracture

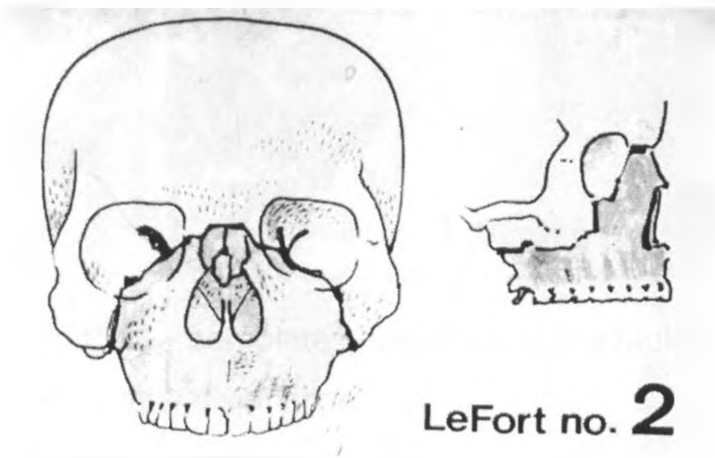

Fig. 3b: Le Fort II — a fracture separating off the central portion of the face.

- Is a fracture through the medial orbital and lateral maxillary walls. It begins at the bridge of the nose and extends in a pyramid fracture through the nasal septum, frontal processes of the maxilla, medial wall of the orbit, inferior orbital rim, superior, lateral and posterior walls of the maxillary antrum and mid portion of the pterygoid plates.
- Zygomatic arch and lateral orbital walls are left intact.
- Usually associated with posterior displacement of the facial bones resulting in a "dish-face " deformity and malocclusion.

C. The Le Fort III or craniofacial dysjunction

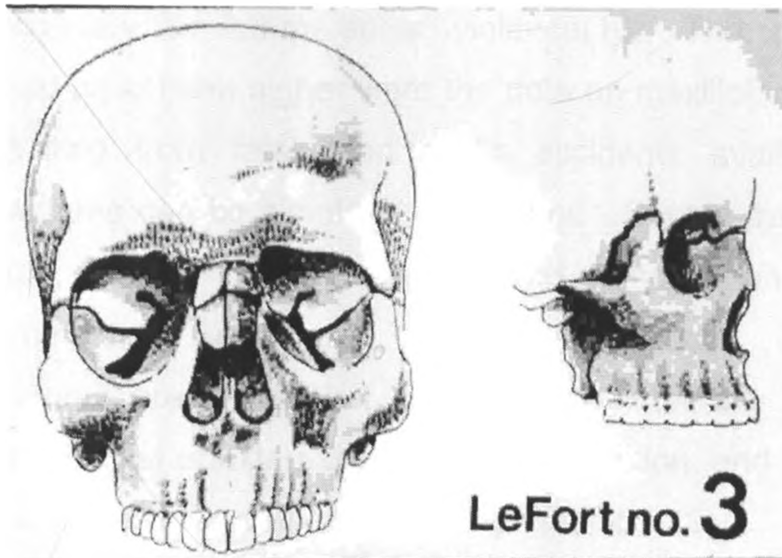

Fig. 3c: Le Fort III — complete separation of the facial skeleton from the skull, craniofacial disjunction.

- Is a horizontal fracture through the orbits. It begins near the nasofrontal suture and extends posteriorly to involve the nasal septum, medial and lateral orbital walls, zygomatic arch and base of the ptergoid plates.
- On plain films the orbits appear elongated in Water's and Caldwell views (15).

Mandibular fractures

- These are very common in patients with maxillofacial injury. They occur with a high frequency in adolescents and young adults. Condylar fractures make up 80% of lower jaw fractures and affect further growth of the mandible (9). Different studies have shown the mandible to be commonly involved in maxillofacial fractures. In the Kenyan study the mandible was found to account for 51% of maxillofacial fractures occurring secondary to interpersonal violence(10). The percentage could have been higher were the data on maxillofacial injuries resulting from fatal road traffic accidents available (17). Fractures can be simple or compound . Simple fractures are most common in the ramus and condyle and do not communicate externally or with the mouth. Compound fractures are those that communicate internally through a tooth socket or externally through a laceration, and are almost always fractures of the body of the mandible (2).

IMAGING OF FACIAL TRAUMA

1. Plain films
   - Constitute the initial evaluation and many facial fractures can often be diagnosed.
   - The standard radiographic evaluation of facial trauma includes four projections: Caldwell, Water's, Lateral and Submentovertical views.
   - The complex anatomy of the facial skeleton normally obscures the anatomic detail significantly because of overlapping of structures. This is the reason why these standard views have been selected to minimize this overlap (18). These four views are presented in Figures 4a, b, c and d

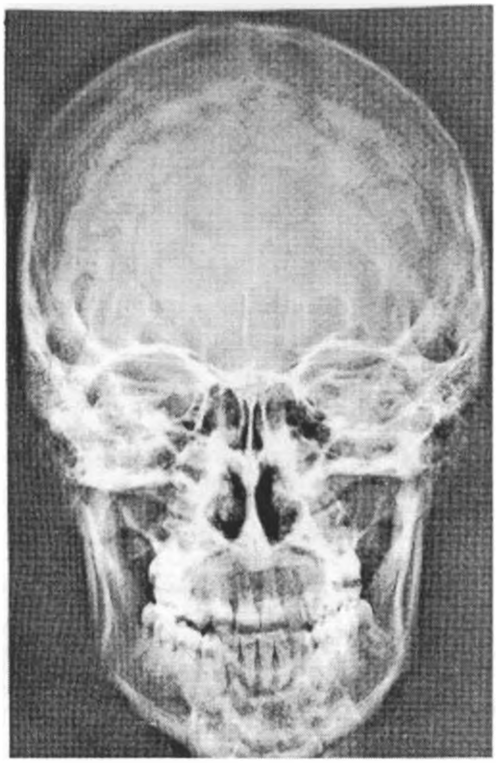

Fig. 4a: Caldwell view.

This view is obtained by centering on the nasion with the x-ray tube angled 15 degrees to the canthomeatal line.

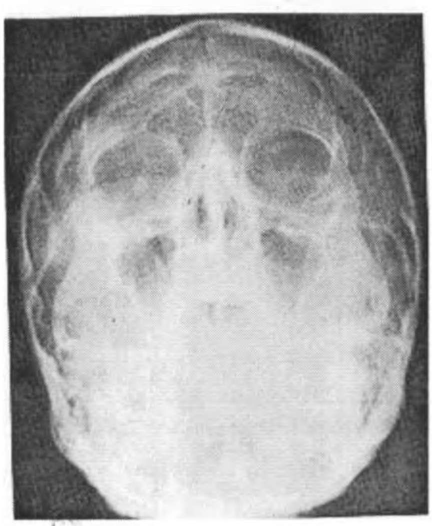

Fig. 4b: Shallow Water's view.

