TITLE:

Maxillofacial Fractures in Children attending the Red Cross War Memorial Children's Hospital

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF PICTURES/PHOTOGRAPHS/ILLUSTRATIONS

LIST OF APPENDICES

MAXILLOFACIAL FRACTURES IN CHILDREN ATTENDING THE RED CROSS WAR MEMORIAL CHILDREN'S HOSPITAL

BY

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Dissertation submitted to the Faculty of Dentistry of the University of the Western Cape, in partial fulfillment of the requirements for the degree of Magister Chirurgiae Dentium in the discipline of Maxillofacial and Oral Surgery

DECLARATION

I, SUNILDUTT ANIRUTH, declare that this dissertation entitled **"Maxillofacial fractures in children attending the Red Cross Children's Hospital"** is my own work and that all sources that I have quoted, have been indicated and acknowledged by means of references.

Signed: _____
Sunildutt Aniruth

Date: _____

ACKNOWLEDGEMENTS

I sincerely would like to thank the following individuals and companies for their assistance with this research project:

1. Department of Oral and Maxillofacial Surgery at Groote Schuur Hospital, for affording me the opportunity to complete my study.
2. My supervisors, Professors G Kariem and AB van As for their support and guidance.
3. Miss K Rawoot and Dr N Behardien for their enormous assistance in all aspects of this project.
4. Mrs Sonitha Thulkanam for her extensive advice and planning of the manuscript.
5. My consultants, Drs GJ Hein and S Singh for their guidance and support.
6. Mrs Nelmarie du Toit of the Child Accident Prevention Foundation and the staff (Norma, Yusuf, Ricardo, Deon, Beverly and Tommy) of the records office at the Red Cross Children's Hospital for the assistance with the compilation of the case lists.
7. The company, Synthes SA, for their generous and unconditional financial support.
8. My fellow registrars for their assistance during the project.
9. Lucinda Cornelius (and her son Kevin), for granting me permission to use photographs of Kevin, in my study.

DEDICATION

This thesis is dedicated to my greatest supporters: My wife, Charmaine, and my son Rohil; my mother, the late Mrs Manpathie Aniruth; my father-in law, the late Mr Arumugam Pillay.

ABSTRACT

The literature shows that maxillofacial fractures in children are uncommon. Although the Department of Oral and Maxillofacial Surgery of the Faculty of Dentistry, of the University of the Western Cape, has been providing a service to the Red Cross Children's Hospital (RXH) for the past twenty years, no study had been undertaken to determine the age, gender, number of patients per year, aetiology, patterns, and management of maxillofacial fractures at this institution. A retrospective records based study was undertaken to determine these features. This study accessed the records of patients seen at the trauma unit at RXH, from 1994 to 2003 inclusive, and referred for maxillofacial attention.

One-hundred-and-five patient records were obtained and analyzed using the SPSS statistic package. One-hundred-and-twenty-seven fractures were recorded in one hundred and five patients. The age of the patients ranged from one to thirteen. Sixty-five male and forty female patients were seen. Dentoalveolar fractures were the most common fracture seen in both the midface and mandible. Midface fractures were more common than mandibular fractures. Falls, followed by motor vehicle accidents, were the most common cause of facial fractures. Most fractures were successfully managed by closed procedures. At this institution, nasal and frontal fractures have surprisingly little or no input from the Department of Oral and Maxillofacial Surgery.

KEY WORDS

1. Maxillofacial
2. Fractures
3. Children
4. Mandible
5. Maxilla
6. Trauma
7. Open reduction
8. Closed reduction
9. Nonsurgical
10. Surgical

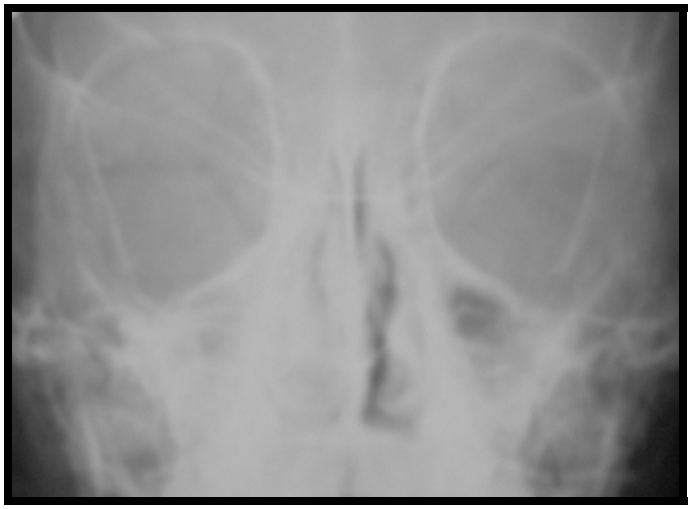
ABBREVIATIONS

1.	RXH:	Red Cross War Memorial Children's Hospital
2.	SPSS:	Statistical Package for the Social Sciences
3.	IMF:	Intermaxillary Fixation
4.	MMF:	Mandibular-maxillary Fixation

1.0. INTRODUCTION

The literature states that facial fractures in children are rare (MacLennan WD.1956; Rowe NL. 1969; Thoren H, Iizuka T*, et al.*1992; Tanaka N, Uchide N, *et al.* 1993; Haug HR, Foss J. 2000; and Iida S. 2002). Even with extensive soft tissue injuries, there are often no markedly displaced maxillofacial fractures.

Picture 1: Facial injuries. An eight year old child admitted to the Red Cross War Memorial Children's Hospital, after being struck by a motor vehicle. Extensive soft tissue injuries are noted.



Picture 2: Antero-posterior facial radiograph of the patient in picture 1, showing no markedly displaced fractures. The right maxillary sinus is opacified.

The Red Cross Children's Hospital caters for the medical and surgical needs of children younger than 13 years of age. Children presenting with facial fractures are admitted to the Trauma Unit and assessed and managed by both, The Department of Maxillofacial and Oral Surgery (Faculty of Dentistry, University of the Western Cape) and, The Department of Plastic and Reconstructive Surgery (Faculty of Medicine, University of Cape Town).

Although these services have been operational for more than 20 years, no analysis of the maxillofacial fractures in this pediatric sample has as yet been done at this institution. Haug HR, Foss J. (2000) published a comprehensive review based on the last 25 years of publications, in the English literature, on maxillofacial injuries in children, which contain references from Nigeria and Zimbabwe, but none from South Africa.

Studies have been performed in European countries, Japan and the United States of America to ascertain aetiology and fracture patterns of maxillofacial fractures in children. Continuous long-term data collection on maxillofacial fractures is important because it allows for the development and evaluation of preventative measures (Hogg NJ, Stewart TC, *et al*. 2000). The two African studies reported, are those of Chidzonga MM. (1987) who reported on 18 cases in Zimbabwe, and Adekeye E. (1980) who reported on 85 cases in Nigeria. The only South African study to date is that of Bamjee Y, Lownie JF, *et al.* (1996). They report on maxillofacial injuries in a group of South Africans below 18 years of age.

It was therefore considered prudent that such a study be undertaken at the Red Cross Children's Hospital, the regional trauma centre for Children in the Western Cape, where, according to the Head of the Red Cross Hospital trauma unit, Dr AB van As, approximately 10 000 injured children are treated annually.

2.0. LITERATURE REVIEW

There is general consensus that maxillofacial injuries in children are not common. MacLennan WD. (1956) reported that only 1% of mandibular fractures occur in children younger than 6 years of age. Rowe NL. (1969) analyzed 1500 fractures and found that less than 5% of fractures occur in children younger than 12 years. More recently, studies suggest that this low incidence still holds true. (Thoren H, Iizuka T, *et al.*1992; Tanaka N, Uchide N, *et al.*1993; Haug HR, Foss J. 2000; and Iida S. 2002). The experience a maxillofacial surgeon has in dealing with pediatric fractures is likely to be limited. The pediatric patient is anatomically different to the adult, with its skeletal and dental development at various stages of maturation. Thus the patterns of injury are bound to reflect these differences. Thoren H, Iizuka T, *et al.* (1992) explains that in infants and young children, the face is smaller in proportion to the head size. Furthermore, the prominent frontal cranium shields the facial skeleton. The small paranasal sinuses and great elasticity of the bones are also characteristic of young children and provide resistance to fracturing. McGraw BL, Cole RR. (1990), report that fractures shifted from the upper to the lower region of the face with increasing age. Orbital injuries were more common in younger children and mandibular fractures in the older age group.

As children get older there seems to be a trend towards fracture patterns resembling those of adolescents and young adults. Thoren H, Iizuka T, *et al.* (1992), Tanaka N, Uchide N, *et al.* (1993), Ilzuka T, Thoren H, *et al.* (1995), Infante CP, Espin GF, *et al.* (1994).

