UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

ADEQUACY OF NUTRITIONAL SUPPORT IN ORAL AND MAXILLOFACIAL RESECTED AND RECONSTRUCTED PATIENTS WITH ODONTOGENIC TUMOURS

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master in Dentistry

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DECLARATION.

I, Mbali Thembekile Nkonyane declare that this research report is my own work. It is being submitted for the Master of Dentistry at the University of the Witwatersrand. It has not been submitted before for any degree or examination at any other Institution.

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DEDICATION.

To my parents for their undying love, support and for being such excellent role models.

To my son for the unconditional love that he has given me.

ABSTRACT

Introduction

Malnutrition is an important risk factor for weakening of the host immune defence system and increasing complications in the surgical patient. In addition, swallowing and difficulty in mastication in patients with maxillofacial neoplasms often result in insufficient feeding and subsequent weight loss. Despite this, there is a world-wide paucity of studies in the literature reporting on pre-operative and post-operative nutritional support in patients with maxillofacial tumours.

Aim of the study

This study was undertaken to review and assess the adequacy NG feeding protocol in patients with odontogenic tumours in our unit

Material and Methods

This was a prospective observational study of patients who underwent resection of benign odontogenic tumours of the mandible and reconstruction of the resultant defect with autogenous bone at CHBAH and CMJAH over a six-month period. In this study, a bio-electrical impedance analysis machine (BIA), which measures the weight (kg), height (cm), body mass index (BMI), body fat (kg), muscle mass (kg) and total body water (%), was used pre-operatively to assess the body weight and composition. Post-resection or reconstruction of the defect, the patients were

placed into intermaxillary fixation (IMF) intraoperatively. At the same time a thin, small bore polyurathane tube, the naso-gastric tube (NGT) was inserted and enteric feeds were initiated within the first 24hrs post-operatively. The aim was to deliver 25Kcal/Kg/Day of NGT feeds for a maximum of 7 days. All the body compositions were recalibrated immediately after the removal of the NGT after 7 days.

Results

21 patients were included in this study (14 females and 7 males at 66% and 33% respectively). Ameloblastoma resection was the most common surgical procedure among the patients (61.9%). Post-surgically, all the body composition measures except body water decreased. The weight, muscle mass and BMI all decreased by the same amount which was 4.17%.

A paired t-test pre-operatively and post-operatively showed that there was a statistically significant 2Kg decrease in the muscle mass of the female patients seven days post-surgery. Males lost a mean body fat of 2.01Kg which was statistically significant.

Conclusion

All the patients lost both body fat and muscle mass during the 7 days post-operatively, despite being on high protein fiber containing naso-gastric feeds. These results suggest that the current feeding formula of 25Kcal/kg/hr may be inadequate in this study population. There was also a significant difference between males and females, suggesting that the delivery of nutrition should be modified according to gender or even more importantly, possibly rather be calculated according to the specific nutritional needs of the individual patient.

ACKNOWLEDGMENTS.

To the Head of Oral Sciences, Prof S Nemutandani, thank you for granting me permission to conduct my study.

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ADEQUACY OF NUTRITIONAL SUPPORT IN ORAL AND MAXILLOFACIAL RESECTED AND RECONSTRUCTED PATIENTS WITH ODONTOGENIC TUMOURS

CHAPTER 1

1.1 SURGICAL INTRODUCTION AND BACKGROUND

Odontogenic tumours are lesions derived from epithelial, ectomesenchyme and/or mesenchyme elements that are still or have been part of the tooth-forming apparatus (Barnes *et al.,* 2005). These tumours, although benign, have a locally aggressive course and may grow to reach grotesque proportions, sometimes causing disfigurement of the face (Figure 1.1), displacement of teeth, leading to difficulty in feeding (Figure 1.2),+ even massive destruction and bone expansion as shown by the 3D-scan in Figure 1.3. Several types of odontogenic tumours are described in the literature. The most common being the conventional or solid and multicystic ameloblastoma which accounts for 1% of all oral tumours of the jaws (Mosadomi, 1975). Several surgical techniques have been suggested including curettage, cauterization, enucleation and marginal resection with preservation of the lower border of the mandible. The treatment of choice in large tumours usually entails

resection of the tumour along with the portion of the jaw involved, in order to achieve tumour free margins (Figure 1.4). The general consensus is a 1-2cm tumour free margin beyond the clinical and radiographic margins (Olaitan *et al*., 1993).

Subsequently, reconstructive surgery is performed in order to rehabilitate the patient by restoring function and aesthetics. Several reconstructive options are available including a free vascularized flap, grafting with cortical cancellous bone or distraction transport osteogenesis. Although these treatment options have been used successfully, they also bear both donor and recipient site complications and patient morbidity. Immense and meticulous care should be taken to reduce the risk of complications and aid the patient to an uneventful recovery as soon as possible.

Patients who have had oral surgery however face many metabolic and physiological changes, which may compromise their nutritional status. Nutritional Support Therapy (NST) is part of Nutrition Therapy which is a component of medical treatment that can include oral, enteral and parenteral nutrition to maintain or restore optimal nutritional status. The inadequacy of nutrition for 7-10 days, especially in a period of increased metabolic demands during post-operative recovery can result in increased complications and mortality rates in patients not receiving sufficient nutritional support. Consistent with this, the guidelines of the American Society for Parental and Enteral Nutrition (A.S.P.E.N) recommends early initiation of nutritional support after surgery for patients unable to take adequate oral nutrition (A.S.P.E.N, 2002). Importantly,

poor nutritional status can compromise the function of many organ systems and predispose the patient to poor healing as well as susceptibility to infections. These factors may therefore lead to prolonged hospital stay, higher re-admission rates and markedly increased health costs.