In this view the central ray passes at the junction of the upper lip and nose at an angle of 37 degrees with the canthomeatal line.

Fig 4c: Cross-table lateral view.

A true lateral position is important to reduce superimposition of structures. The canthomeatal line is parallell to the cassette, the central ray passing through the outer canthus of the eye at right angles to the film.

Fig. 4d: Submental vertical view.

This view should be done when injuries to the cervical spine have been excluded clinically or radiographically. The head is extended until the orbitomeatal line is parallel to the film. The central ray is perpendicular to the canthomeatal line at a point 1-2 cm anterior to the external auditory meatus.

Figs. 4c and d are done with the horizontal beam for detection of air fluid level.

Some authors advocate the use of a single 30 - degree occipitomental radiograph as a screening modality for midfacial fractures instead of a series of plain radiographs, which is the conventional mode of investigation (19). In other centers the standard protocol is a series of projections constituting of the lateral view, occipitomental (OM) and OM with an upward tilt of the face of 30 degrees (OM30) (5,20,21). But Raby and Moore in 1998 in their study of radiography of facial trauma found that the lateral film could safely be omitted with apparently no loss of information on fractures (21). They recommended that if further information on a fracture picked up by the OM and OM30 is needed, then a lateral film or CT scanning might be used depending on the clinician's preference.

For visualization of bony contours and fracture identification, Dolan and Jacoby have described imaginary lines in Water's view (18) (Fig. 5).

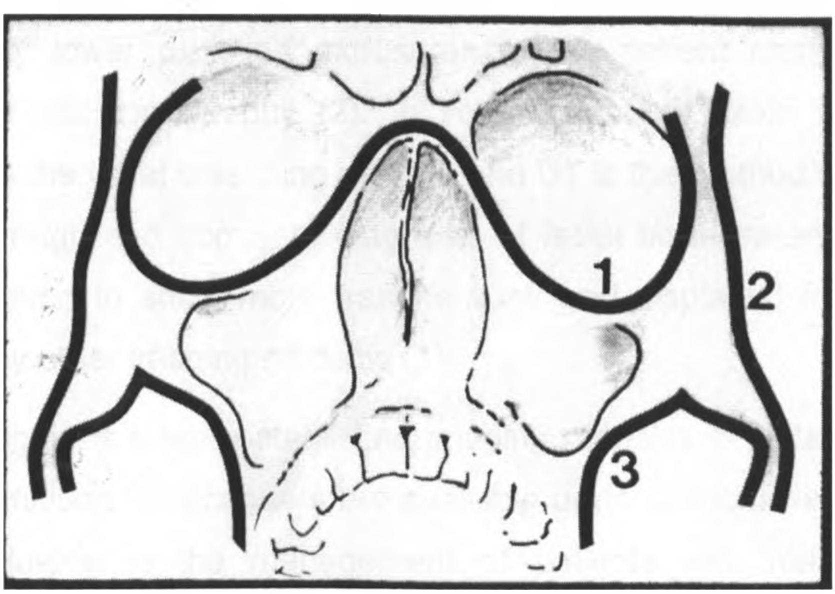

Fig. 5: Dolan's 3 lines of reference.

Line 1— begins at the inner surface of the zygomaticofrontal suture and follows the orbital surface of the zygoma, the orbital surface of the maxilla, the frontal process of the maxilla and the arch produced by the nasal bones and then follows the same course on the opposite orbit. The line has a contour of a 'lazy W'.

Line 2 — begins at the outer surface of the zygomaticofrontal junction and runs downward along the orbital process of the zygoma and along the upper and outer surface of the zygomatic arch and curves medially to the glenoid fossa of the temporomandibular joint on each side.

Line 3 — begins at the lateral and inferior margin of the maxilla and extends along the lateral wall of the maxillary antra and the inferior surface of the zygomatic arch to the glenoid fossa.

2. Computed Tomography (CT)

This has better contrast resolution than plain radiography and relatively lower radiation exposures to the patient compared to conventional tomography (2). In some countries, plain films are used as the initial screening method and CT is the method of choice for thorough and complete diagnosis of facial bone trauma. It has been found to show more fracture lines and displaced fragments than any other imaging modality (1).

CT imaging is a well-established imaging modality in Britain where high definition CT scanners are available up to district level. Its use is invaluable in the management of patients with maxillofacial injuries involving the frontal, nesoethmoidal and orbital fractures (22).

In general CT is indicated when clinical or plain films suggest complex facial fractures or complications like extra-ocular muscle entrapment or optic nerve impingement. Usually 5mm sections and 1.5mm for the orbits are obtained through the facial bones in the axial plane.

- Direct coronal scans can be done for better visualization
- Mandibles should be included in maxillary alveolar or palatal fractures
- Soft tissue windows can be used to evaluate soft tissue injury especially in the orbit.
- Three dimension (3D) CT is invaluable in delineating the extent of the fracture and in evaluating different methods of management including elevation and bone grafting.
- Contrast medium is rarely used except in suspected vascular injury.

3. Ultrasound Imaging

This technique appears to be useful as an adjunct to physical examination in the assessment of patients where an orbital floor fracture is suspected. It has an overall accuracy of 86% compared with CT and is important in the assessment of uncooperative patients where CT is impracticable (23).

4. Magnetic Resonance Imaging

- Useful for injuries to orbital contents including the optic nerve, globe and extra-ocular muscles, vascular complications like pseudoaneurysm.
- But because the facial bones and the adjacent aerated sinuses are relatively signal void, the use of MRI in evaluating facial trauma is limited.

5. Angiography

- May be indicated when clinical or radiographic evidence suggests a vascular injury.
- Vascular injuries occur frequently with gunshot or stab wounds
- Another useful application is in reconstructive surgery where the arteries are available (24).

RATIONALE

This study has not been done in Kenya before. Owing to the increase in the prevalence of RTA and interpersonal violence in this country, the facial skeleton is a vulnerable body region. Following injuries to the face, the clinician performs resuscitation and deals with life threatening complications. It is important that proper diagnosis of a skeletal maxillofacial injury is made as early as possible for definitive management in order to reduce the duration of hospital stay and medical cost to the patient. This requires a minimum number of radiographs of diagnostic quality or other imaging modalities to be decided without further delay. This study investigated the current trend in imaging of maxillofacial skeletal trauma and will form a baseline reference point for further studies in the subject.

OBJECTIVES

Broad Objectives

To study the pattern of maxillofacial skeletal trauma imaging modalities in Nairobi.