2.1. Age

There is no consensus in the literature as to the age group considered pediatric.

Haug HR, Foss J. (2002) reports that the pediatrician may treat patients up to the age of 21 and claims that inconsistencies appear throughout the current literature regarding the terms “pediatric” and “child” and their corresponding ages. They accept the common definition of pediatrics according to Dorland’s Illustrated Medical Dictionary as “That branch of medicine that addresses the child and its development and care and the diseases of children and their treatment”. This definition for “pediatric” varied amongst the studies reviewed, making comparisons of findings difficult. The age groupings in the studies reviewed are demonstrated in Table 1 below.

REPORT	YEAR	AGES
MacLennan WD.	1956	6 years and younger
Rowe NL.	1969	6-11
Chidzonga MM.	1987	0-16
Tanaka N, Uchide N*, et al.*	1993	1-15
Bamjee Y, Lownie JF, *et al.*	1996	Birth to18
Thoren H, Iizuka T, *et al.*	1997	Under the age of 16
Iida S.	2002	Under the age of 16

Table 1: Age groups studied.

There appears to be consensus that the incidence of maxillofacial fractures increases with age. The sites of these injuries also appear to be age related. Thoren H, Iizuka T, *et al.* (1997) report that fractures of the body, angle and ramus increased with age but the relative frequency of condylar fractures decreased. Iida S. (2002) reported that in the age group younger than six years, 75% of patients suffered condylar fractures,

whilst, in his older age groups (11 to 13 years) mandibular angle fractures were most common. Haug HR, Foss J. (2000) reported that the incidence among all facial fracture patients younger than sixteen years of age was between 1.0% to 14.7% but that in the age group younger than five this percentage was between 0.87% to 1.0%.

2.2. Gender

There is overwhelming evidence of a male preponderance with regard to maxillofacial fractures in children. Most studies confirm at least a 2:1 male to female ratio. Table 2 illustrates this finding. Kaban B. (1993) sites the study of Waldron's 1943 article describing 5 female and 2 male patients. This unusual ratio may be attributed to the small sample size. Table 2 demonstrates the male predominance in facial fractures in children.

STUDY	YEAR	MALE: FEMALE
Chidzonga MM.	1987	2:1
Tanaka N, Uchide N, *et al*	1993	2:1
Bamjee Y, Lownie JF, *et al*	1996	2.3:1
Thoren H, Iizuka T, *et al*	1997	1:0.7
Iida S.	2002	2:1

Table 2: Gender review

2.3. Aetiology

The aetiology of facial fractures includes: motor vehicle accidents, interpersonal violence, falls, sports, bicycle accidents, and other unusual causes. While motor vehicle and interpersonal violence are implicated in the vast number of adult facial fractures, the aetiologies in children are somewhat different in that “falls” during daily activities appear to be the most common cause.

The wide range of aetiologies clearly suggest that there are factors specific to each study with regard to socio-economic, transport medium, infrastructure, sporting and recreational facilities, etc. which affect the incidence and types of facial fractures observed. Population characteristics are further reasons for differences.

The aetiology of fractures differs within countries as well. The study of Tanaka N, Uchide N, *et al.* (1993) of a population in Tokyo, showed falls to be the most common cause (28.4%), but the study conducted by Iida (2002) in Osaka, showed bicycle accidents (26%) to be the most common aetiology.

Thoren H, Iizuka T, *et al.* (1997) in Finland, showed bicycle accidents as the predominant course (48%), but in their 1992 study, also in Finland, road traffic accidents were the predominant cause at 57.3%, with a decrease to 38.9% of causes related to accidents involving cycling.

Kaban LB, Mulliken JB. (1997) reported falls from a bicycle, steps or climbing apparatus as the common aetiology at 30% of total injuries.

Bamjee Y, Lownie JF, *et al.* (1996) reported that in the teenage group of 13 to 18 years, violence accounted for almost half of the injuries, followed by motor vehicle accidents. He reported only one case of abuse. Thoren H, Iizuka T, *et al.* (1997) reported 6 cases of children involved in violence. Table 3 below represents the prevalence of the various aetiologies as reported in the review study of Haug HR, Foss J. (2000).

AETIOLOGY	PERCENTAGE
MVA	5% - 80%
Violence	3.7% - 61.1%
Falls	7.8% - 40%
Bicycle	7.4% - 48%
Play	10% - 42%
Sports	1.2% - 33%
Pedestrian	10% - 25%
Other	4.5% - 23%
Objects	1% - 23%
Crush	10%

Table 3: Aetiology of fractures in pediatric patients (Haug HR, Foss J. 2000)

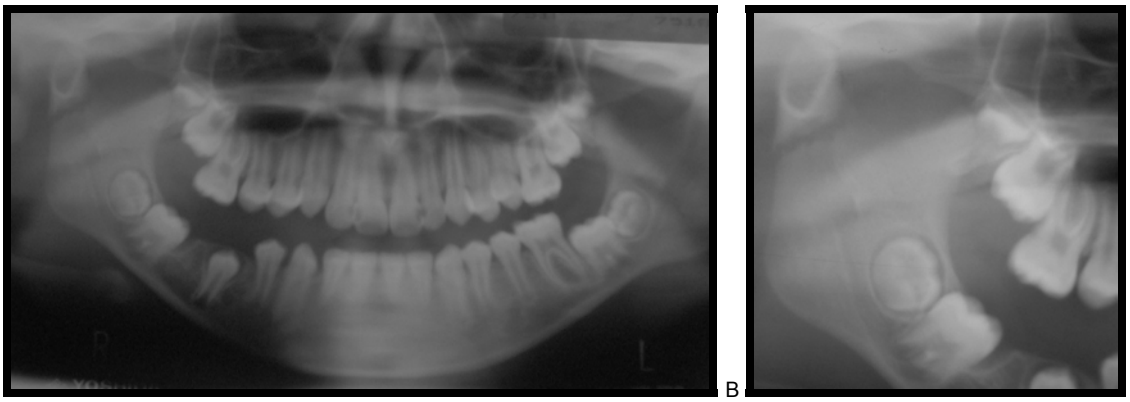
2.4. The Sites and Patterns of Fractures

There is agreement that most fractures in children occur in the mandible, [Rowe (1969), Zachariades N, Papavassiliou D, Koumoura F. (1990), Bamjee Y, Lownie JF*, et al.* (1996), Thoren H, Iizuka T, *et al.* (1997)]. Furthermore, there is widespread acceptance of the change in patterns of fractures with an increase in age. McGraw BL and Cole RR. (1990) reported that the fractures shifted from the upper to the lower region of the face with an increase in age. They found mandibular fractures more prevalent in older age groups and frontal and orbital fractures occurred more frequently in the youngest age group.

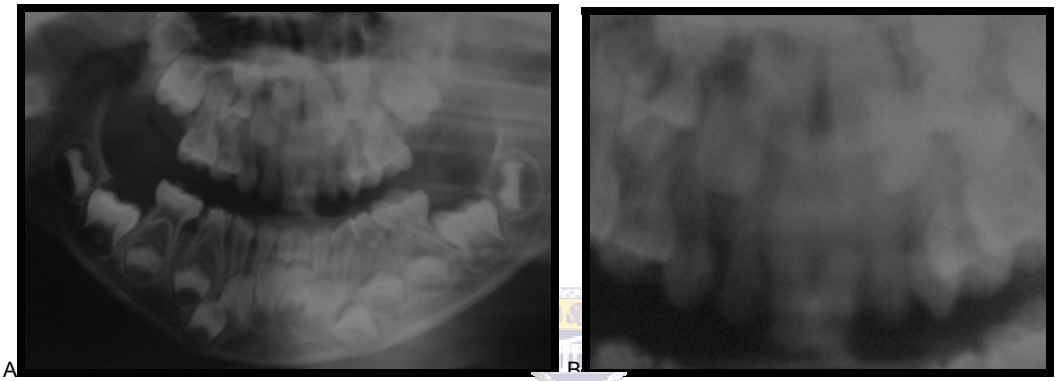
Haug HR and Foss J. (2000) tabulated their findings from a review of publications and showed the following patterns of mandibular and maxillary fractures.