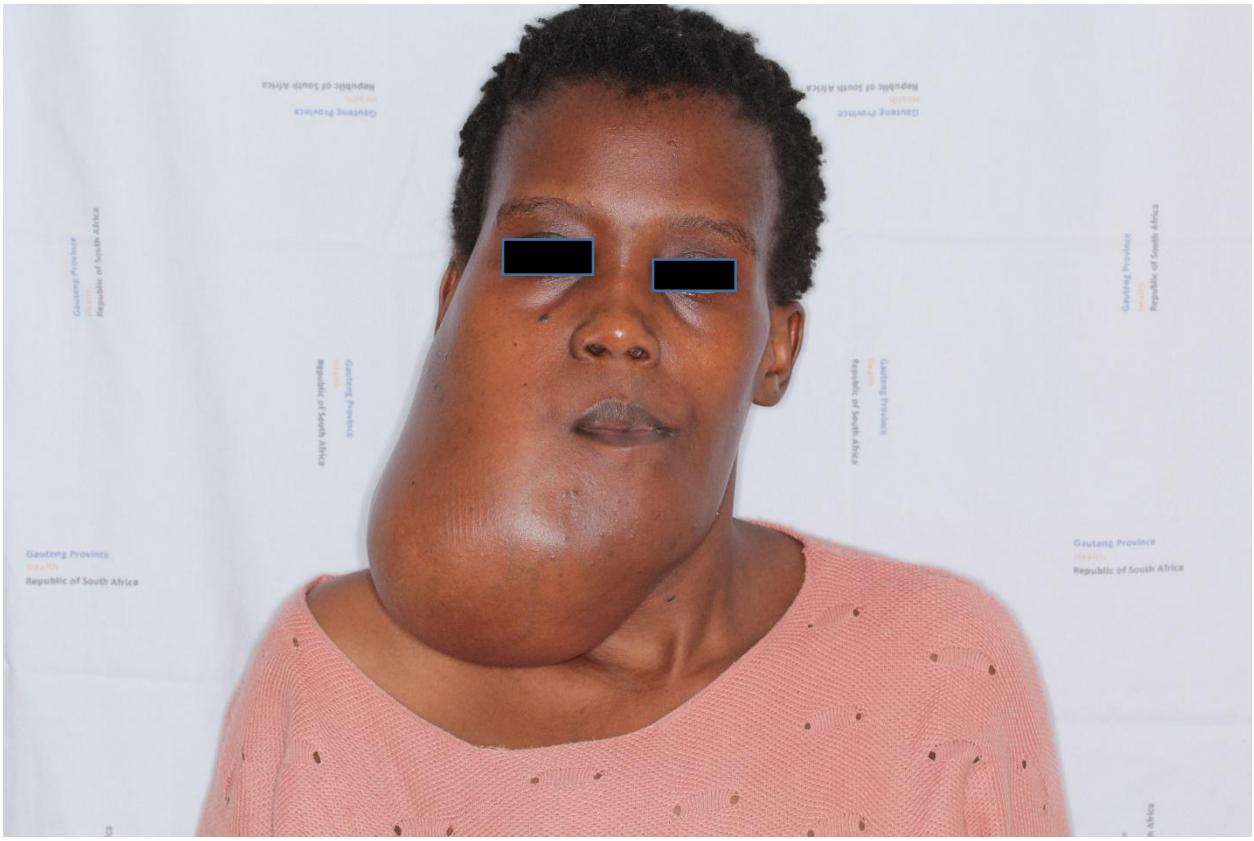

Fig. 1.1: Patient with facial disfigurement due to long standing ameloblastoma (with patient consent to Primary Investigator).

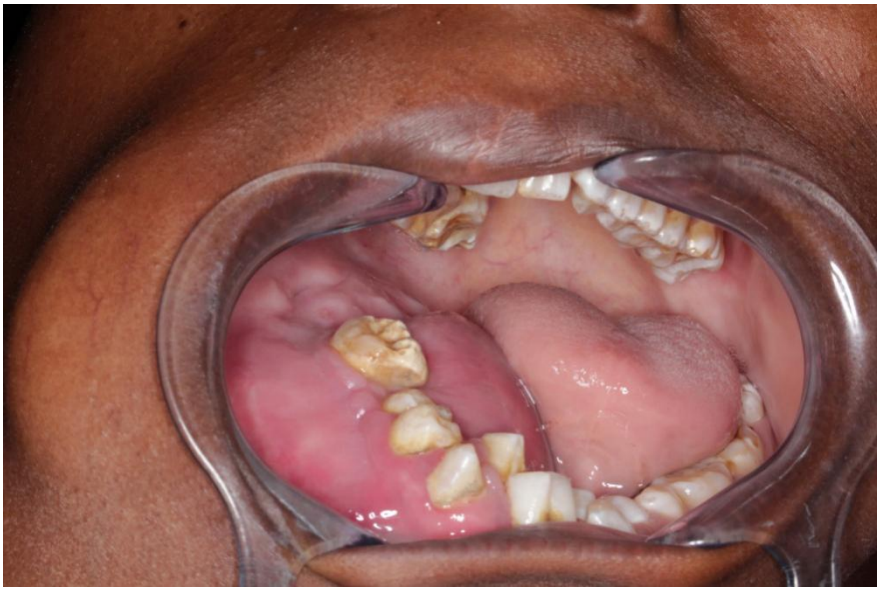

Fig.1.2: Intra-oral picture demonstrating displacement of teeth and the tongue, leading to difficulty in feeding.

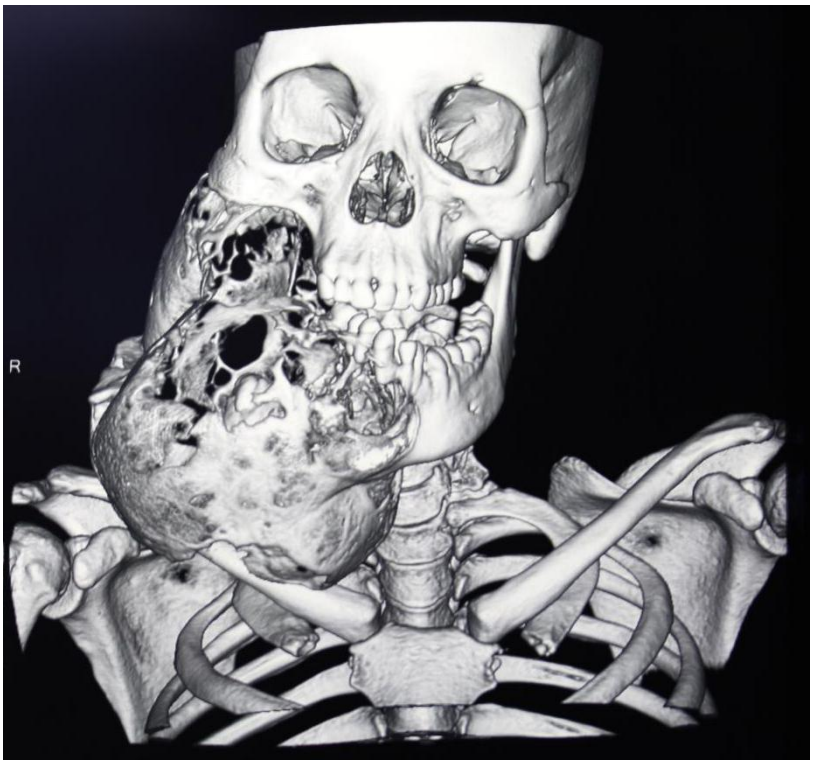

Fig.1.3: 3D scan, showing massive destruction and bone expansion

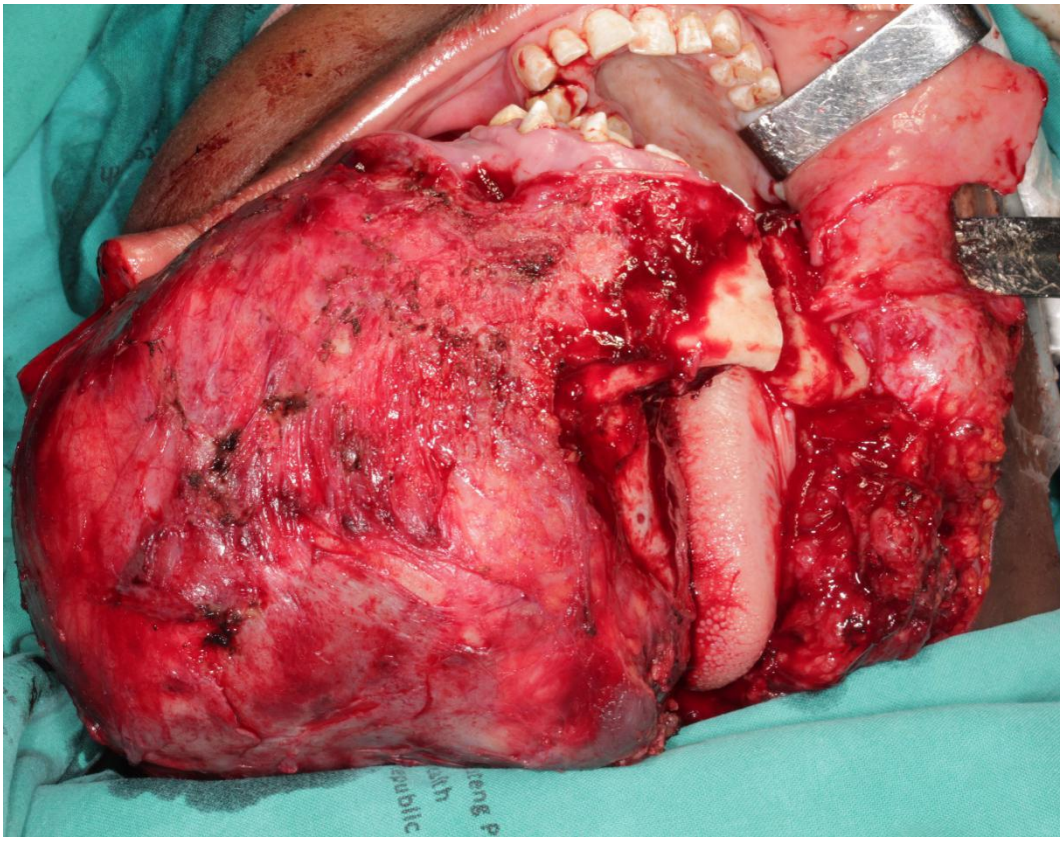

Fig.1.4: Intra-operative resection of the tumour.