Specific Objectives

1. To show the pattern of radiological imaging utilization for the diagnosis of maxillofacial skeletal trauma in Nairobi.

2. To determine the number of plain radiographs and particular projections required for the diagnosis of maxillofacial injuries in the different hospitals.

3. Propose a standard protocol of imaging/views that may ensure accurate diagnosis of maxillofacial skeletal injury.

4. To determine the type of bone fractures in imaging of maxillofacial injuries.

CHAPTER 3

PATIENTS, MATERIALS AND METHODS

A five- year retrospective descriptive study was conducted reviewing records from 3 major hospitals in Nairobi. Records were obtained from X-ray departments of KNH, AKHN, and NH dating as far back as June 1996. Other hospitals were not included because of difficulties encountered in retrieving information especially on radiographs since patients in these hospitals were allowed home with them.

A total of 168 males and 30 females were included in the study population. Two patients had no gender identity. These were patients who presented with MFST during the study period. Files, radiographs and radiological reports, where available, were reviewed. Consultation was possible with the dental radiologist at the University of Nairobi.

Each patient's serial number, age, sex and hospital were recorded in the data sheet. Indication for the examination, types of imaging modalities used and radiographic views were noted. If a CT scan was employed, different protocols were noted. The quality of investigation performed was assessed using a checklist, which included basic radiographic work such as positioning and centering, presence of right/left marker and exposure factors. A score was given as good, acceptable or poor.

Other information obtained from the study was the cause of injury, the type of bone fractured and the number of films used per single examination.

CHAPTER 4

RESULTS

Two hundred cases with MFST over a period of 5 years were reviewed. The distribution of the number of records evaluated at each study site is depicted in Fig.1. Males were found to have been more commonly affected than females by a ratio of 5.6:1 (Fig.2). The age group that had the most cases was found to be between 31-35 years (21%) followed by 26-30 years (17.5%) (Fig.3). The most frequent indication for imaging of MFST was a suspected facial fracture (97%), the remaining percentage was contributed by exclusion of complications(Fig,4). Plain radiography was the most frequent imaging modality employed in the primary investigation accounting for 71% ; 28% was attributed to CT scan in combination with plain radiography and 1% was due to CT scan alone (Fig. 5).

The average utilization of plain radiography by hospitals was more than 50%: KNH 88.7%, NH 60% and AKHN 52.1%. There was a variety of plain radiographic views employed in this study, but 110 cases (55%) had a combination of views done apart from PA and lateral views. Fifty cases (25%) had a combination of PA and lateral views only (Fig. 6). Majority of the cases, 138 (69.3%) in this study had no CT scan examination performed on them (Fig.7).

A great number of cases were found to have had an average of one to two films used: 87 cases(43.5%), but there were 41 cases (20.5%) who had used 5-6 films and even another 4 cases (2%) who had more than eight films used (Fig.10). KNH was found to have had a relatively larger proportion of poor films (69.4%) compared to AKHN (20.4%) NH (10.2%).

Assault was the predominant cause of injury found in 97 cases (48.7%), followed by RTA (37.7%) (Fig.8). Mandibular fractures featured highest contributing to 33.7% in this study (Fig. 9).

FIGURES OF RESULTS

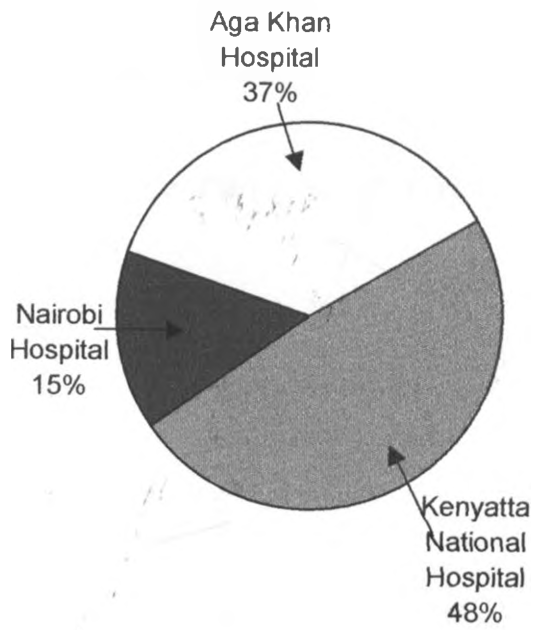

Figure 1: Pie chart showing distribution of patients according to hospitals covered.

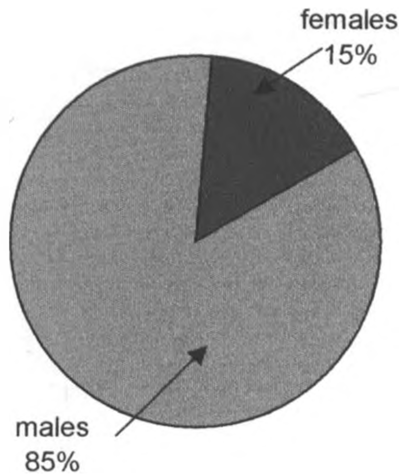

Fig. 2: Sex distribution

From this figure it can be deduced that males are more commonly involved in MFST.

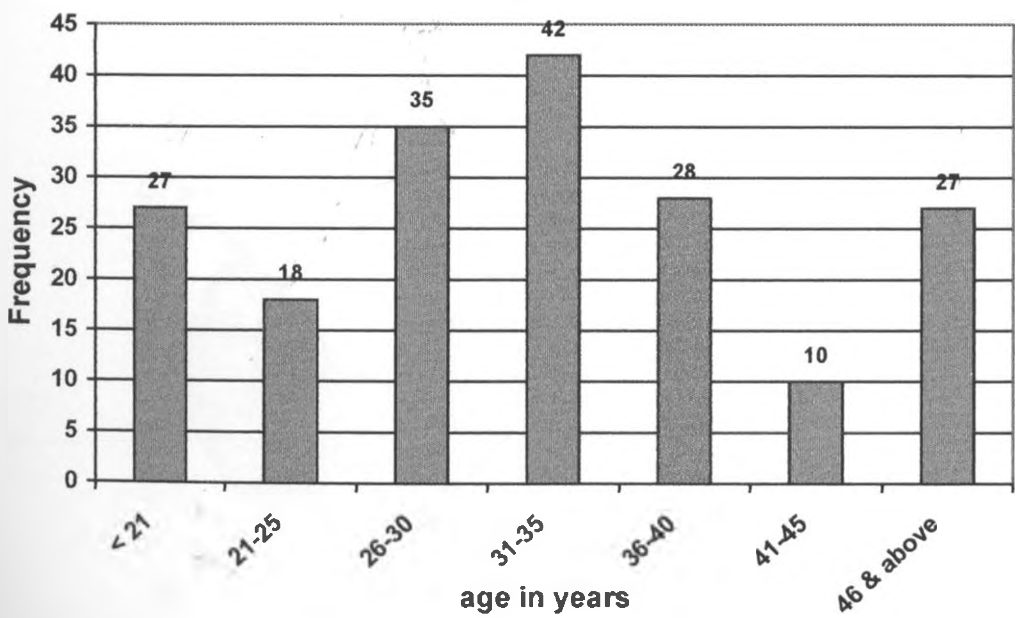

Fig. 3: Age distribution in years

The ages of thirteen patients were not indicated.