MANDIBLE			**MAXILLA**	
Site	**Percentage**		**Site**	**Percentage**
Condyle	14.5 – 60%		Alveolus	5 – 65
Alveolus	8.1 – 50.6%		Nose	1 – 45
Body	5.6 – 44%		Zygoma	7 – 41
Symphysis	1.8 – 40.4%		Maxilla	1.2 – 20
Parasymphysis	23.9 – 33.7%		Le Forte I	0.5 – 26
Angle	3 – 27%		Le Forte II	0.9 – 20
Ramus	0.75 – 10%		Le Forte III	1.9 – 16
Coronoid	0 – 19%			

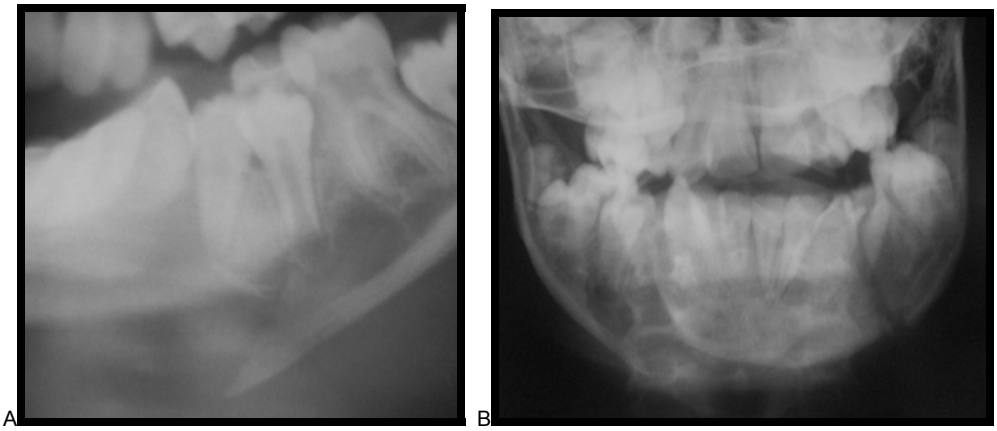
Table 4: Sites and Frequency of fractures in the Mandible and the Maxilla (Haug HR, Foss J 2000)



Picture 3 (A and B): The mandibular condyle is considered the most commonly fractures site in children



Picture 4 (A and B): maxillary dentoalveolar fracture involving the upper anterior region is the most common fracture in the maxilla.



Picture 5 (A and B): The mandibular body is less commonly fractured, but is often displaced and needing open reduction and rigid internal fixation for correction.

2.5. Management

Minimally displaced fractures are managed non-surgically, with soft diet and antibiotic prophylaxis and analgesia. Appreciably displaced fractures are treated by closed or open reduction. Rowe NL. (1969) proposed a treatment of closed reduction probably because of the remodeling potential of the pediatric craniofacial skeleton. Posnick JC, Wells M, Pron GE. (1993) favoured the concept of accurate primary repair with open reduction, claiming that the remodeling potential is unpredictable and provides a poor rationale for inadequate anatomic reduction and fixation. For non-displaced fractures, observation is acceptable. Closed reduction with or without intermaxillary (mandibulo-maxillary) fixation depends on the age of the patient, extent of displacement, and presence of dentition in the oral cavity. Dentoalveolar fractures are treated by way of arch bars with or without intermaxillary fixation (IMF) [or as some surgeons prefer the term mandibular-maxillary fixation (MMF)]. They may also be managed with composite splints. Displaced fractures are managed by open reduction and internal fixation, with transosseous wires or titanium plate and screw osteosynthesis, with careful consideration to the developing dental structures. The development of resorbable plates, have added an additional treatment option (with transosseous wires, stainless steel plates, titanium plates and screws, and now resorbable plates and screws), to the management of pediatric facial fractures. The use of bioresorbable plate fixation in pediatric cranio-maxillo-facial surgery provides a means of avoiding potential problems of plate migration seen in rigid metal fixation (Imola MJ, Hamlar DD, *et al.* 2001).

With the surgical experience of most clinicians limited because of the low incidence of maxillofacial fractures, the approach of management may not have been refined to the same degree as in adults (Myall RWT, Dawson KH, Egbert MA. 2000).

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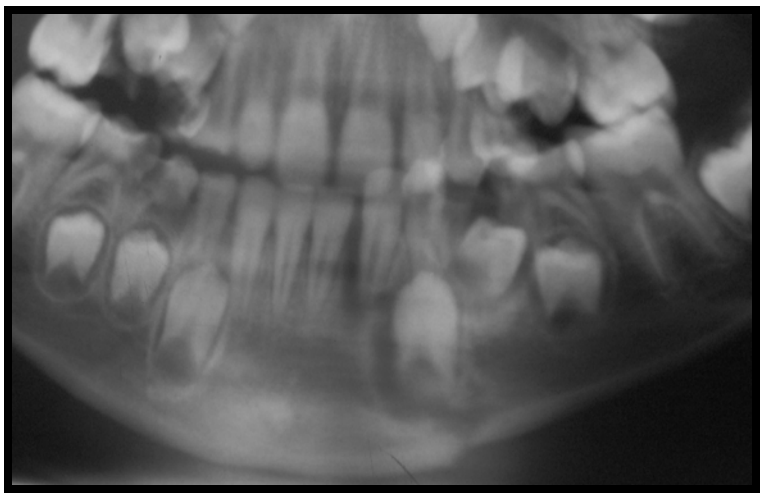
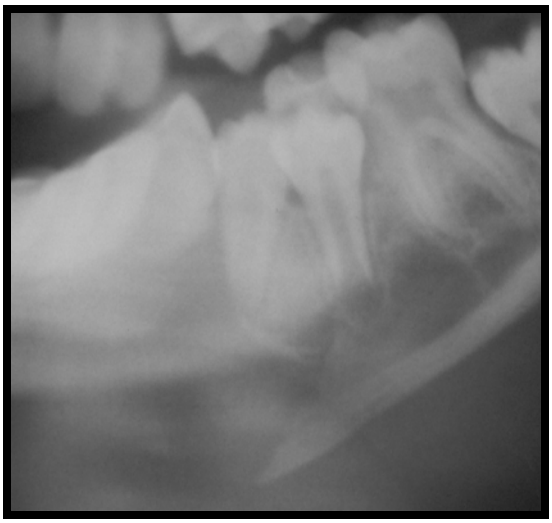
The review by Haug HR, Foss J. (2000) suggested that the treatment for mandibular fractures be initiated within 4 – 7 days after injury.

For midface injuries, there is consensus that anatomical reduction is essential if there is displacement of the fracture segments. [(Porter SR. (1987); Iizuka T, Thoren H, *et al.* (1995), Thaller SK, Huang V. (1992)] and that treatment be initiated within 2 to 4 days. There is no consensus on the extent of displacement and each clinical case has to be assessed on its merits.



Picture 6: A minimally displaced fracture of the parasymphysis with adequate dentition to be treated with closed reduction



Picture 7: Displaced fracture of the left body of the mandible that will require open reduction and internal rigid fixation

3.0. STUDY METHODOLOGY

3.1. Aim

To provide an analysis of the maxillofacial fractures presenting at the Red Cross Children's Hospital, Cape Town, South Africa.

3.2. Objectives

1. To determine the age, gender, incidence, aetiology, patterns of fractures and methods of management, of maxillofacial fractures in patients presenting at the Red Cross Children's Hospital.

2. To compare these findings with those of other similar studies.

3. To make recommendations, for the management of these fractures.

3.3. Materials and Method

3.3.1. Study design

A retrospective record based study was performed.

3.3.2. Method

All the patients referred from the trauma unit at the Red Cross War Memorial Children's Hospital (RXH), for assessment and management by the Departments of Maxillofacial Surgery and Plastic and Reconstructive Surgery, from the period of 1 January 1994 to 31 December 2003 were included.

The data was obtained from the patient's records held at the Red Cross War Memorial Children's Hospital and recorded on a collection sheet (Appendix 1).

The cases were retrieved from the registers at the trauma unit, and from the records captured by the office of the Child Accident Protection Foundation of Southern Africa, stationed at the Red Cross War Memorial Children's Hospital. The patient admission and treatment folders were used.

3.3.3. Data Capturing and Analysis

The data was captured onto the prepared Proforma (Appendix 1) and then entered onto a Microsoft Excel Spreadsheet. The analysis of this data was carried out using the Statistical Package for the Social Sciences (SPSS) software. The results are presented in a series of tables and bar graphs, reported on and discussed.

4.O. ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the Research Committee of the University of the Western Cape.

Written permission to use the records was obtained from the Medical Superintendent of the Red Cross War Memorial Children's Hospital.

Written informed, consent was obtained from the patient's parent or legal guardian for the use of any photographs.

Patient confidentiality was strictly maintained. No names, addresses or contact details of the patients were divulged.