1.2 NUTRITION

Experts define malnutrition as an “acute, sub-acute or chronic state of nutrition, in which varying degrees of over-nutrition or under-nutrition with or without inflammatory activity have led to a change in body composition and diminished function” (A.S.P.E.N, 2010). Patients with medical conditions of prolonged duration such as those with benign tumours of the jaws, usually present with a catabolic state as a result of poor nutritional intake. These alterations, which are characteristic of protein calorie malnutrition, increase the risk of infection, weaning time in patients who are ventilator dependent, duration of hospital stay and mortality (Jeejeeboy *et al.,* 2000).

It has been proven in several studies that poor nutrition is associated with a variety of post-operative complications and that it plays a role in the development of post-operative complications (Stableforth *et al.,* 2009, Bozetti *et al.,* 2007, Lewis *et al.,* 2006 and Eley *et al.,* 2012). Importantly, peri-operative nutritional support of patients with oral and maxillofacial carcinoma must be properly managed (Chuen-Bin-Guo *et al.,* 2006). It was shown in a randomized trial comparing peri-operative standard polymetric nutrition to no nutritional supplementation in the treatment of patients with head and neck carcinoma that peri-operative immunonutrition was associated with a reduced length of hospital stay (Stableforth *et al.,* 2009).

Furthermore, the role of nutritional support was investigated on post-operative complications with regards to demographic and nutritional factors, intra-operative factors, types and routes of nutritional administration (Bozzetti et al., 2007). A total of 1410 patients who underwent various forms of major abdominal surgery for gastro-intestinal cancer and received various types of nutritional support were investigated. The findings showed that major complications occurred in 101 patients and minor complications occurred in 446 patients. This study concluded that nutritional support reduced morbidity compared with standard intravenous feeding (Bozzetti *et al.,* 2007).

In agreement with Bozzetti *et al.,* (2007), Lewis *et al.,* (2009) showed in a randomized controlled study of 1173 patients, comparing early enteral feeding (within 24hrs) to traditional management in patients undergoing gastro-intestinal surgery, that early enteral nutrition is associated with decreased morbidity (Lewis *et al.,* 2009).

In a retrospective review, 144 patients who underwent oral cancer resection and reconstruction to compare percutaneous endoscopic gastrostomy (PEG) and naso-gastric tube (NGT) feeding, was reported on (Eley *et al.*, 2012). A pre-operative scoring system identifying the key factors, making it possible to choose the most appropriate feeding method, was presented. One hundred and twenty patients were managed with a PEG for a mean duration of 71 days. The NGT method was used in 21 patients for a mean period of 13 days. They concluded that the complication rate was much higher in the PEG group and that the duration of use was prolonged compared to the NGT group (Eley *et al.,* 2012). Importantly, PEG tubes are associated with both morbidity and mortality and should be restricted to those patients who require longer term nutritional support (Eley *et al.*, 2012). The National Institute for Health and Clinical Excellence (NICE) of 2004 and the Scottish Intercollegiate Guidelines Network (SIGN) of 2006 guidelines made similar findings early in the new millennium and subsequently suggested that PEG tubes should only be considered if it is anticipated that nutritional intake is likely to be inadequate for a period of longer than 2-4 weeks.

1.3 NUTRITION SCREENING AND MEASUREMENTS

Nutrition screening has been defined by A.S.P.E.N as a “process to identify an individual who is malnourished or who is at risk for malnutrition to determine if a detailed nutrition assessment is indicated” (A.S.P.E.N, 2011). Several methods for nutrition assessment have been described and used; these include the following: medical history, anthropometric studies, body composition measurements, laboratory tests and determination of nitrogen balance (Jolliet *et al*,. 1998). However, there is no standard method for screening and diagnosing patients with malnutrition, leading to confusion and varying practices across the world (Bharadwaj *et al.,* 2016). The commonly used biochemical markers such as albumin, pre-albumin, transferrin, retinol-binding protein C-reactive protein, and total leukocyte count are sensitive to the assessment of nutrition but are not specific. In addition, there are various disease processes that alter the serum levels of these mentioned markers, and as a result they become unreliable serum markers for malnutrition (Bharadwaj *et al.,* 2016).

There are several other techniques which are used to assess body composition, for example the assessment of fat-free mass (FFM) and fat mass (FM) and Dual Energy X-ray Absorptiometry (DEXA) which is the gold standard noninvasive method of measuring body composition (Tewari *et al.,* 2017). Other methods for evaluating body composition include magnetic resonance imaging (MRI), computer-tomography (CT) and bioelectrical impedance analysis (BIA). DEXA, MRI and CT produce much more reliable results, however, they have the disadvantages of cost, exposing patients to

radiation, reduced accessibility and can only be used by trained personnel. (Thibault *et al.,* 2012) suggested that to implement routine assessment of body composition during the course of the treatment and the rehabilitation phase, it is necessary to use the simplest and least expensive method, with BIA meeting these criteria. The ideal tool for nutrition assessment should be sensitive, accurate, reproducible by various observers, relevant in health and illness, applicable to all patients at the bedside and cost-effective (Carney *et al*., 2002).

Energy requirements may be estimated at 25-30 non-protein Kcal/Kg per day for men and 20-25 non-protein Kcal/Kg per day for women (Genton *et al.,* 1999). Usually the patient's actual weight is used, but in emaciated patients the mean between the ideal and actual weight is used and in obese patients the actual weight plus 20% is used (Genton *et al.,* 2001). A fundamental goal for nutritional support is to meet the energy requirements for metabolic processes, core temperature maintenance and tissue repair. Failure to provide adequate non-protein energy sources will lead to consumption of lean tissue stores (Brunicardi *et al.,* 2010).

1.4 NUTRITION SUPPORT

Nutritional support is indicated when a patient cannot balance his or her nutrition or energy requirements (Genton *et al.,* 2001). Two types of nutritional support are commonly used, namely enteral and parenteral nutrition. Enteral nutrition is the most preferred form of delivering nutritional support in patients who cannot meet their energy requirements.

Enteral nutrition is considered the most superior route of nutritional administration, with fewer associated complications as compared to parenteral nutrition in patients with a functional gastro-intestinal tract (Pichard *et al.,* 2009). There is overwhelming evidence that demonstrates that enteral nutrition is associated with less morbidity and mortality (Lewis *et al.,* 2009).

Furthermore, the advantages of enteral feeding include: bypassing the oral cavity and pharynx, permitting healing of the surgical site and recovery of a safe swallowing mechanism (Eley *et al*., 2012). The enteric route is considered ideal in promoting return towards normal dietary intake (Ziccardi *et al.,* 1993).