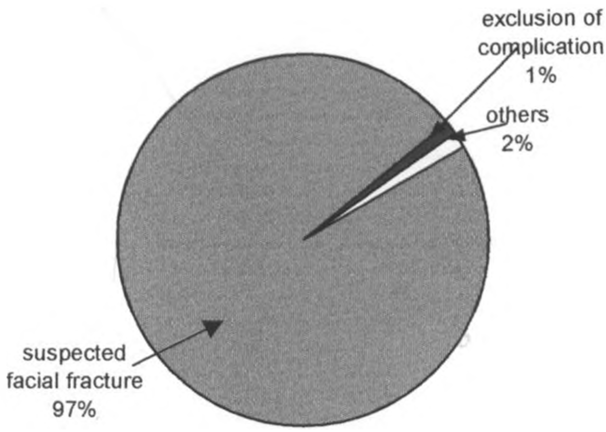

Fig. 4 : Indication for which examination was done

97%of the indication was due to suspected facial fracture.

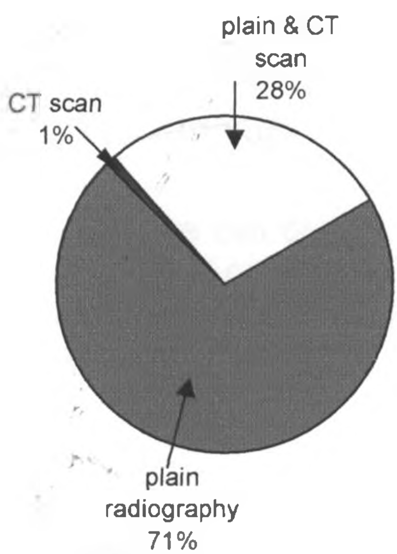

Fig. 5: Imaging modality employed

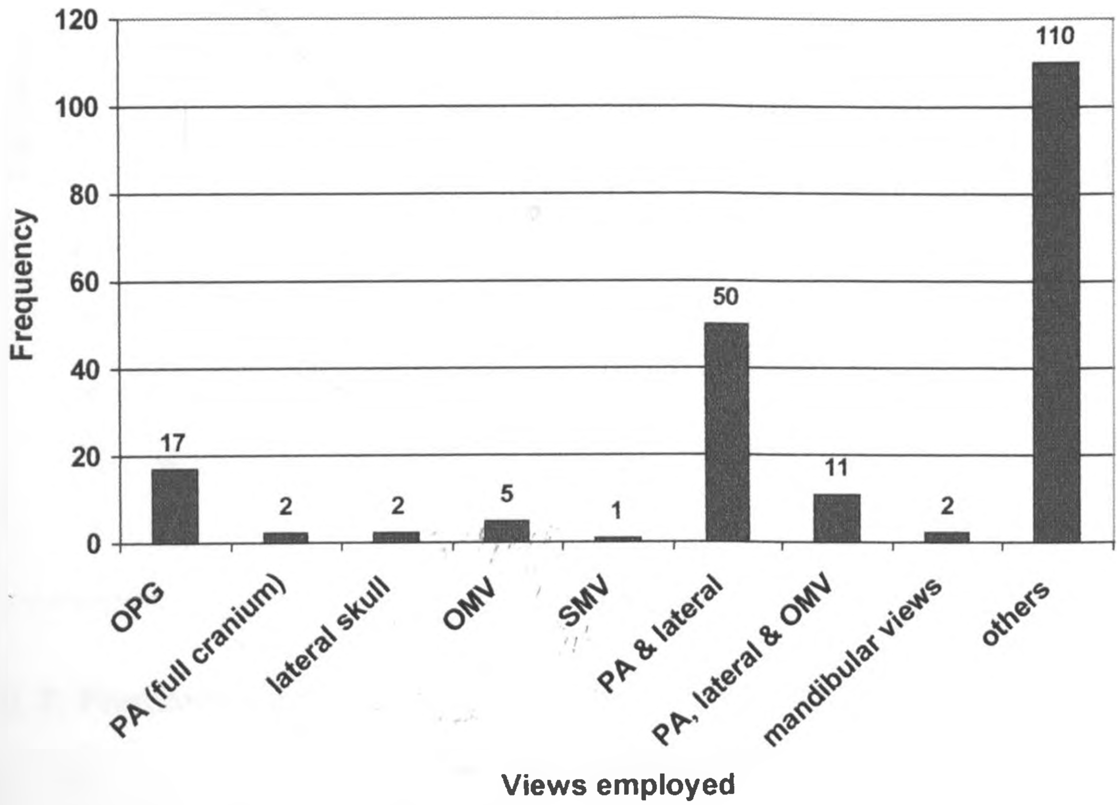

Fig. 6: Frequency distribution of plain radiographic views

From this histogram we can deduce that there were one hundred and ten cases (55%) with other combination of views done apart from PA and Lateral, PA, Lateral and OMV. Fifty cases (25%) had a combination of PA and Lateral views.