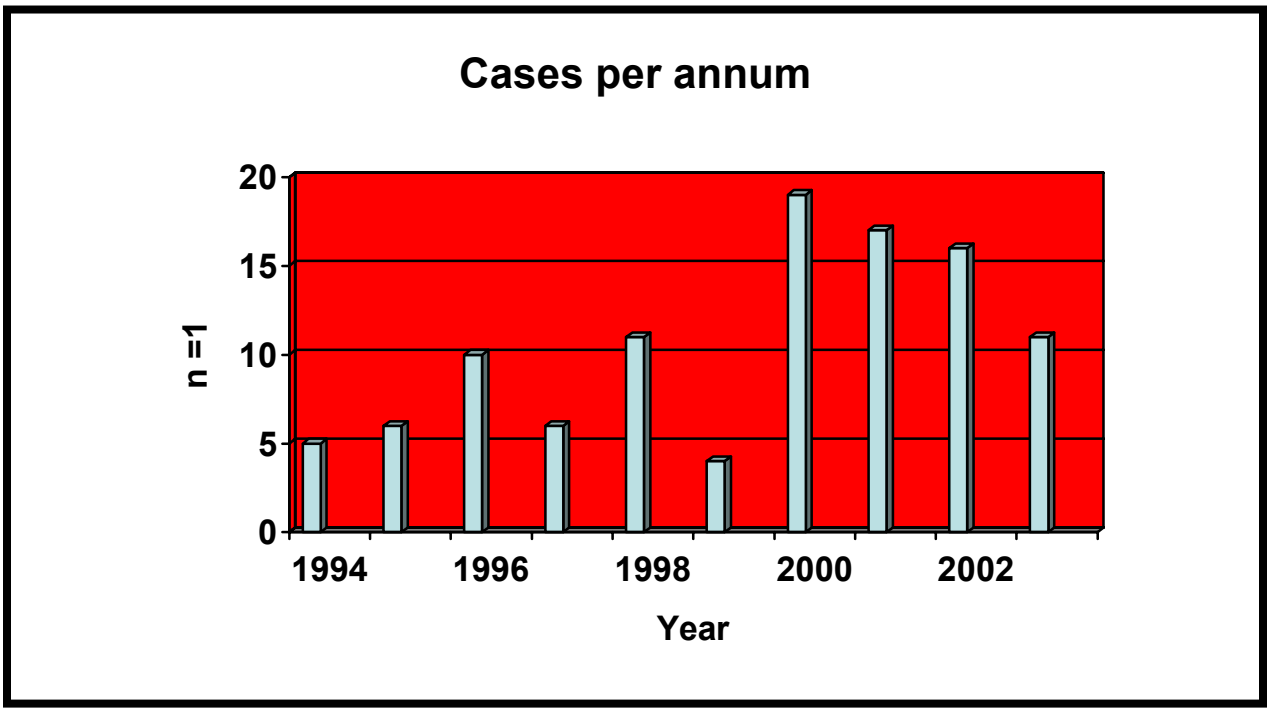
5.0. RESULTS

The complete records of 105 patients were accessed for the period, January 1, 1994 to December 31, 2003. These records were analyzed using the Statistical Package for the Social Services (SPSS) computer software programme. One-hundred-and-twenty-seven (127) fractures were reported in the 105 patients.

5.1. Number of cases per year

One-hundred-and-five (105) patients were seen for maxillofacial management in the 10 year period under review. The range was from 4 to 19 cases per year with a mean of 10.5. Sixty-three of the 105 cases (60%) were recorded over the last four years. Nineteen cases (18.1%) occurred in 2000. Seventeen cases (16.2%) occurred in 2001; sixteen cases (15.2%) in 2002 and eleven cases (10.5%) in 2003. In 1999, the least number of cases, (n=4 or3.8%), were reported.

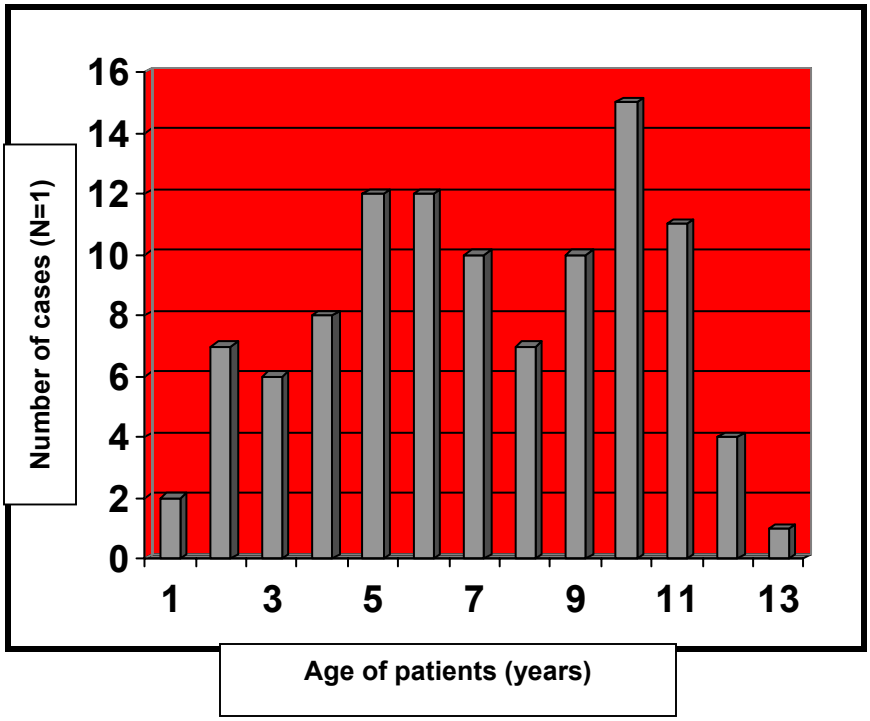
Graph 1: Number of cases presenting per annum



5.2. Gender and Age

Sixty five (61.9%) male patients and forty (39.1%) female patients comprised the study. The patients' ages ranged from 1 to 13 with a mean of 7.1 years. The majority of cases involved children in the age group of 5 to 11. The 5, 6 and 7 year old children and the 9, 10 and 11 year groups were most commonly injured. In this study, fewer 8 year old children sustained fractures. Only nine patients (8.6%) sustained fractures within the first two years of life, and five patients (4.8%) in the 12 to 13 age group, sustained fractures.

Graph 2: Number of cases at each Age



5.3. Aetiology

The most common cause of facial fractures was falls, the majority being playground incidents, but also present were injuries sustained in the home. Falls were implicated in forty (38.1%) cases. Motor vehicle injuries accounted for thirty nine (37.1%) cases, of which twenty two (21.0%) were pedestrians and seventeen (16.2%) were passengers. There were nine (8.6%) cases arising from assaults, one (0.9%) due to a gunshot wound, and one (0.9%) due to a sporting injury and in four (3.8%) cases, other factors were involved. These interesting aetiologies were:

1. A gate which had fallen onto the patient's face
2. Patient struck by a shopping trolley
3. Patient injured by bed springs
4. Patient head butted by a dog

AETIOLOGY	NUMBER OF PATIENTS	PERCENTAGE
Falls	40	38.1
MVA Pedestrian	22	21.0
MVA Passenger	17	16.2
Bicycle	11	10.5
Assault	9	8.6
Gunshot	1	0.9
Sport	1	0.9
Other	4	3.8
Total	105	100

Table 7: Frequency of aetiology

5.4. Region of referral

Patients are referred to the Red Cross Children's Hospital from the entire Province of the Western Cape Province. Most of the referrals though were from within the greater Cape Town area (the nearby suburbs) with occasional referrals from the outlying regions. Mitchell's Plain and Khayelitsha are the largest suburbs and it was therefore not surprising that the majority of cases are from these areas. Eighteen cases (17.1%) were reported to have occurred in Mitchell's Plain and sixteen cases (15.2) from Khayelitsha. Only seven cases (6.6%) were from a distance greater than fifty kilometers away from the Red Cross War Memorial Children's Hospital. There are primary and secondary level referral centres in many of the suburbs and it is quite likely that some cases are managed there during normal working hours of 08H00 to 16H00 from Monday to Friday. Maxillofacial services to the community in the outlying regions of the Western Cape, is offered only on a part time basis. Surprisingly very few cases that are treated at the Red Cross Children's Hospital came from areas more than fifty kilometres away from the Cape Metropole.

5.5. Site and Patterns of Fractures

The mandible was involved in 45 patients and the midface in 60 patients. Only 6 patients had both mandibular and midface fractures. There were 57 mandibular fractures and 70 midface fractures. In the mandible, there were 20 dentoalveolar fractures; 12 body fractures; 8 condylar fractures; 6 angle and 6 parasymphyseal fractures. Isolated condylar fractures occurred in 3 cases, in conjunction with parasymphyseal fractures in 3 cases and with body fractures in 2 cases. The symphyseal fractures occurred without other mandibular fractures but in 2 cases there were associated midface dentoalveolar fractures. Ramus fractures were rare, (only 1 case), and no coronoid fractures were reported. The midface was involved in 60 patients with 70 fractures recorded. There were 54 dentoalveolar fractures; 7 nasal fractures; 6 orbital fractures, and 3 zygomatic fractures. Two peaks were observed with orbital injuries: at ages 4/5 and at age 10/11. There were no records of frontal fractures, Le Fort I, II, or III type fractures or palatal fractures. Of the 105 cases recorded only 6 patients had midface and mandibular fractures. The midface component in 5 of these instances was a dentoalveolar fracture with one nasal fracture. The mandibular component of these fractures included 2 symphyseal fractures, 2 body fractures and 2 dentoalveolar fractures. The table below illustrates the frequency of fractures related to the sites involved.