(Nozoe *et al.,* 2002) investigated the relationship between pre-operative nutritional condition and the post-operative complications and prognosis following surgical treatment for patients with oesophageal carcinoma. Two hundred and fifty-eight

patients with oesophageal carcinoma who had undergone oesophagectomy and reconstruction were selected. The correlation of pre-operative nutritional index with the incidence of post-operative complications and prognosis of the patients was investigated. Of these patients included in the study, 71 had post-operative complications. Nineteen patients had severe pneumonia and 54 patients had anastomotic breakdown including two who had both. The follow-up period ranged from 28 days to 9 years.They concluded that pre-operative assessment of the nutritional status could provide predictive information for post-operative complications in patients with oesophageal carcinoma.

1.5 RATIONALE FOR THE STUDY

There is a world-wide paucity of studies in the literature reporting on pre-operative and post-operative nutritional support in maxillofacial and oral patients with benign odontogenic tumours of the mandible. Against this background, this study was undertaken to review and assess the adequacy of current NG feeding protocol in patients with odontogenic tumours in our unit. It is envisaged that data obtained from this study will be used to evaluate and/or modify our current protocol for feeding patients undergoing resection of odontogenic mandibular tumours and/or reconstruction with autogenous bone grafts.

1.6 AIM OF THE STUDY

The aim of this study was to assess the adequacy of post-operative nutritional support in patients who had resection of benign odontogenic tumours followed by reconstruction of the defect with autogenous bone grafts.

1.7 OBJECTIVES OF THE STUDY

a) To compare the pre-operative and post-operative weights in both resected and bone grafted patients, after naso-gastric tube feeding in males and females.
b) To compare the pre-operative and post-operative body composition measurements in both resected and bone grafted patients, after naso-gastric tube feeding in males and females.
c) To record post-operative complications in both resected and grafted patients.
d) To determine if there is any correlation between post-operative weight loss and post-operative complications associated with naso-gastric tube feeding.

CHAPTER 2

In this chapter, we focus on the materials and methods as well as the surgical techniques. We also outline the study design, inclusion and exclusion criteria, data collection as well as ethical considerations.

2.1 MATERIALS AND METHODS

This was a prospective observational study of patients undergoing resection of benign odontogenic tumours of the mandible and reconstruction of the resultant defect with autogenous bone at CHBAH and CMJAH conducted from April 2017 to October 2017. Currently the Department of Maxillofacial and Oral Surgery follows a protocol, which initially involves confirmation of the diagnosis by performing an incisional biopsy. Once a conclusive biopsy result has been obtained, it is followed by surgical resection of the tumour. The patient is placed into intermaxillary fixation (IMF) intraoperatively. At the same time a thin, small bore polyurathane tube, the naso-gastric tube (NGT) is inserted into either one of the nostrils and advanced into the upper third of the stomach.

. The tube is confirmed to be in the stomach, by taking a chest X-ray as well as by aspirating and/or spontaneous drainage of gastric contents. Should any of the test

prove negative, the NGT is removed and re-inserted until there is clear and positive evidence that the NGT is in the stomach.

In a case where the patient requires grafting of the defect with autogenous bone, the autogenous bone was harvested either from the anterior or the posterior iliac crest. The bone was then milled and compressed into the mandibular defect. This was followed by insertion of the NG tube and placement of the patient into intermaxillary fixation

The current feeding protocol of the Maxillo Facial and Oral Surgery Departments of the Chris Hani Baragwanath Academic Hospital and Charlotte Maxeke Johannesburg Academic Hospital include weighing of patients pre-operatively and post-operatively. The enteric feeds were initiated within the first 24hrs post-operatively via a NGT. The initiation of feeds was done in consultation with a dietician. The initial feeds were started at 20ml/hr and gradually increased hourly until the maximum limit is reached (which is calculated according to ideal body weight/ml/hour). All patients received high protein fiber containing polymeric enteral formula. The enteric feeds were administered continuously via a peristaltic pump. The aim was to deliver 25Kcal/Kg/Day of NGT feeds for a maximum of 7 days as per the Maxillofacial and Oral Surgery Department's protocol. Concurrently every patient received maintenance crystalloid fluids via intravenous infusion at a minimum rate of approximately 20ml/hr. A urinary catheter was also inserted intra-operatively to monitor urinary output for a period of 48 hours. Thereafter, the patient's output was monitored manually and recorded. The patient's input and output were measured and recorded daily. This aids in assessing whether the patient is under or over loaded with

fluids. Any discrepancies noted were adjusted appropriately in consultation with the dietician.

A dietician consulted with the patients on a daily basis during their stay in hospital. The patients were then weighed after one week (immediately after the removal of the NGT). In this study, a bio-electrical impedance analysis machine (BIA), which measures the weight (kg), height (cm), body mass index (BMI), body fat (kg), muscle mass (kg) and total body water (%), was used pre-operatively as well as post-operatively to assess the body composition. The patient's body composition measurements were recorded for statistical analysis. All measurements were recorded whilst patient were still admitted in the respective hospitals. All measurements were performed by the same operator using the *Tanita Body Composition Scale BC313*.

In those individuals who experienced any adverse effects of naso-gastric feeds, such as nausea, vomiting, bloating, constipation, diarrhea, etc., the feeds were stopped immediately and the patient was supported and treated symptomatically. Any patients who experienced >5% weight loss during this period of enteric feeding (7 days) warranted further clinical investigations and was referred appropriately to various disciplines for further assessment and management. Furthermore, any post-operative complications encountered were recorded and managed appropriately.

2.2 STUDY DESIGN

This was a prospective observational study of patients undergoing resection of benign odontogenic tumours of the mandible and reconstruction of the resultant defect with autogenous bone at Chris Hani Baragwanath Academic Hospital and Charlotte Maxeke Johannesburg Academic Hospital conducted from April 2017 to December 2017.

2.3 STUDY GROUP

All patients admitted for mandibular resection and placement of intermediate reconstruction plate and reconstruction of the defect with autologous bone following resection of an odontogenic tumour of the mandible in Charlotte Maxeke Johannesburg Academic Hospital and Chris Hani Baragwanath Academic Hospital were approached to participate in the study. It was anticipated that the number of patients included in the study would be approximately 20, assuming that 100% of patients provided consent.

2.4 INCLUSION CRITERIA

1. Patients between the ages of 18 years and older, with a histological diagnosis of a benign odontogenic tumour of the mandible requiring resection of the tumour.
2. Any patient requiring reconstruction of the defect with autologous bone following resection of the mandible.

2.5 EXCLUSION CRITERIA

1. Patients diagnosed with malignant tumours of the jaw.
2. Patients involved in any traumatic injuries such as gunshot wounds to the face.
3. Patients who required graft augmentation following previous grafting.
4. Patients with gastro-intestinal conditions or other co-morbidities in which enteral nutrition was contra-indicated.
5. Patients who presented with benign odontogenic tumours in the craniofacial and maxillary region

2.6 DATA COLLECTION

A data collection sheet was designed for purposes of recording the different measurements. The following variables were recorded pre-operatively and post-operatively: patients' pathology, height (cm), body weight (Kg), muscle mass (%) and body water (%). See attached Appendix 3.

2.7 DATA ANALYSIS

Descriptive statistics of mean, standard deviation, frequencies and percentages were used to summarize the data. One way ANOVA test was be used to determine the significant difference between the weights and body compositions of the patients on admission and prior to discharge (after removal of the NGT). Correlation analysis and T-test were used to determine the significant relationship between the dependent and independent variables. All statistical tests were be conducted using the IBM SPSS 23. Statistical significance was set at $p<0.05$.

2.8 ETHICAL CONSIDERATIONS

Permission was obtained in writing from the Head of School of Oral Health Sciences and the Head of Maxillofacial and Oral Surgery to access and use patient's records. Approval of the study was obtained from the Human Research Ethics Committee (HREC) of the University of the Witwatersrand. The clearance certificate was issued with the reference no: M170554. All patients were informed both orally and in writing about the details of the study. Informed consent was obtained from the patients, prior to participation in the study. Confidentiality was maintained at all times by using a numbering system rather that patient's personal details or hospital numbers. The participants were given the option to withdraw from the study at any time without future treatments being compromised in any way.