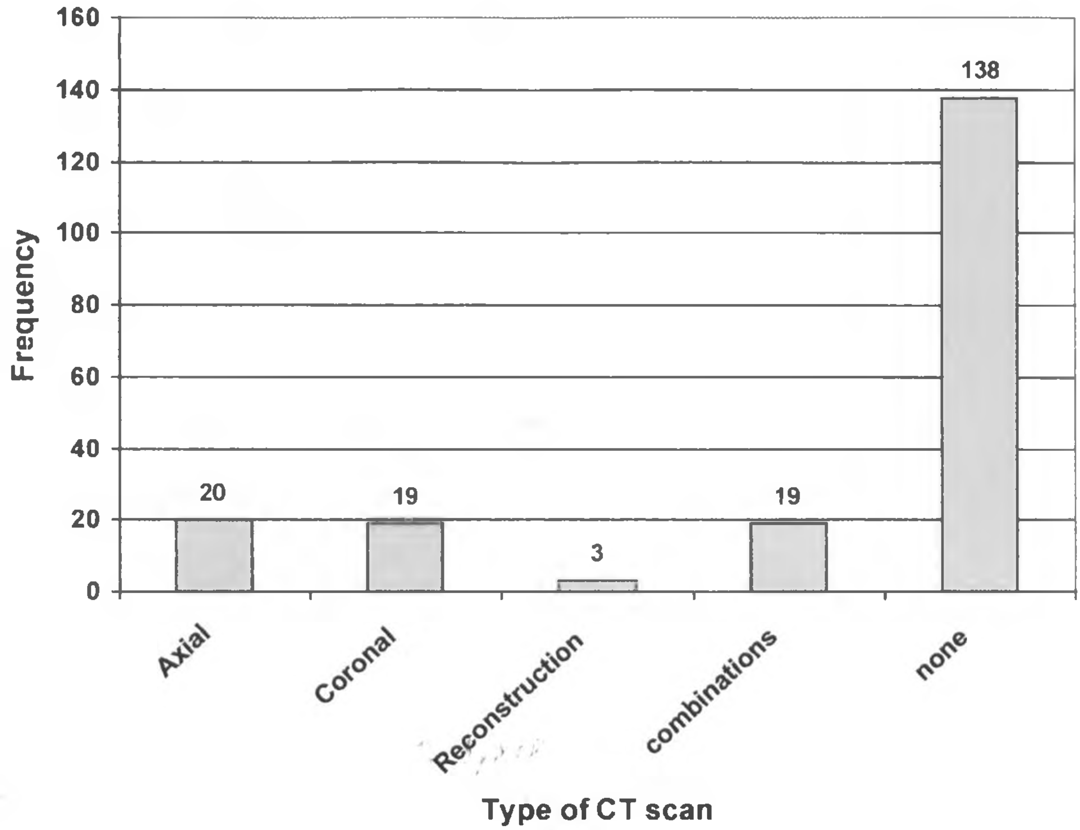

Fig. 7: Frequency distribution of type of CT scans employed

Majority of cases— one hundred and thirty eight (69.3%) with MFST in this study had no CT scan performed on them. There were only 3 cases (1.5%) with CT and 3D reconstruction.

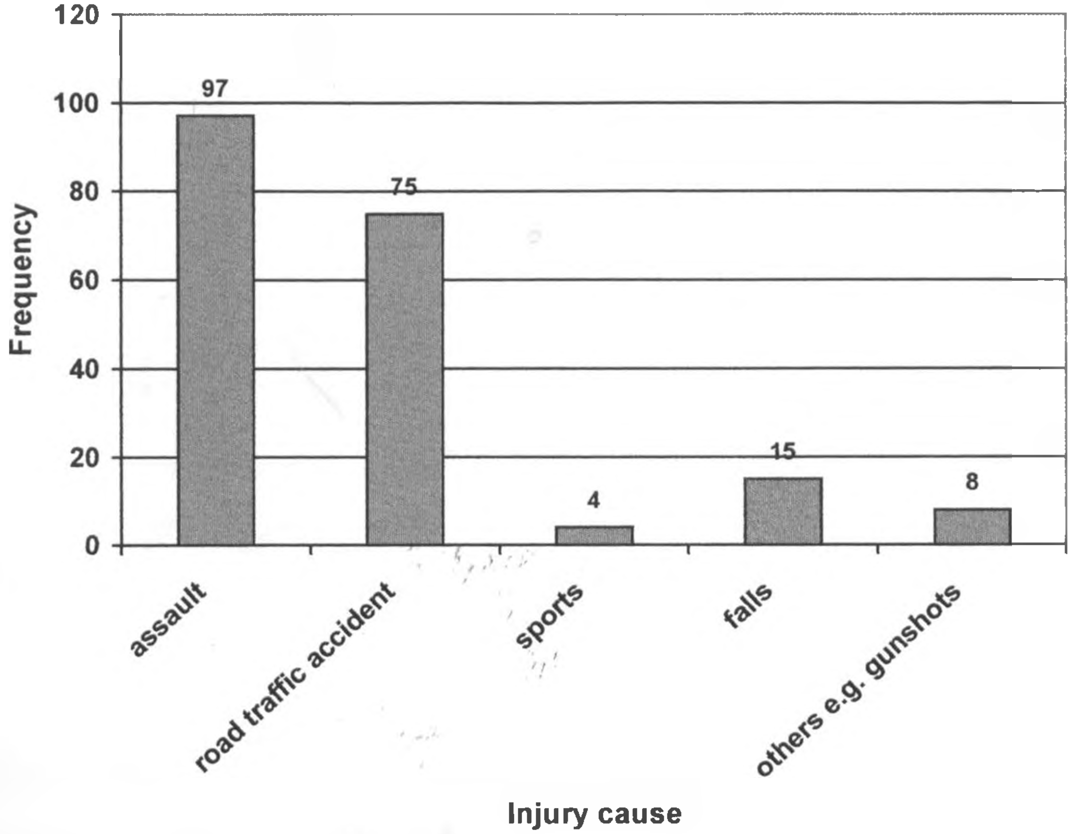

Fig. 8: Frequency distribution according to cause of injury

This histogram shows that assault — ninety seven cases (48.7%) was the commonest cause of MFSI. RTA contributed to 37.7% followed by falls 7.5%.