MANDIBULAR FRACTURES			MIDFACE FRACTURES	
SITE	**FREQUENCY**		**SITE**	**FREQUENCY**
Dentoalveolar	20 (35.1%)		Dentoalveolar	54 (77.1%)
Body	12 (21.1%)		Nasal	7 (10.0%)
Condyle	8 (14.0%)		Orbital	6 (8.6%)
Angle	6 (10.5)		Zygomatic	3 (4.3%)
Parasymphysis	6 (10.5%)		**Total**	**70 (100%)**
Symphysis	4 (7.0%)			
Ramus	1 (1.8%)			
Coronoid	0 (0.0%)			
Total	**57 (100)**			

Table 8: Frequency of mandibular and midface fractures

5.6. Management of Fractures

Sixty-five (61.9%) of the patients required active maxillofacial intervention. This was done under local anaesthetic in 21 (32.3%) instances and under general anaesthetic in 43 (66.2%) cases. Only 1 (1.5%) case was treated under sedation. Extractions and debridement were needed in 25 (38.5%) cases; closed reduction was performed in 35 (53.8%) patients and open reduction in 5 (7.7%) patients. Duration of intermaxillary fixation was not recorded. Forty (38.1%) patients were managed non-surgically by medication, soft diet and reassurance. The nasal fractures were managed with medication and reassurance or closed reduction. These patients were referred to the Department of Otolarygology or Department of Plastic and Reconstructive Surgery rather than the Department of Oral and Maxillofacial Surgery.

PROCEDURE	FREQUENCY	PERCENTAGE
Non surgical	40	38.1
Extractions/debridement	25	23.8
Closed reduction	35	33.3
Open reduction	5	4.8
Total	105	100

Table 9: Frequency of Surgical and Nonsurgical procedures

6.0. DISCUSSION

There is agreement in the literature that maxillofacial fractures in children are uncommon [(MacLennan WD (1956), Rowe NL. (1969), Thoren H, Iizuka T, *et al.* (1992), Tanaka N, Uchide N, *et al.* (1993), Haug HR, Foss J. (2000) and Iida S. (2002)]. In the ten-year period under investigation this study reports a similar experience. It is estimated that the Red Cross Children's Hospital trauma unit treats in excess of ten thousand patients each year. Only about 10 cases a year involve fractures of the maxillofacial skeleton. This constitutes only 0.1% of the patients seen at this unit. However when considering all injuries to the maxillofacial region, this percentage is bound to be higher.

6.1. Number of cases per year

Records accessed in this study show an increase in the number of cases of maxillofacial fractures presenting over the past 4 years. The reasons for this are a matter of speculation. It could be due to:

1. Inadequate reporting in previous years
2. A definite increase in the number of cases seen
3. Improved triage and appropriate referral
4. Improved record keeping and data capturing

Record keeping at RXH has become more efficient. The office of the Child Accident Prevention Foundation of South Africa was started in 1978. According to Nelmarie du Toit of this foundation, electronic recording of information commenced in 1991, however it has only been reliably operational since 1999.

More recently, in patients with head injuries, computerized tomography scans have been performed to include the facial bones. This has facilitated the detection of midface fractures.

6.2. Age

There are no established criteria defining the age groups studied, with the upper limits varying to a maximum of 18 years, in the articles reviewed in this study. Thoren H, Iizuka T*, et al.* (1992) suggested that a decisive limit seems to be 10 years of age since the aetiologies and fracture patterns after this age become similar to those of young adults. Iida S. (2002) found that patterns and aetiologies in patients older than 13 years resembled those of adolescents. He suggested that the decisive limit be 13 but cautions that they may vary from country to country and educational and socio-economic environments.

This study evaluated facial fractures in children between the ages of 1 to 13 years. The mean age was 7.1 years. Fractures in the first three years of life are rare occurrences. This study found fractures that 15 of the 105 patients who had facial fractures were younger than 3 years of age.. The majority of fractures in this study occurred in the age group of 5 to 11. This could be due to the increased socialization within these groups. Posnick JC, Wells M, Pron GE. (1993) reported a peak incidence in the age group of 6 to 12. Guven O. (1992) reported a peak incidence in the 6 to 8 year age group. This finding differs from that in my study where there appears to be a decrease in the number of 8 year old patients with facial fractures. In the South African study by Bamjee Y, Lownie JF, et *al*. (1996) the peak reported was in the age group of 12 to 18, but their findings are more in keeping with an adult population rather than in a pediatric sample.

Table 10 illustrates the differences in the age groups studied.

REPORT	YEAR	AGES
MacLennan WD	1956	6 years and younger
Rowe NL	1969	6-11
Chidzonga MM	1987	0-16
Tanaka N, Uchide N. *et al*	1993	1-15
Bamjee Y, Lownie JF. *et al*	1996	Birth to18
Thoren H, Iizuka T, *et al.*	1997	Under the age of 16
Iida S.	2002	Under the age of 16
Aniruth S.	**2005**	**1 to 13**

Table: 10: Comparison of studies with regard to Age of patient

6.3. Gender

Almost all studies report a male preponderance, as does this study. The only report encountered that suggesting that female patients were more frequently injured, was that of Kaban B. (1993) who cited the study of Waldron (1943) describing 5 female and 2 male patients. This unusual ratio may be attributed to the small number of cases. It is very likely that male patients are more prone to facial fractures because the physical activities they are involved in still tend to be more robust than those that female patients are involved in. However, while this may be so for the daily activities this may not hold true for motor vehicle accidents and the reason for the male predominance remains an area of speculation.

STUDY	YEAR	COUNTRY	MALE: FEMALE
Chidzonga MM.	1987	Zimbabwe	2:1
Tanaka N, Uchide N, *et al.*	1993	Japan	2:1
Posnick JC.	1994	Canada	1.7:1
Bamjee Y, Lownie JF, *et al.*	1996	South Africa	2.3:1
Thoren H, Iizuka T, *et al.*	1997	Finland	1:0.7
Iida S.	2002	Japan	2:1
Gassner R, Tuli T, *et al.*	2002	Austria	1.8:1
Aniruth S.	**2005**	**South Africa**	**1.6:1**

Table 11: Comparison of studies with regard to Gender

6.4. Aetiology

In this study the predominant cause of facial fractures was falls, usually from normal playing activities. Motor vehicle accidents (where the patient has been a pedestrian or a passenger) were the second most common cause. Bamjee Y, Lownie JF, *et al.* (1996) reported a similar trend in their study but also reported violence as a common cause in their teenage group. In this study the patient population is prepubertal and violence was reported in only 9 cases. Of these 9 cases reported due to assault, the perpetrators were older children striking younger children with blunt objects such as rocks or bricks. There was no report of children struck by abusive parents and certainly no paper trail existed in the documentation suggesting a definitive course of action against a suspected case of abuse. Studies show that the most common causes of facial fractures in children are falls and traffic accidents (Guven O. 1992; Thoren H, Iizuka T, *et al.* 1992; Kaban B. 1993; Tanaka N, Uchide N, *et al.*1993; Iizuka T, Thoren H, *et al.* 1995; Iida S. 2002; Gassner R, Tuli T, *et al.* 2004).

The incident of a gunshot injury was that of the patient being caught in shootout crossfire and such causes are not commonplace among children. It seems endemic in our adult population, as our department certainly treats many cases of gunshot injuries in adults. Socio- economic conditions must surely play a role in the aetiology and with the lack of proper recreation facilities in the lower socio-economic communities, encourage many children to play in the streets. As such they are at risk of being involved in a motor vehicle accident. Furthermore, playgrounds where available, are seldom if ever, properly maintained in the poorer suburbs. Hence the children are at risk of injury. Lack of parental supervision in many instances may also be responsible for injury to children. Iida S (2002) reported that bicycle accidents were the most common cause of fractures in children in his sample. He suggests that the aetiology of facial fractures in children will change. He postulates that with the popularity of television and computer games

Japanese children spend more time indoors than before. With the present expense of those luxuries in South Africa I would venture that such a change here in the Western Cape will be more than an entire generation away, for the less fortunate among us. I may however be beginning for the more affluent. The fact that no cases presented to the unit from the more affluent communities, is probably due to them seeking management in the private sector.