CHAPTER 3

3.1 RESULTS

As outlined in Table 3.1, a total of 21 patients participated in the study with 14 (66.7%) being female and 7 (33.3%) being male. The mean age of the participants was 32.1±7.6 years, the mean height for the males was 167 cm and for the females was 156 cm with an overall height of 1.59±0.11m. The mean weight for the males was 66.3 kg and for the females was 69.8 kg with an overall BMI of 28.6±7.5 kg/m^2 and 23.6±2.1kg/m^2 for females and males respectively. The weight and height was used to calculate the BMI for each patient.

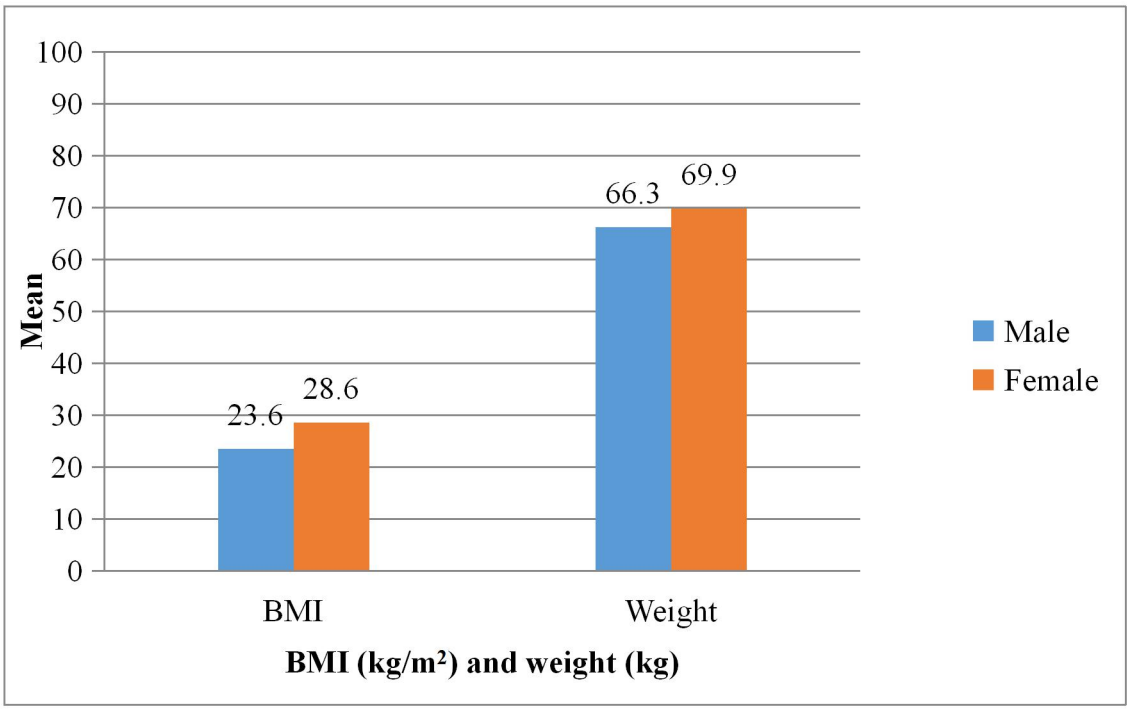

Figure3.1: BMI and weight according to gender

Table 3.1 Demographic characteristics of the patients.

Female n (%)	**Male n (%)**
14 (66.7%)	7 (33.3%)
Age	
Female and Male Mean ± SD (years)	
32.1±7.6 years	
Height	
Female Mean ± SD (meter)	**Male Mean ± SD (meter)**
1.56± 0.5m	1.67± 0.8m
Weight	
Female Mean ± SD (kg)	**Male Mean ± SD (kg)**
69.8± 20.2kg	66.3±10.0kg
BMI	
Female Mean ± SD (kg/m^2)	**Male Mean ± SD (kg/m^2)**
28.6 ±7.5kg/m^2	23.6± 2.1kg/m^2

Ameloblastoma resection was the most common among the patients with a mean of 61.9% as outlined in Table 3.2. Only five patients required reconstruction of the defect with an autogenous bone graft after resection of the primary tumour, which was an ameloblastoma. The remainder of patients presented with other forms of odontogenic tumours requiring ablative surgery. These tumours were odontogenic keratocyst, odontogenic myxoma and calcifying epithelial odontogenic tumour respectively and there was only one patient in each group.

Table 3.2: Total procedures performed.

Procedure (N=21)	**n**	**%**
Amelo	13	61.9
Ant iliac graft (after ameloblastoma resection)	1	4.8
CEOT resect	1	4.8
Myxoma resect	1	4.8
OKC resect	1	4.8
Post iliac graft (after ameloblastoma resection)	4	19

Post surgically as shown in Table 3.3 below, all the body composition measures except body water decreased. Overall, body fat reduced the most 5.02% in this study group. The weight, muscle mass and BMI all decreased by the same amount which is 4.17%. The body water remained relatively unchanged at 0.34%.

Table 3.3: The mean pre- and post-operative results.

Body Composition measures	**Pre**		**Post**		**Difference**
	Mean	**SD**	**Mean**	**SD**	**%**
Weight	68.68	17.28	65.84	16.79	-4.17
Body fat	31.24	11.30	29.98	11.87	-5.02
Muscle mass	43.72	7.64	41.80	6.91	-4.17
Body water	49.07	7.69	49.38	8.77	0.34
BMI	26.93	6.61	25.85	6.57	-4.17

Figure 3.2 Below is the graphic presentation of the decrease in body composition and weight of the patients.