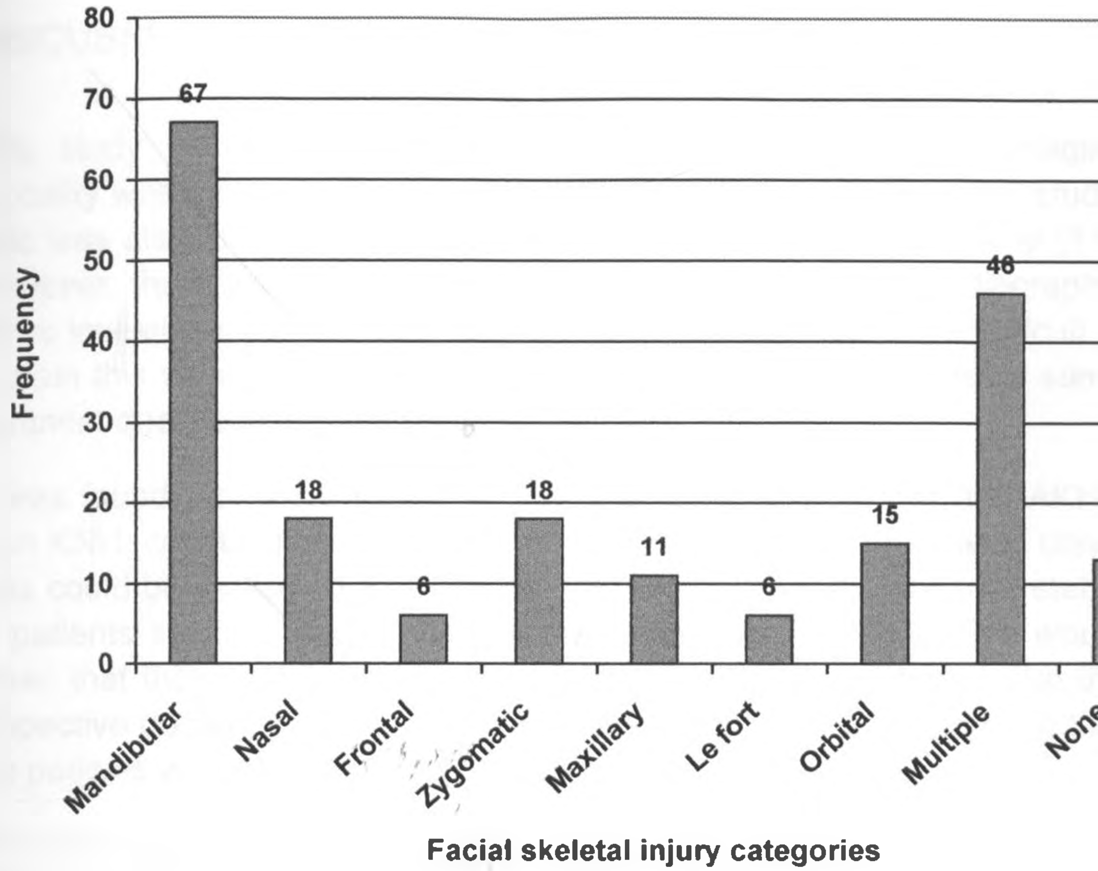

Fig. 9: Categories of facial skeletal injuries

From this figure mandibular fractures were seen to be more frequent- sixty seven cases (33.7%). Forty six cases (23%) had multiple faci bones fractured.

CHAPTER 5

DISCUSSION

This study has shown that plain radiography as a primary imaging modality was universally utilised by all the hospitals included in the study. This was also found to be the case in a study done by Akama *et al* (11). However, there was a wide variation in the use of different radiographic views investigated in the hospitals, with a p-value of 0.001. It is difficult to explain this variation but it is possible, perhaps necessary, to raise some pertinent questions and postulate possibilities.

It was found that more views for the face were done in NH and AKHN than KNH, constituting an average of 72% of all radiographic views done. This could be explained by a comparatively higher socio-economic status of patients seeking medical care in the two private hospitals. This would mean that they could pay for any number of views requested or that the respective doctors would request more views, with the understanding that the patients would afford to pay for them.

It is also possible that KNH uses relatively fewer radiographic views of the face in accordance with the professional viewpoint that standard views of the face be requested only when certain fractures are suspected (21). Such a viewpoint would encourage a rather conservative approach towards requesting a wide variety of the standard radiographic views of the face.

One could also look at the variation from yet another perspective. It is possible that patients who go to private hospitals (like NH and AKHN in this study) receive specialised and personalised care right from the time they arrive at the hospital, that is, from specialised surgeons, compared to public hospitals like KNH where a patient has to be seen initially by a medical (casualty) officer and only later that such a patient would get experienced care - after some few days have passed - say during a major ward round which may take place after 2 or 3 days on average. Furthermore, there are relatively far fewer patients attending private hospitals compared to those attending a large public hospital such as the KNH. The relatively small number of patients at NH and AKHN would imply that there would be better communication both between the doctors and the patients and between the requesting doctors and the radiology department. In terms of communication between the doctors and the patients, the fewer patients would allow for more doctor-patient time and better doctor-patient interaction, thereby better capture the clinical history and make proper radiological requests. The outcome of proper examination would make it possible for the requesting doctors to give the radiographer appropriate instructions and guidelines on the views required, thus enhancing the radiographic performance. Any breakdown in information, such as poor or absent clinical history, routine use of abbreviations like PA and lateral skull could lead to laxity in radiography work. Whatever the explanation, one wonders how this variation affects the quality of the management of patients in these hospitals.

The number of films used per case also varied across the hospitals with KNH featuring as the hospital that used the least number of films. Again, it is important to pose the question as to why fewer films were utilized at the KNH. Any number of suggestions could be made. It is possible that the use of many films is simply unnecessary, and therefore, the KNH goes for only the absolutely necessary radiographic exposures. Although the number of films to be used should depend on the number of views requested, facial imaging would require at least three films (17,18). Therefore, the average of one to two films per patient utilized at the KNH may have been too low. But it could be hypothesised that KNH faces hard economic conditions, thus having far fewer film supplies and yet must attend to a vast number of patients with little income who cannot afford to go to private hospitals. In addition, it is possible that the majority of the medical staff who attend to patients with MFST do not have adequate or specialised knowledge on imaging of such patients. Consequently, they do not request for the standard views of MFST. It is interesting to note that the "skull X-ray " PA and lateral views were done in 25% of the cases instead of the recommended standard views of the face (13,17, 18, 21). Whether the failure to request for the standard views was because of lack of adequate knowledge or was due to mere laxity would require investigation. The issue is that this inadequate imaging of the face could lead to loss of important radiographic detail and consequently affect management and outcome of treatment (18).

There was an overall under - utilisation of CT scan in all the hospitals, despite this imaging modality being readily available. It is difficult to explain this under utilisation from this study. It is possible to attribute the under - utilisation seen in this study at least partly to lack of knowledge on the importance of the CT scan in imaging of MFST by the requesting doctor. It is also possible that CT scan was under - utilised just for "no reason", as other authors have found out (22). Since this study was retrospective, it is difficult to propose with any certainty the reasons for the under - utilisation of this imaging modality. Nevertheless, certain implications for the under - utilisation can be suggested. Other studies have shown that many patients who have undergone a primary CT scan examination had at least one fracture detected (22, 27), increasing the chances of not missing a fracture. Also the CT scan has been found to give additional information over and above that provided by clinical examination and conventional radiography (28). The CT scan is, therefore, invaluable especially where there is suspicion of severe mid-facial and naso-ethmoidal injuries. It is important that such injuries are detected and corrected immediately as it has been found that these injuries are difficult to correct at a later stage. This means that the CT scan should have been properly utilised, where it was possible.

Of the individual facial bones fractured in MFST, the mandible had the highest frequency (70 cases), which corresponds to studies done elsewhere (10,25,26). This has been associated with a high interpersonal violence rate in this country, which was also observed in this study, as well as an increase in RTA in developing countries (10,25,26). This high frequency might suggest that many mandibular fractures could have been missed out, since the higher the incidents detected the more likely that some were not (29). This would imply that there is need to always suspect that in an MFST there could be a mandibular fracture, that would always necessitate obtaining views of the mandible.

CONCLUSIONS AND RECOMMENDATIONS

1. Proper imaging of MFST is essential as it affects the middle a group, which is also the most productive in the society.