STUDY	**A**	**B**	**C**	**D**
No of Cases	326	138	review	**105**
Aetiology	**Percentage Incidence**			
Falls	14.7	13	7.8-48	**38.1**
MVA	24.8	18	5-80.2	**37.2**
Bicycle	4.0	48	7.4-48	**10.5**
Assault	47.5	5	3.7-61.1	**9.5**
Sport	7.7	15	1.2-33	**0.9**
Other	1.3	1	4.5-23	**3.8**

Table 12: Comparison of aetiology A: Bamjee Y, Lownie JF, *et al.* 1996; B: Thoren H, IizukaT, *et al.* 1997; C: Haug HR, Foss J. 2000; D: Aniruth S. 2005

6.5. Patterns of maxillofacial fractures

The literature indicates that as patients increase in age the patterns of fractures progressively resemble that of the adult patient. (Thoren H, Iizuka T, *et al.* 1992; Tanaka N, Uchide N, *et al.* 1993; Iizuka T, Thoren H, *et al.* 1995; Infante CP, Espin GF, *et al.* 1994) Patterns of fractures in children are determined to a large extent by the stage of development of their anatomical features. With the established cephalo-caudal growth gradient in humans, the forehead and midface are more prominent facial features of the younger child. Therefore they are more easily traumatized. Further features of elasticity of the bone, sinus development and stages of development of the dentition influence the fracture patterns.

McGraw BL, and Cole RR. (1990), report that fractures shifted from the upper to the lower region of the face with increasing age and orbital injuries were more common in younger children and mandibular fractures in the older age group.

In this study midface fractures were far more common in the patients between the ages of 1 to 5 and as the ages increased mandibular fractures began to predominate.

This study reported similar experiences to those of Iida S. (2002); Posnick JC. (1994); Tanaka N, Uchide N *et al.* (1993), with regard to the predominance of the dentoalveolar component being fractured. It differed from the studies of Bamjee Y, Lownie JF, *et al.* (1996), and Guven O. (1992) in that midface fractures were more common than mandibular fractures.

6.5.1. Mandibular fractures

Thoren H, Iizuka T, *et al.* (1997); Tanaka N, Uchide N, *et al.* (1993); Iida S. (2002) and Guven O. (1992) reported condylar fractures as the most common fractures. Haug HR, Foss J. (2000) from their analysis of multiple studies, suggest that the condylar region is the most commonly injured region of the mandible. This finding was not evident in this study where dentoalveolar fractures predominated, followed by body fractures and only then by condylar fractures. Further differences existed with regard to the relationship between condylar fractures and other sites. Whereas their experience was that condylar fractures occurred together with symphyseal fractures, none of the condylar fractures in the current study had an associated symphyseal fracture. There were associations with the body (2 0f 8 cases), parasymphysis (in 3 cases) and without other site involvement in 3 cases. The symphyseal fractures were single fractures. Admittedly these numbers are small and in a larger series it could well be similar to the previously published experiences. The comparison table below illustrates the differences.

SITE	HAUG HR, FOSS J. (2000)	ANIRUTH S. (2005)
Condyle	14.5 to 60	**14.1**
Alveolus	8.1 to 50.6	**35.1**
Body	5.6 to 44	**21.1**
Symphysis	1.8 to 40.4	**7.1**
Parasymphysis	23.9 to 33.7	**10.1**
Angle	3 to 27	**10.1**
Ramus	0.75 to 10	**1.2**
Coronoid	0 to 19	**0**

Table 13: Comparison of Studies with regard to mandibular sites and patterns

6.5.2. Midface fractures

Kaban B. (1993) claims that midface fractures in children including nasal, zygomatic complex, Le Fort-type and nasoethmoidal fractures have recently been reported more frequently but does not offer a reason for this. Haug HR, Foss J. (2000) review of midface fractures suggested that the maxilla is the least frequently injured pediatric facial bone. However if the dentoalveolar component is considered then the Red Cross Hospital study indicates that the maxillary dentoalveolar fracture is by far the commonest fracture of the midface. Indeed this study showed that of the 70 midface fractures reported, 54 (77.1%) were of the dentoalveolar region. Furthermore these fractures did not predominate in a particular age group and was spread throughout the age range. This pattern should be unsurprising as it is clearly evident that the anterior dentoalveolar region is very prominent in the age group considered in this study, and thus at risk for injury.

SITE	HAUG HR, FOSS J. (2000) %	ANIRUTH S (2005) %
Dentoalveolar	5 to 65	**77.1**
Nasal	1 to 45	**10.0**
Orbital	10 to 13	**8.6**
Zygomatic	7 to 41	**4.3**

Table 14: Comparison of studies with regards to midface sites and patterns

Le Fort I, II, III fractures have been reported in other studies (Haug HR, Foss J. 2000) but are unrecorded in the Red Cross Children's Hospital sample. The maxillofacial unit was rarely if, ever, called to assess nasal fractures. These fractures were managed by

the Department of Plastic and Reconstructive Surgery or by the Department of Otolaryngology. Fractures of the frontal bone were similarly not referred directly to the maxillofacial unit, but rather preferentially to the Department of Neurosurgery. These patients inevitably would require neurologic observations and stabilization before any maxillofacial intervention. It is possible that these patients usually have significant head injuries and were sent for neurological observations from the trauma unit without input from the maxillofacial surgeon. The receiving trauma officer may not have recorded them as having had any maxillofacial fractures. This may also explain why no records of frontal fractures have been reported from the referrals to maxillofacial surgery by the trauma unit at RXH.

7.0. MANAGEMENT

7.1. Non-Surgical

The management of maxillofacial fractures at the Red Cross Children's Hospital follows the universally accepted range of non-surgical and surgical treatment options.

Non-surgical management is the term preferred to the term conservative management, as this latter term seems to be finding increasing disfavour within the profession. Non-surgical management ranges from no treatment, to treatment of the patients with medication, diet counseling, and (often) reassurance. The medication prescribed or administered are usually antibiotics, analgesia and an oral rinse.

7.2. Surgical

Surgical intervention involves extractions and debridement, closed reduction or open reduction. In those instances where the injury presents a hopeless prognosis to the dentition there is no alternative but to perform extraction of the teeth and sometimes enucleation of the dentoalveolar segment. Great care is always taken to prevent excessive tissue (bone and mucosa) loss. Closed reductions are performed with the use of either eyelet interdental wires or with arch bars on the dentition. The application of arch bars or eyelets is very dependent on the presence and state of the dentition. Intermaxillary (or as some surgeons prefer the term mandibulomaxillary) fixation is performed by means of straight wires or elastics. Elastics are applied in most cases that involve condylar fractures and were maintained for a period of between 2 to 4 weeks. Shorter fixation periods were used for the condylar fractures as early mobilization and function is encouraged in these patients. Removal of the arch bars and eyelet wires is performed under general anaesthetic on an outpatient basis.

Open reductions are performed using the already established and widely performed techniques of titanium plates and screws for osteosynthesis. No preference is given to any particular plating system. As yet no biodegradable implants have been used for direct bony osteosynthesis, of maxillofacial fractures, at the Red Cross Children's Hospital. A reason for this could be that no plating company has as yet, formally presented this product for placement on the tender list. The tender process is utilized at the public institutions, when acquiring materials, equipment or services. Another reason could be the perceived increased cost of the bioresorbable plating system.

Imola MJ, Hamlar DD, *et al*. (2001) reported on the use of bioresorbable plate fixation in pediatric craniofacial patients and claim it an excellent means of avoiding problems of plate "migration" seen with rigid metal plates. Initially, the use of these plates in the high stress and load-bearing areas had not been extensively studied and even the producers of the product did not offer them as an indication in these regions thereby cautioning their use in the mandible even in children. During the presentations at the General Principles in Craniomaxillofacial Surgery Course of the AO (Association of Osseointegration) in Davos, Switzerland held December 2004, there was discussion on rigid fixation techniques. The following concerns regarding the biodegradeable implants were raised.

1. The adequacy of strength for load bearing and high stress areas
2. The bulk of the implant and its placement in the mandible especially with regard to the developing dentition and the extensive stripping of the periosteum for placement of the implant
3. The adequacy of the initial rigid fixation and subsequent loss of strength as the implant loses it rigidity and begins its resorptive process

4. The persistence of the material despite the claims of complete disappearance of the material with 18 to 24 months as claimed by the producers
5. The present increased costs of the material, cumbersome handling and the need to overcome the learning curve as expected with all new techniques.