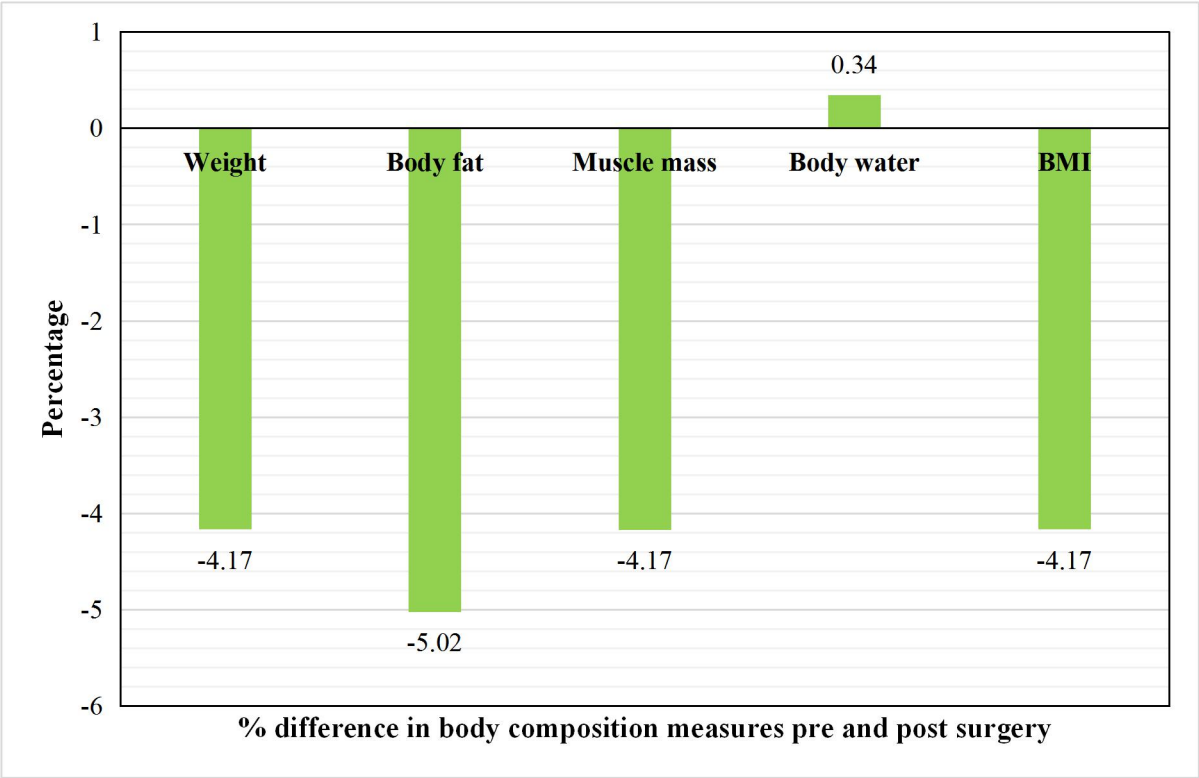

Figure 3.2: % difference in body composition measures pre- and post-surgery

Table 3.4 shows the difference the decrease weight and body composition measurements between the genders. The males showed significant reduction in body fat of 10.88%. The BMI and weight were reduced only 5.4%. The females had a total loss of 3.55% in body weight and BMI. The females had a significant reduction in muscle mass of 4.72% and the body fat was only reduced by 2.1%.

Table 3.4: Pre-and post-operative comparison between the genders.

Body Composition measures	Female (n=14)					Male (n=7)				
	Pre		Post		Dif	Pre		Post		Dif
	Mean	SD	Mean	SD	%	Mean	SD	Mean	SD	%
Weight	69.87	20.22	67.44	19.75	-3.55	66.29	10.02	62.63	8.78	-5.40
Body fat	36.50	9.88	35.61	9.96	-2.10	20.71	4.49	18.70	5.64	-10.88
Muscle mass	40.64	5.57	38.61	4.66	-4.72	49.89	7.78	48.19	6.37	-3.08
Body water	44.88	6.00	44.62	6.66	-0.73	56.84	2.62	58.21	3.87	2.34
BMI	28.59	7.50	27.62	7.40	-3.55	23.60	2.05	22.32	1.83	-5.40

Figure 3.3 Is a graphic illustration of results in Table 3.4.

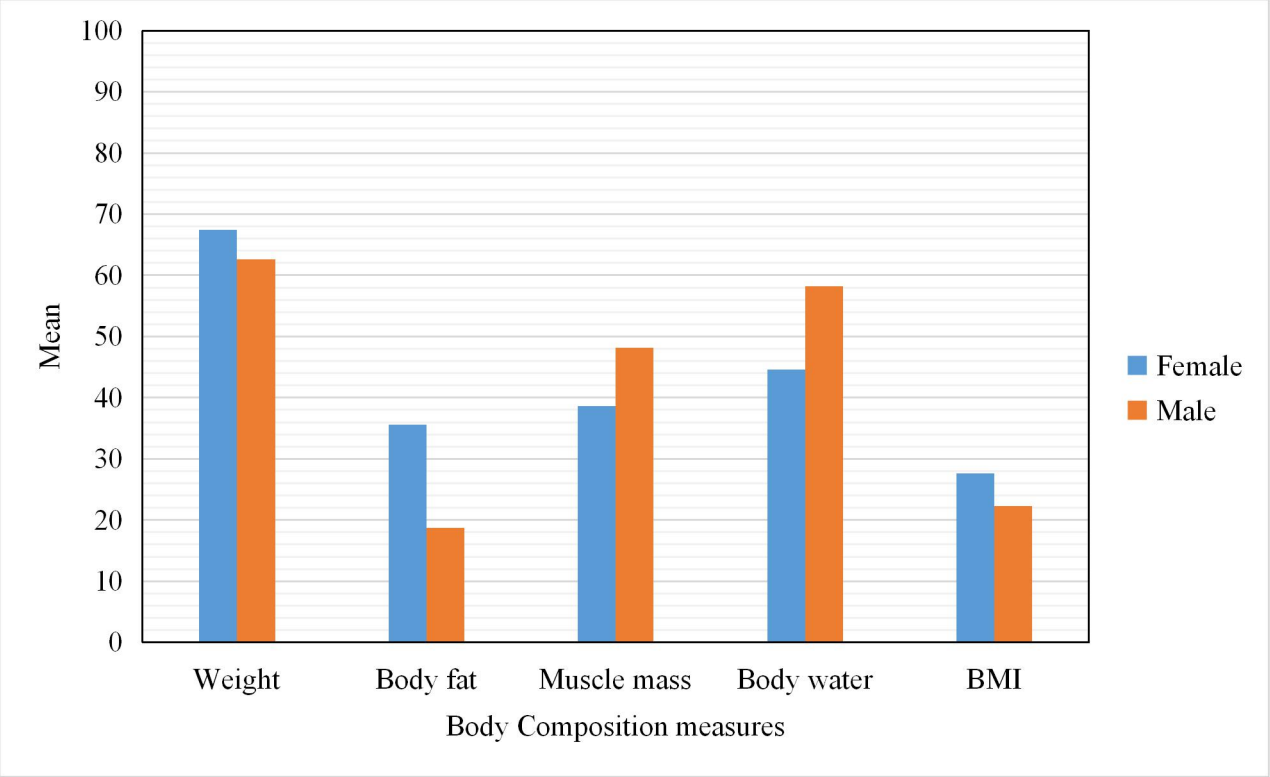

Figure 3.3: Post-surgery mean comparison of body composition measures between male and female

There was a decrease in the muscle mass of the males although it was statistically not significant. The reduction in weight and BMI pre- and post-operatively in the male patients was statistically significant. The decrease in weight, BMI and muscle mass of the female pre- and post-operatively was statistically significant.

Table 3.5: Paired T-Test results.

Gender	Body Composition measures	Paired differences		95%CI		Sig. (2-tailed)	
		Mean	SD	Lower	Upper	t	p
Female	**Weight**	2.43	1.18	1.74	3.11	7.69	0.00*
	Fat	0.89	3.89	-1.36	3.13	0.85	0.41
	Muscle mass	2.03	1.94	0.91	3.15	3.90	0.00*
	Water	0.26	1.70	-0.77	1.29	0.55	0.59
	BMI	0.97	0.46	0.70	1.23	7.78	0.00*
Male	**Weight**	3.66	1.55	2.24	5.09	6.28	0.00*
	Fat	2.01	2.03	0.14	3.89	2.62	0.04
	Muscle mass	1.69	2.05	-0.20	3.58	2.19	0.07
	Water	-1.37	1.63	-2.88	0.14	-2.22	0.07
	BMI	1.28	0.46	0.86	1.71	7.38	0.00*

There was a significant reduction in muscle mass in females ($p<0.05$). Males showed no significant reduction in muscle mass ($p>0.05$).

Table 3.6: Independent sample T-test

% Difference pre and post measure	Mean Dif	Std. Error	95% Confidence Interval		Sig. (2-tailed)
			Lower	Upper	p
%Weight	1.85	0.83	0.12	3.58	**0.04**
%Fat	8.78	4.81	-1.29	18.85	0.08
%Muscle mass	-1.64	1.84	-5.49	2.21	**0.38**
%Water	-3.08	1.63	-6.50	0.34	0.08
%BMI	1.85	0.83	0.12	3.58	**0.04**

A total of 12 patients were healthy with no known comorbidities. Seven patients were on treatment for HIV, one patient was on treatment for hypertension and one patient diagnosed with iron deficiency anaemia.

Fig 3.4 Illustrates the distribution of patients with or without comorbidities.