2. There is no uniformity among hospitals on the imaging maxillofacial skeletal injuries; moreover, the standard radiograp views are hardly in use in some hospitals.

3. The present evidence shows that there is a great variation imaging modalities used, views for plain radiography and number films used.

4. Utilization of other imaging modalities like CT is still on the low side compared to other places. A prospective study will give mo and accurate information concerning this matter.

5. It would also be important to investigate on the reasons for adopti non-standard radiographic views and whether these views influen the overall patient care. The issue of under/over - investigation the patients with MFST needs to be addressed so that ionisi radiation and unnecessary cost are dealt with without compromisi the diagnostic component.

6. The awareness on the importance of CT scanning in the prima investigation of MFST should be studied and if found lacking effort should be made to educate doctors on the value of th imaging modality.

LIMITATIONS

1. This having been a retrospective study, it was difficult to obtain some information like demographic factors because of relying entirely on the available records.

2. During the reviewing of some films it is possible that some films had partly or totally lost some detail during storage.

REFERENCES

1. Turetschek K, Wunderbaldinger P, Zontsich T. Trauma of the facial bones and skull. *Universitatsklinik for Radiodiagnostic* 2000;20: 20-21.

2 Federle MP, Zawadzki MB. CT of Maxillofacial injury. *Computed Tomography in the Evaluation of Trauma* 1st edition; Zawadzki MB, Rowe LD Eds, London. Williams and Wilkins 1982; pp 60 –105.

3. Hogg NJ, Stewart TC, Armstrong JE, Girotti MJ. Epidemiology of maxillofacial injuries at trauma hospitals in Ontario, Canada, 1992 and 1997. *J Trauma* 2000; 49 :425 –32.

4. Martello Y J, Vasconez HC. Supraorbital roof fractures : a formidable entity with which to contend. *Ann Plast Surg* 1997. 38 : 223-7.

5. Ugboko VI, Odusanya SA, Fagade OO. Maxillofacial fractures in a semi- urban Nigerian Teaching Hospital. A review of 442 cases. *IhOral Maxillofac Surg* 1998; 27:286-9.

6. Tan WK, Lim TC. Aetiology and distribution of mandibular fractures in the National University Hospital Singapore. *Ann Acad Med Singapore 1999; 28 : 625-9.*

7. Abiose BO. The incidence and management of middle third facial fractures at the University College Hospital, Ibadan. *East Afr. Med. J.*1991; 68: 164-73.

8. Shinya K, Taira T, Sawada M, Isshiki N. Facial injuries from falling : age–dependent characteristics. *Ann Plast Surg* 1993: 30: 417-23.

9. Zerfowski M, Bremerich A. Facial trauma in children and adolescents.*Clin Oral Investig*1998;2 :120-4.

10. Mwaniki D L, Guthua S W. Occurrence and characteristics of mandibular fractures in Nairobi, Kenya. *Br J Oral Maxillofac Surg*.1990; 28: 200-202.

11. Akama MK, Chindia ML, Odhiambo WA, Guthua SW, Macigo FG. *Injuries of the maxillofacial skeleton in Nairobi, Kenya.* (unpublished)

12 Snell RS. The head and neck. *Clinical Anatomy for medical students* 4th edition; Philadelphia. Richard Snell 1992; pp 769-803.

13. Zatzikin H.R. Injuries to the head. *The Roentgen diagnosis of Trauma* 1st edition, Year Book Medical Publishers, Chicago. HR Zatzikin1965; pp 70-100.

14. Rabukhina NA, Filimonor G P, Luginar N R et Al. Comparison of the results of roentgenography, panoramic zonography and computer-aided tomography in some deformations of facial skull Fest Rentgenol Radiol 1997; 10: 20-4.

15. Brant W E, Helms C A. Craniofacial Trauma. *Fundamentals of Diagnostic Radiology* 1[st] edition, Philadelphia, Williams and Wilkins 1994 pp 72-84.

16. Burn J S, Chung C H , Oh SJ. Pure orbital blowout fracture : new concepts and importance of medial orbital blowout fracture. *Plast Reconstr. Surg.* 1999; 103: 1839-49.

17. Young JWR.Skeletal trauma regional. In: *A textbook* of *radiology and imaging, 5th ed.* Sutton D, Ed. Edinburgh: Churchill Livingston 1993; pp 1223-30.

18. Rogers LF. The Face. In: *Radiology of skeletal trauma,* Vol. 1, 1[st] Ed. Rogers LF, Ed. Broadway, NY: Churchill Livingstone 1982;pp 229-270.

9. Pogrel MA, Podlesh SW, Goldman KE. Efficacy of occipitomental radiograph to screen for midfacial fractures. *J Oral Maxillofac Surg* 2000;58:24-6.

McIvor J. Maxillofacial radiology In: *Diagnostic radiology*, 2[nd] ed. Granger RG and Allison DJ , Eds. Edinburgh: Churchill Livingstone,1992: pp 2165-2201.

Raby N , Moore D. Radiology of facial trauma ,the lateral view is not required. *Clinical Radiology* 1998; 53: 218-220.

Davidson MJC, Daly BD, Russell JL. The use of computed tomography in the management of facial trauma by British oral and maxillofacial surgeons.*Br J Oral Maxillofac Surg* 1991; 29 :80-81.

23. Jenkins CN, Thuau H. Ultrasound imaging in assessment of fractures of the orbital floor. *Clin Radiol* 1997 ;52 : 708-11.

24 Scheepers A, Lownie M. The role of angiography in facial trauma: a case report. *Br J Oral Maxillofac Surg*. 1994; 32 : 69-136.

25. Muyembe VM. *Internal fixations of fractures in a peripheral set-up in Kenya.* East Afr. Med. J. 1999;77:295-298.

26. Akama MK, Chindia ML. *Occurrence and pattern of mandibular fractures at Kisii District Hospital, Kenya.* East Afr. Med. J. 1993; 70: 732-733.

27. Pearl WS. *Facial imaging in an urban emergency department.* Am J Emerg Med. 1999; 17:235-7.

28. Russell JL, Davidson MJC, Daly BD, Corrigan AM. *Computed tomography in the diagnosis of maxillofacial trauma.*Br J Oral Maxillofac Surg. 1990; 28:287-291.

29. Bailey KD. Survey Sampling. In: *Methods of social research,* 3rd Ed; Free press, New York, 1989; pp 79-102.

APPENDIX I

ETHICAL CONSIDERATIONS

There were no major ethical issues considered since this was a retrospective study dealing with patients' records. Nevertheless serial numbers were used instead of names and reviewing of the files was done in the records departments of respective hospitals to ensure confidentiality.

APPENDIX II

IMAGES

Figure 1: Le fort 1 fracture. There is a fracture of the alveolar process with posterior displacement. There is a strong suggestion of nasal septum fracture.