Even with these concerns however, resorbable plates are becoming the next generation of implants for the rigid internal fixation of facial fractures and increasing successes are being reported in the literature, even in the load and stress bearing areas. Eppley BL, Morales L, *et al.* (2004) reported that the use of resorbable plate and screw devices offered all of the benefits of rigid fixation without many of their potential risks and documented the safety and long-term value of the use of resorbable (LactoSorb) plate and screw fixation in pediatric craniofacial surgery in the infant and young child.

A study undertaken to determine whether a resorbable poly-l-lactide (PLLA) miniplate system could be used to treat mandibular condylar process fractures showed that the PLLA miniplate system provided reliable stability when used for the fixation of mandibular condylar process fractures (Suzuki T, Kawamura H, *et al.* 2004).

Yerit KC, Enislidis G, *et al.* (2004) studied the stability of biodegradable, self-reinforced poly-L-lactide plates and screws for the internal fixation of fractures of the human mandible and concluded that self-reinforced biodegradable osteosynthesis materials provided a reliable and sufficient alternative to conventional titanium plate systems.

The resorbable polymer-based plates and screws tested in their investigation were reported to be of adequate strength and stiffness for the successful application to the rigid fixation of mandibular angle fractures (Cox T, Kohn MW, Impelluso T. 2003).

Certainly in the teaching institutions in the Western Cape, the use of resorbable plates and screws is not an active part of the training and no data exists with regard to their use in these centres.

7.3. Type of Anaesthesia

General anaesthesia is the predominant choice in the management of patients with facial fractures even for closed procedures. The determination of whether the choice of local or general anaesthesia is chosen as the treatment option is related largely to patient compliance, extent of injury, and method of reduction. Injured children are difficult to manage under the best of times and it is unlikely that a child will be compliant while some surgical intervention is being performed. At RXH removal of intermaxillary fixation arch bars or eyelets are also removed under general anaesthetic. For less severe injuries and in compliant patients local anaesthetic is the first consideration.

There has been increasing use of conscious sedation at the Faculty of Dentistry of University of the Western Cape. Furthermore, in an attempt to reduce costs, many third party funders are now encouraging the use of conscious sedation as an alternative to general anaesthetic for certain surgical procedures. Such a facility is not operational at the Red Cross Children's Hospital, so the choice is one of no anaesthesia, local anaesthetic or general anaesthetic.

7.4. Post operative follow up

Patients are followed up on a weekly basis by the maxillofacial or plastic surgery registrars. They are discharged from maxillofacial care upon removal of arch bars or eyelets and if the fracture has been successfully treated. This follow up period is between 4 to 6 weeks. Surprisingly none of the 105 records reviewed made mention of any complications. Kaban B. (1993) reports that with rigid internal fixation on the facial skeleton, infection, ankylosis and abnormal growth effects remain a significant problem. These need to be assessed and managed.

This information was not properly documented in the records accessed. Therefore this study is not able to report on complications stemming from the treatments performed. The Faculty of Dentistry of the University of the Western Cape offers a dental service to the Red Cross Children's Hospital and has a dental clinic at the hospital. Unfortunately it is not fully utilized for the post operative dental needs of the patients and there is no team approach to these patients.

8.0. CONCLUSIONS

From this study the following conclusions can be made:

8.1. Maxillofacial Fractures in children attending the Red Cross Children's Hospital is uncommon. This is in keeping with international trends

8.2. Dentoalveolar fractures are the most common maxillofacial fractures seen in children at this institution

8.3. Midface fractures were more common than mandibular fractures at this institution. This differs from most other studies.

8.4. Almost 40% of fractures needed no surgical intervention, and over 90% of fractures could be managed by closed reduction which is in keeping with international trends

8.5. When surgical intervention is needed most patients require a general anaesthetic

8.6. Open reduction and internal rigid fixation is managed by way of titanium plates and screws

8.7. There is little or no involvement of the Department of Oral and Maxillofacial Surgery Department, in Nasal or Frontal fractures at this Institution.

8.8. There is no team approach to managing pediatric facial fractures. Management is performed largely by only one person: the registrar on call.

9.0. RECOMMENDATIONS

9.1. Maxillofacial assessment is needed in Nasal and Frontal fractures to detect or exclude other maxillofacial fractures

9.2. Greater involvement and support from the Dental department toward establishing a team approach in managing maxillofacial fractures in children, especially the post operative needs.

9.3. With the establishment of a sedation unit at the Dental Faculty the removal of wires and arch bars, at the end of treatment, at this facility may offer another option to the need for a general anaesthetic for this procedure.

9.4. The role of resorbable plates has not yet been established in South Africa but is becoming the norm internationally. This being a teaching and training institution, such techniques need to be taught to the next generation of surgeon. With the small number of cases needing open reduction and internal fixation, this will not be so immense a financial burden.

10.0 APPENDICES

Appendix 1

PROFORMA

Folder Number: _____ Case No _____

1) Age of patient (at time of injury) _____ years

2) Area / Suburb of residence _____

3) Gender of patient

1	Male	2	Female

4) Aetiology

1	Motor vehicle
2	Pedestrian
3	Bicycle
4	Falls (playground)
5	Assault
6	Gunshot
7	Sport
8	Other

5) Site

A; Mandible

1	Dento-alveolar	4	Angle	7	Coronoid
2	Symphysis	5	Ramus		
3	Body	6	Condyle		

B: Midface

1	Dento-alveolar	5	Zygoma
2	Le fort I	6	Orbital
3	Le fort II	7	Naso /ethmoidal/ orbital/frontal
4	Le fort III	8	Nasal

6 Management

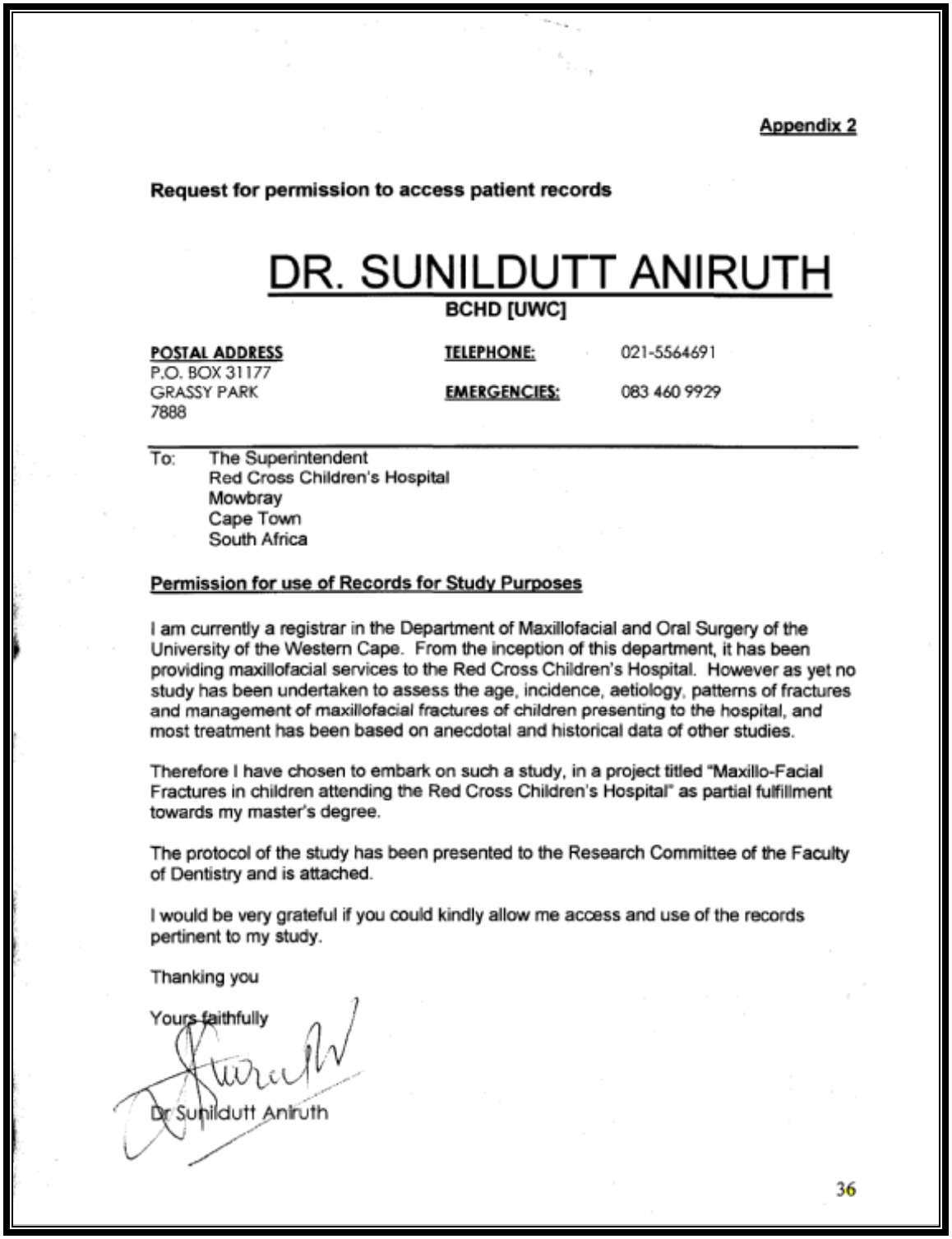
A: Anaesthetic

1	None	2	Local	3	General	4	Sedation

B: Technique

1	Non surgical	2	Extractions	3	Closed reduction	4	Open reduction

Request for permission to access patient records



Appendix 2

Request for permission to access patient records

DR. SUNILDUTT ANIRUTH

BCHD [UWC]