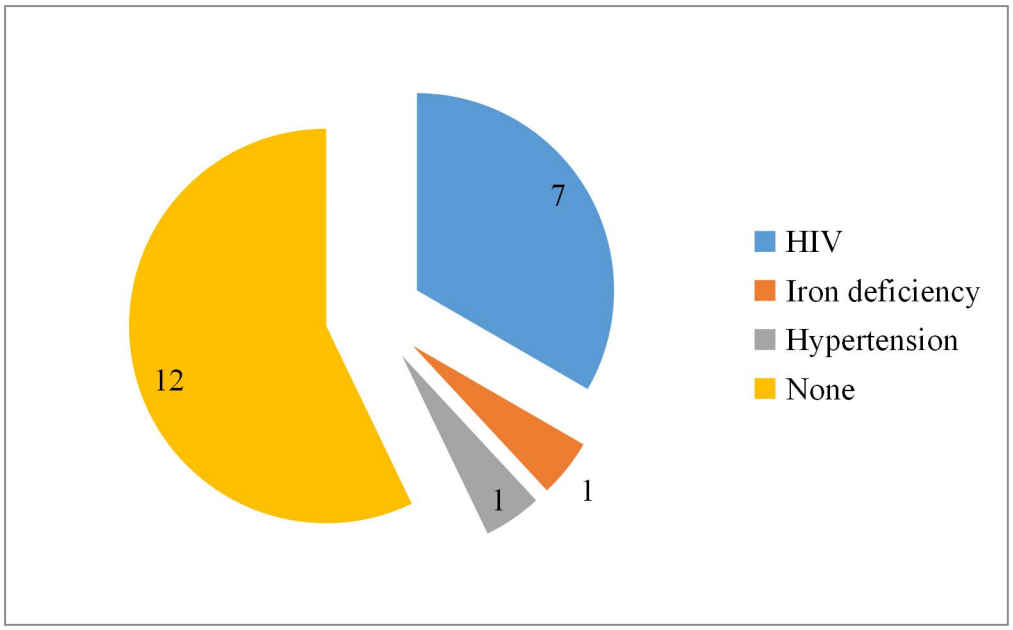

Figure 3.4: Comorbidities

The reduction in weight, muscle mass and fat in patients with comorbidities was comparable to those of healthy patients. The mean pre-operative weight of HIV positive patients was 75.1±24.1kg and that of healthy patients was 65.0±11.7kg, which decreased by approximately 3kg in both groups post operatively. The mean pre-operative body fat in the healthy group was 26.9±9.3kg and in the group with other co-morbidities was 38.0±12.2kg. The post-operative reduction in the two groups was statistically not significant as it decreased by only 1kg. The mean pre-operative muscle mass in the healthy population was 45.1±8.9kg and in the patients with comorbidities was 42.0±6.3kg, post-operatively it only reduced by 2kg in both groups which was also not statistically significant.

Table 3.7: Body Composition and comorbidities

	Pre						Post					
	None		HIV		Others		None		HIV		Others	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight	64.95	11.66	75.06	24.07	68.70	23.48	62.10	10.71	72.00	23.66	66.70	24.18
Fat	26.91	9.34	37.91	12.15	33.85	12.52	25.49	10.12	36.59	12.56	33.75	12.94
Muscle mass	45.11	8.89	41.84	5.83	41.95	6.29	43.46	7.93	39.34	4.74	40.45	7.00
Water	51.85	6.93	44.43	7.73	46.25	7.71	52.61	7.99	44.00	8.68	46.10	7.92
BMI	25.56	3.46	29.74	9.95	25.28	8.02	24.51	3.67	28.53	9.76	24.54	8.30

There was no significant difference between patients with associated pathologies ($p>0.05$). The patients with comorbidities had the same physiological response to enteral feeding as the healthier patient.

Table 3.8: One ANOVA to measure differences between comorbidities.

	Body Composition measures	**F**	**Sig**
Pre	Weight	0.74	0.49
	Fat	2.48	0.11
	Muscle mass	0.44	0.65
	Body water	2.28	0.13
	BMI	0.95	0.41
Post	Weight	0.75	0.49
	Fat	2.31	0.13
	Muscle mass	0.81	0.46
	Body water	2.38	0.12
	BMI	0.86	0.44
%Difference	%weight	0.21	0.81
	%Fat	0.38	0.69
	%Muscle mass	0.80	0.47
	%Body water	0.98	0.39
	%BMI	0.21	0.81

CHAPTER 4

4.1 DISCUSSION

The aim of this study was to assess the adequacy of post-operative nutritional support in patients who had a resection of an odontogenic tumour followed by reconstruction of the defect with autogenous bone graft.

A total of 21 patients underwent surgery between April and October 2017. The majority of the patients were females and the overall mean age was 31.2 years. A total of 17 patients required surgery for odontogenic tumour ablative surgery, while only four patients required reconstruction of the mandibular defect with autogenous bone graft, after primary tumour resection all of which was an ameloblastoma. Ameloblastoma was the most common presenting odontogenic tumour at 61.9%. The other odontogenic tumours had an equal distribution of 4.8%. These tumours were the odontogenic keratocyst, odontogenic myxoma and calcifying epithelial odontogenic tumour, respectively. Govind et al (2017), reviewed 161 cases of odontogenic tumours and also found a high prevelance of ameloblastomas (49%), followed by keratinizing cystic odontogenic tumours at 32%, odontome tumours at 6.2%, adenomatoid odontogenic tumours at 5.5%, odontogenic myxomas at 2.4%,

ameloblastic fibromas at 0.6%, calcifying epithelial odontogenic tumours at 1.8% and squamous odontogenic tumours at 1.2%.

Although all the participants were healthy and well-nourished pre-operatively, we deemed it necessary to introduce enteric feeds post-operatively so as to limit the undesirable complications associated with surgical stress. This is also to nutritionally support the patients post-operatively during the initial phase of healing. In our study we used the BIA scale to evaluate the pre-operative and post-operative body composition of patients who either had a resection of an odontogenic tumour of the mandible or grafting of the bony defect with autogenous bone. Our choice to utilize this method of estimating body composition was informed by scientific and evidence based research found in the literature. Body Impedance Analysis is a recently developed technique for estimating body composition. It has the advantage of being non-invasive, relatively cost-effective and allows for simple bedside determination of muscle mass Bharadwaj *et al*., (2016). A systematic review by Haverkort *et al.,* (2015) suggested that BIA is useful if implemented as a longitudinal tool (e.g., before and after an intervention). Indeed, Tewari *et al.,* (2017) stated that BIA is an especially useful tool for research and particularly for clinical purposes compared to the other more invasive methods.

The variables that were measured pre- and post-operatively were: BMI, weight, body water, body fat and muscle mass.

The majority of patients that participated in the study were females at 66.7% and 33.3% were males. The female population was found to be overweight

with a mean BMI of 28.6kg/m^2 and an average weight of 69.9kg, while that of the male patients was 23.6kg/m^2 and 66.3kg respectively. A BMI of 25-30kg/m^2 implies being overweight. In accordance with results obtained from our study,

Owolabi *et al.,* (2017) reported that the prevalence of obesity was higher in females (53.4%) compared to males (27.4%) among South African adults.

A paired t-test pre-operatively and post-operatively showed that there was a statistically significant 2kg decrease in the muscle mass of the female patients seven days post-surgery. There was also a post-operative decrease of 1.69kg in the muscle mass of the males, although this was not statistically significant. Body fat showed no significant difference in females, as only a slight mean reduction of 0.89kg occurred post-operatively. In contrast, in this study, males lost a mean body fat of 2.0kg which was indeed statistically significant. For both males and females, body water increased by 1.37% but this was not statistically significant.