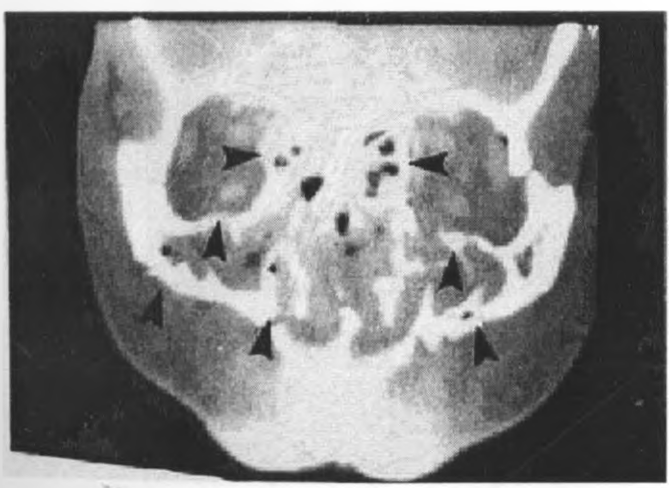

Figure 2: A coronal CT scan image of the face showing Le Forte 2 injury — fracture of maxilla inferior orbital wall, comminuted fracture of nasofrontal ethmoid region.

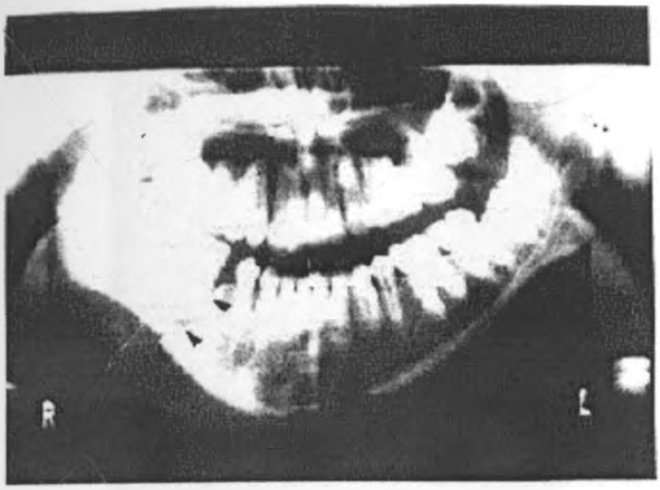

Figure 3: A panoramic view of the mandible (OPG) showing a linear fracture in the right body of the mandible.

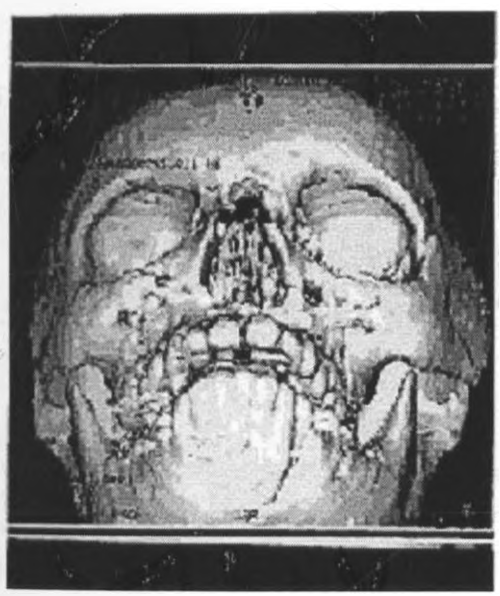

Figure 4: CT image with 3D reconstruction of a 13 year girl following RTA. There's a displaced parasymphyseal fracture.

Figure 5: There is a depressed fracture of the frontal bone on the right, the maxillary bone and the right inferior orbital rim in this 3D reconstructed image of a 25-year female patient who was assaulted.

Figure 6: PA view of the mandible showing a linear fracture on the body on one side.

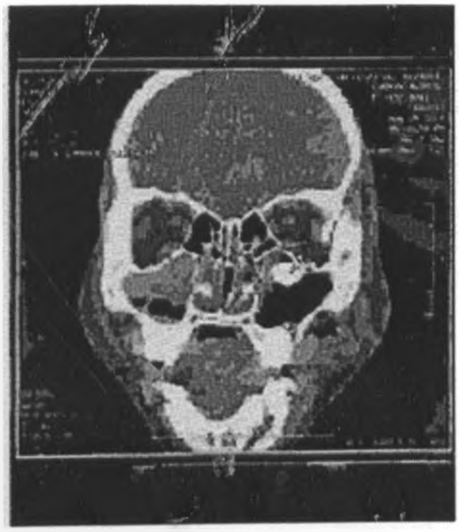

Figure 7: A tripod fracture on coronal CT scan image.

Figure 8: Right orbital blow-out fracture (arrow) with opacification the ipsilateral maxillary antrum and ethmoid cells on a coronal C scan image.

Figure 9: A Submentovertical view of the skull showing a fracture of the left zygomatic arch.

APPENDIX III

Questionnaire Example/Data Collection form

CASE NO.____________________________AGE________________

GENDER: M=1 ☐

F=2

HOSPITALS: ☐

KNH =1

NAIROBI =2

AGA KHAN=3

Indication(s)for which the examination was requested: ☐

Suspected facial fracture=1

Exclusion of complication arising from facial injury=2

Other=3

(specify) ....

Type(s) of imaging modalities employed during primary investigation: ☐

Plain radiography =1

CT scan (conventional) =2

MRI =3

Ultra sound =4

Spiral CT with 3D reconstruction=5

Combinations =6

(specify) ....

Plain radiographic views employed: ☐

OPG	=1
PA (full cranium)	=2
Lateral skull	=3
OMV	=4
SMV	=5
Combinations	=6

Specify combinations ____________________

Type(s) of CT scans employed: ☐

Axial	=1
Coronal	=2
Reconstruction	=3

Quality of imaging investigations performed: ☐

Good	=1
Acceptable	=2
Poor	=3

Cause of injury: ☐

Assault	=1
RTA	=2
Sports	=3
Others	=4

(specify) ....

Radiological findings

1. ....
2. ....

Plain radiographic views employed: ☐

OPG	=1
PA (full cranium)	=2
Lateral skull	=3
OMV	=4
SMV	=5
Combinations	=6
Specify combinations	____________________

Type(s) of CT scans employed:

Axial	=1	☐
Coronal	=2	
Reconstruction	=3	

Quality of imaging investigations performed:

Good	=1	☐
Acceptable	=2	
Poor	=3	

Cause of injury:

Assault	=1	☐
RTA	=2	
Sports	=3	
Others	=4	

(specify) ....

Radiological findings

1. ....

2. ....