POSTAL ADDRESS
P.O. BOX 31177
GRASSY PARK
7888

TELEPHONE: 021-5564691

EMERGENCIES: 083 460 9929

To: The Superintendent
Red Cross Children's Hospital
Mowbray
Cape Town
South Africa

Permission for use of Records for Study Purposes

I am currently a registrar in the Department of Maxillofacial and Oral Surgery of the University of the Western Cape. From the inception of this department, it has been providing maxillofacial services to the Red Cross Children's Hospital. However as yet no study has been undertaken to assess the age, incidence, aetiology, patterns of fractures and management of maxillofacial fractures of children presenting to the hospital, and most treatment has been based on anecdotal and historical data of other studies.

Therefore I have chosen to embark on such a study, in a project titled "Maxillo-Facial Fractures in children attending the Red Cross Children's Hospital" as partial fulfillment towards my master's degree.

The protocol of the study has been presented to the Research Committee of the Faculty of Dentistry and is attached.

I would be very grateful if you could kindly allow me access and use of the records pertinent to my study.

Thanking you

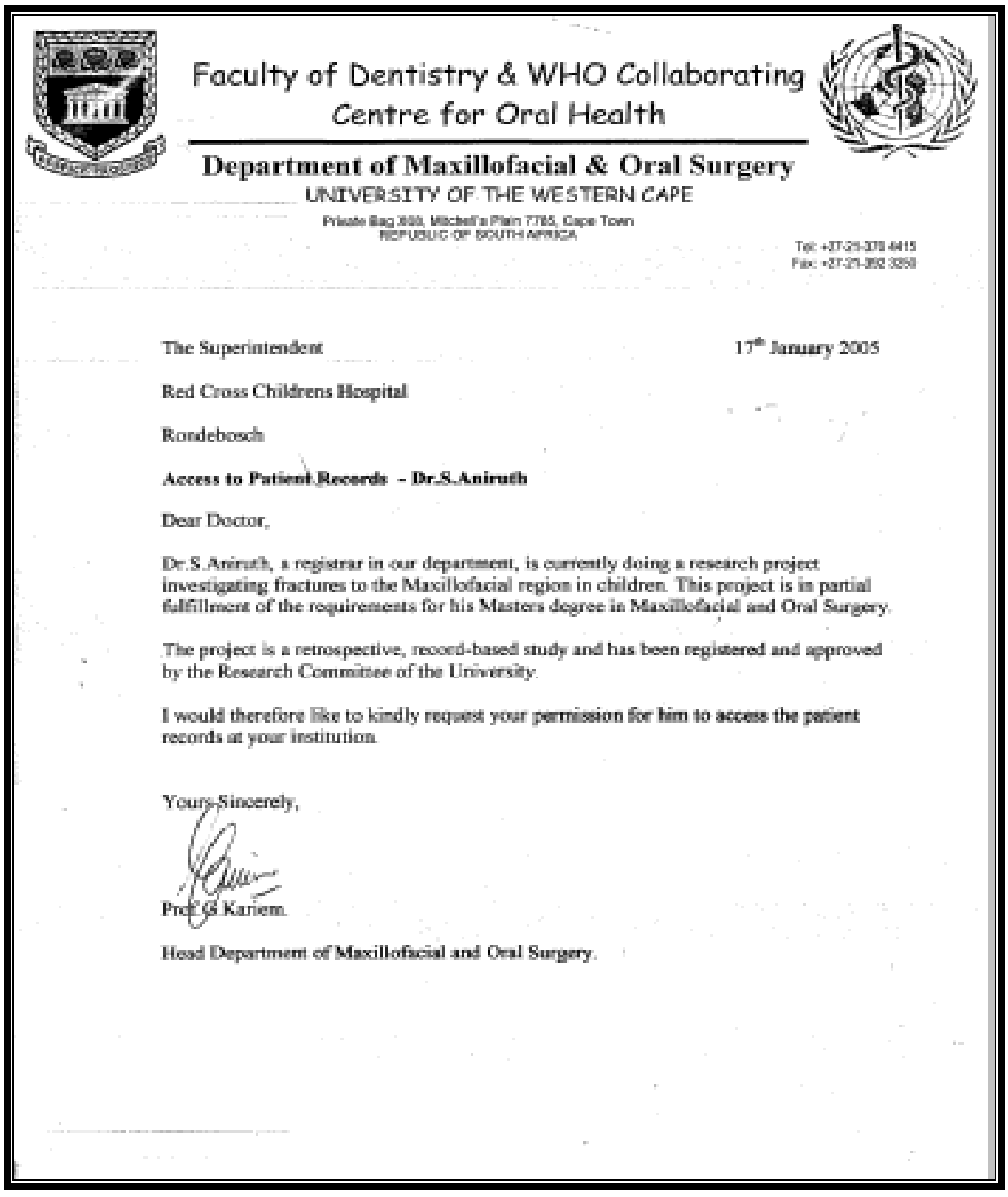
Yours faithfully

Dr Sunildutt Aniruth

36

Appendix 3

Request from Chief Supervisor to Superintendent



Faculty of Dentistry & WHO Collaborating Centre for Oral Health

Department of Maxillofacial & Oral Surgery

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The Superintendent

17th January 2005

Red Cross Childrens Hospital

Rondebosch

Access to Patient Records – Dr.S.Aniruth

Dear Doctor,

Dr.S.Aniruth, a registrar in our department, is currently doing a research project investigating fractures to the Maxillofacial region in children. This project is in partial fulfillment of the requirements for his Masters degree in Maxillofacial and Oral Surgery.

The project is a retrospective, record-based study and has been registered and approved by the Research Committee of the University.

I would therefore like to kindly request your permission for him to access the patient records at your institution.

Yours Sincerely,

Prof S Kariem.

Head Department of Maxillofacial and Oral Surgery.

Appendix 4

Letter of Authorization for use of records

NAVRAE:
ENQUIRIES: Dr KR Ramiah
IMIBUZO:

TELEFOON:
TELEPHONE: 021 658 5005
IFONINI:

FAKS:
FAX: (021) 685 5096
IFAX:

VERWYSING:
REFERENCE: Research
ISALATHISO:

DATE: 17 January 2004

PROVINCIAL ADMINISTRATION: WESTERN CAPE
Department of Health

PROVINSIALE ADMINISTRASIE: WES-KAAP
Departement van Gesondheid

ULAWULO LWEPHONDO: INTSHONA KOLOMI
Isebe Lezempilo

Dr Sunildutt Aniruth
PO Box 31177
Grassy park
7888

Dear Dr Aniruth

ACCESS TO HOSPITAL RECORDS

Thank you for submitting your request to use patient records for your study.

Permission is granted for you to review the patient folders/records at Red Cross War Memorial Children's Hospital. Please notethat-

1. No folders may leave the hospital
2. Acknowledgement will be appreciated
3. A copy of your final report will be appreciated.

Wishing you a successful completion of your research project.

Yours sincerely

Dr K R Ramiah
Senior Medical Superintendent

c.c. Marc Meldau
Norma Esau

KRamiah Research Aniruth 17 1 05

Appendix 5

Permission for use of photographs

DR SUNILDUTT ANIRUTH

BCHD (UBC)

Pr. No. 5459004

ADDRESS	TELEPHONE
P.O. BOX 31177 GRASSY PARK 7888	021 5564691 0834609929

AUTHORIZATION FOR USE OF PHOTOGRAPHS

I LUCINDA CORNELIUS (full name) the legal parent/guardian of KEVIN CORNELIUS,

hereby grant permission to Dr Sunildutt Aniruth, to take clinical photographs of my child/ward.

He may use them for academic purposes in print or electronic or other media and may share this information with professional colleagues. I further acknowledge that I will receive no financial or other reward for allowing this permission.

Furthermore, I hereby indemnify him of any, and all claims that may arise from the use of these photographs, irrespective of the manner in which they may arise.

Signed: L CORNELIUS

Witness 1: [signature] Witness 2: [signature]

Name: BELINDA JANSEN Name: [illegible]

Date: 31/01/15

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