Nemoto *et al*., (2012) in their study of 166 patients found that BIA accurately assessed body composition in non-frail and pre-frail older adults, although fat-mass had proportional bias. This is in agreement with our results in which body fat significantly decreased post-operatively, especially in the male population. We found that patients had a significant reduction in body fat opposed to muscle mass. We can only postulate that this is hunger-related rather than protein catabolism related to the stress associated with surgery.

Furthermore, there is no clear consensus about normal ranges of muscle mass and the uncertainty is even greater for obese individuals, since the normal ranges might be different from the lean population. However, Kozeniecke *et al.,* (2016), found that the initiation and advancement of enteral nutrition were the common reason for sub-optimal delivery of nutrition. There was no significant statistical difference in weight, muscle mass and body fat reduction between patients with comorbidities including those with HIV as compared with healthy individuals.

There were no patients that experienced any adverse complications such as aspiration, diarrhea, constipation, vomiting or bloating.

CHAPTER 5

5.1 CONCLUSIONS

In conclusion this study demonstrates that the patients had a decrease in body fat, muscle mass and weight both in males and females. However, the decrease in these parameters did not have any negative effects on the healing phase post-operatively. The use of bio-electrical impedance analysis proved to be a useful tool in the assessment of body composition for patients undergoing odontogenic tumour ablation surgery and autogenous bone grafting both pre- and post-operatively. We also found that patients with comorbidities were comparable to healthier patients and did not have any significantly different physiological response to enteric feeds. The data obtained from this study however suggests that the current feeding formula of 25kcal/kg/hr may be inadequate in this study population. This is based on the fact that the patients lost both body fat and muscle mass during the 7 days post-operatively despite being on high protein fiber containing naso-gastric feeds. There was also a significant difference between males and females, this could suggest that the delivery of nutrition should be modified according to gender or even more importantly, possibly rather be calculated according to the specific nutritional needs of the individual patient.

5.2 LIMITATIONS OF THE STUDY

The main limitation of this study was the small sample size and there were twice as many females than males. This imbalance made the results obtained difficult to analyse and to come to a conclusive decision based on gender. Another possible limitation to our study, is the inability to monitor precise time when the feeds are initiated, and the difficulty to identify the length of time for which the tube is removed or blocked.

5.3 FUTURE STUDIES

We suggest that future studies should employ an individualistic approach to calculate the nutritional requirements of patients by using the bio-electric impedance test to assess the pre- and post-operative body composition. We suggest that recording of the precise time post-operatively are the feeds initiated as well as recordings any disruptions related to blockade or dislodgement of the NGT.

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APPENDIX 1

ADEQUACY OF NUTRITIONAL SUPPORT IN ORAL AND MAXILLOFACIAL RESECTED AND RECONSTRUCTED PATIENTS STUDY PATIENT CONSENT FORM

Department of Oral and Maxillofacial Surgery University of the Witwatersrand

Dr. Mbali Nkonyane

I, Mr/Mrs/Ms……

File No/Hospital No……..

am willing to participate in the study as described and explained to me by Dr. Mbali Nkonyane. I understand that participation in the study is voluntary. I have been adequately informed about the study. I also understand that I have the right to withdraw from the study at any stage, which will not compromise my future treatment at either CMJAH or CHBAH. I understand that my privacy and rights will be protected at all times.

I hereby consent to be part of the research.

_____	_____
Patient signature	**Research Investigator**
_____	_____
Date	**Date**

APPENDIX 2

ADEQUACY OF NUTRITIONAL SUPPORT IN ORAL AND MAXILLOFACIAL RESECTED AND RECONSTRUCTED PATIENTS STUDY

PATIENT INFORMATION

Department of Oral and Maxillofacial Surgery University of the Witwatersrand, Johannesburg

Dr. Mbali Nkonyane

Good day, my name is Dr Mbali Nkonyane. I am a registrar in the Department of Oral and Maxillofacial Surgery University of the Witwatersrand. I am currently doing a study for which I have permission from the University of the Witwatersrand, Johannesburg Human Research Ethics Committee (Medical) with number M170554, the Head of Department Professor S Nemutandani and the CEO of both Charlotte Maxeke Johannesburg Academic Hospital and Chris Hani Baragwanath Academic Hospital.

I would like to ask your permission to participate in my study please. If you agree when the details have been fully explained to you, you will be asked to sign a consent form. I also have signed permission from Professor Nemutandani to access patients' medical records.

My study involves recording your weight before and after the operation you need in your mouth. This will involve measurement of your body weight and body composition (body fat, muscle and water) using a simple scale. The participant will be required to stand on the scale bare footed and the necessary measurements recorded by me.

Participation in the study is purely voluntary, non-participation in the study will not prejudice anyone and treatment will commence as planned. You may withdraw from the study at any-time even after signing the consent without any consequences. There will be no personal benefit to you from your participation, but I hope that by carrying out this study, we may be able to offer even better management of patients who arrive in the future with a similar condition to yours.

All information obtained and medical records will be kept confidential at all times. Individuals will not be personally identified in any publication or report that arises from the study. Participation is completely voluntary and there will be no payment for persons who choose to take part.

If you have any questions, I may be contacted on telephone number 082 746 2831, or on nkonyanem@mweb.co.za. You may also put questions to my supervisor, Dr Ephraim Rikhotso on Risimati.Rikhotso@wits.ac.za. This study has been approved by the Human Research Ethics (Medical) Committee of the University. You may raise any ethical concerns with the Chairperson, Professor PE Cleaton–Jones (Chairperson), telephone number 011 717 2301, or on Peter.Cleaton-

jones1@wits.ac.za. He is supported by Administrative Officers Ms Zanele Ndlovu, Mr Rhulani Mkansi and Mr Lebo Moeng, whose telephone numbers are 011 717 2700/2656/1234/1252, or on Zanele.Ndlovu@wits.ac.za; Rhulani.Mkansi@wits.ac.za; and Lebo.Moeng@wits.ac.za

Thank you for reading this document and considering my request.

September 2017

APPENDIX 3

ADEQUACY OF NUTRITIONAL SUPPORT IN ORAL AND MAXILLOFACIAL RESECTED AND RECONSTRUCTED PATIENTS

DATA COLLECTION SHEET

Department of Oral and Maxillofacial Surgery University of the Witwatersrand

Dr. Mbali Nkonyane

Pt no.	Procedure	Height (cm)	Pre-op weight (Kg)	BMI (Kg/m^2)	Pre-op Body Fat(Kg)	Pre-op Muscle Mass(Kg)	Pre-op Total Body Water (%)
1.							
1.							
2.							
3.							
4.							
5.							
6.							

Pt no.	Procedure	Height (cm)	Post-op weight (Kg)	BMI (Kg/m^2)	Post-op Body Fat(Kg)	Post-op Muscle Mass(Kg)	Post-op Total Body Water (%)
1							
2							
3							
4							
5							
6							
7							

R14/49 Dr M Nkonyane

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M170554

NAME: (Principal Investigator)	Dr M Nkonyane
DEPARTMENT:	School of Oral Health Sciences Dept of Maxillofacial and Oral Surgery Medical School
PROJECT TITLE:	Adequacy of nutritional support in oral and maxillo-facial resected and reconstructed patients
DATE CONSIDERED:	26/05/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr E Rikhotso
APPROVED BY:	Professor CB Penny, Co-Chairperson, HREC (Medical)
DATE OF APPROVAL:	07/09/2017

UNIVERSITY OF THE WITWATERSRAND
PROF CLEMENT PENNY
HREC (MEDICAL) AND BEC
- 7 SEP 2017
JOHANNESBURG

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially reviewed in **May** and will therefore be due in the month of **May** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

08/09/2017
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES