Assessment of Dental Arch Relationships in a sample of patients with Unilateral Cleft Lip and Palate in the Western Cape, South Africa.

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A research report submitted to the Faculty of Dentistry, University of the Western Cape, Tygerberg, in partial fulfilment of the requirements for the Master of Dentistry in Orthodontics.

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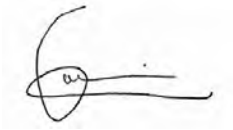
Contents

DECLARATION

I, Mpatikana Leslie Galane hereby declare that this research report is my own, unaided work (except where acknowledgements indicate otherwise). It is being submitted for the Master of Dentistry in Orthodontics at the University of the Western Cape, Tygerberg. It has not been submitted for another degree at this or any other university or tertiary education institution or examination body.



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(Signature of candidate)

8th day of January 2024 in Tygerberg

DEDICATION

This piece of work is dedicated to my late grandfather (Mr. Mathotile Andries Galane), thanks for passing your baton on.

And

To my late father (Mr. Lesetja Johannes Galane) you went through the most in your last days. Thanks for everything and much love.

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To Moeketsi Montsho, it would be impossible to list all you have done to encourage me within the last year. Please know that I am forever grateful for your support.

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To Prof. Zodwa Nkambule, even though I had many doubters, you believed in me. Thank you for encouraging me to work toward my dreams.

ABSTRACT

Background:

Unilateral cleft lip and palate (UCLP) is a specific form of orofacial cleft (OFC) that accounts for 23% of those born with clefts. In the Eastern Cape, Free State and Northern Cape provinces of South Africa (SA), the prevalence of OFCs is 0.1, 0.1, and 1.2 per 1000, respectively. UCLP is more common in males compared to females, with 2:1 gender distribution. In addition, UCLP has a strong predilection for the left side of the maxilla as compared to the right side. Individuals born with UCLP typically require several surgeries and/or other intricate procedures to rectify this anomaly. Individuals diagnosed with UCLP frequently exhibit a range of functional and aesthetic defects, in addition to the particular deformities associated with the condition. Complications related to UCLP include hypoplastic maxilla and a high incidence of Class III malocclusion. Children who are born with UCLP requires a complex management that starts with specialist nursing care, surgical repair on both the lip (which is generally done at three months of age) and the palate (at any time between six to 14 months of age).Several studies have verified that if the initial surgery is performed unskillfully, it can have a detrimental impact on the growth of the face, development of the dentition, and speech. Establishing a dependable approach for evaluating dental arch relationships is crucial in order to evaluate and contrast the outcomes of early management of UCLP in children.

The aim of the study:

The aim of this study was to evaluate the dental arch relationship of people with UCLP in the Western Cape (WC) province using the Goslon Yardstick.

Materials and Methods:

The study involved analysing dental models of children who were between eight to 15 years old and had been diagnosed with UCLP, from January 1990 to October 2022 in the orthodontic clinics of the University of Western Cape (UWC). The models were taken prior to any alveolar bone grafting (ABG) or orthodontic intervention and were assessed by three assessors using the Goslon Yardstick.

To reduce the effect of recall bias, the examiners evaluated one third of the sample to determine inter and intra examiner reliability. The assessments were conducted two weeks apart from the initial scoring. The data was entered into a Microsoft Excel spreadsheet and then cleaned before being imported into SPSS software for further analysis. The study results were reported using descriptive statistics.

Results: Sixty eighty UCLP models between January 1990 to October 2022 were retrieved from the archives of orthodontic clinics at the UWC. The sample group consisted of individuals whose ages ranged from 7.5 to 15.6 years, with a mean age of 11.5 years. Most of the sample consisted of females (52.94%), and in most instances (75%), the cleft was situated on the left side.

The average Goslon score for the UCLP models in the Western Cape was 2.91. The Kappa scores for the agreement between assessors vary from .649 (between assessor 1 and 2) to .788 (between assessor 2 and 3). The intra-rater Kappa ranged from .681 (Assessor 2) to .792 (Assessor 3). Most of the UCLP models were in Goslon category 2 (32.4%) and 3 (32.4%) and there was equal distribution for category 4 (13.2%) and 5 (13.6%).

Conclusions: The main finding revealed that Western Cape (WC) province had a Goslon score of 2.9 which is considered a fair result. The majority of the models were in the good and fair Goslon Yardstick categories.

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ACRONYMS

5YO	5-year-Old
ABG	Alveolar Bone Graft
BMREC	Biomedical Science Research Ethics Committee
CLP	Cleft Lip Palate
CSAG	Clinical Standards Advisory Group
GOSLON	Great Ormond Street, London and Oslo
HB	GOSLON Huddart Bodenham
MHB	Modified Huddart Bodenham
NZ	New Zealand
OFC	Orofacial cleft
RCT	Randomised Control Trail
SA	South Africa
UCLP	Unilateral Cleft Lip and Palate
UK	United Kingdom
UWC	University of Western Cape
WC	Western Cape
WCDH	Western Cape Department of Health
VAS	Visual Analog Scale

CHAPTER 1

INTRODUCTION

This section provides information on the background of the study. Moreover, this section includes the problem statement, which elucidates the rationale behind conducting the study, as well as a subsequent portion that outlines the study's aims and objectives.

1.1 Epidemiology of Clefts

OFCs include several anomalies (Tessier, 1976). UCLP contributes 23% to OFCs (Fitzsimons, 2012). Males present more with UCLP than females (Nagase et al., 2010). Additionally, the left side turns to have a strong predilection of UCLP than the right side. Cleft lip and palate (CLP) are the most frequently occurring birth defect among the top five common birth defects in SA (Kromberg and Jenkins, 1982).

According to Hlongwa et al. (2019), the incidence of orofacial clefts in the Free State, Eastern Cape and Northern Cape provinces of SA is 0.1, 0.1, and 1.2 per 1000 live births, respectively. The number of CLP patients receiving treatment from public specialised academic treatment centres in SA ranges from 0.3 to 0.4 per 1000 live births, after adjusting for the denominator (Hlongwa et al., 2019).

1.2 Development of Clefts

CLP may be part of a syndrome or be a single anomaly (Tessier, 1976). CLP is as a result of multifactorial factors, and this includes genetic, environmental and other factors (Cobourne, 2004). Facial clefts are classified as either unilateral or bilateral according to their anatomical location. Moreover, a cleft can either develop fully or be partial. Incomplete cleft lip varies with sizes and shapes, between a notch and deep groove but does not reach the anterior naris opening that leads to the mouth (Chiego, 2018).

1.3 Presurgical management of Clefts

Patients with CLP have a collection of aesthetic and functional abnormalities (Semb, 1991). These Children with UCLP require a multidisciplinary approach to achieve good facial form and function (Singer et al., 2018). These patients undergo lifelong treatment procedures which puts a strain on the patient and the hospital (government
or private) (Singer et al., 2018).

Embryologically, UCLP results as a disturbance in induction, mesenchymal merging and cell migration. Some embryonic prominences fail to fuse and these results in impaired maxillary growth. Numerous studies have indicated that unoperated cleft patients can achieve normal maxillary growth development (Diah et al., 2007) (Shetye, 2004). Early lip correction in infancy without any surgical palatal repair did not hinder sagittal maxillary growth.

Although children with early palatal surgery in their childhood presented with severe mid-face retrusion (Mars & Houston, 1990 suggests early primary surgical scar tissue contributes to the maxillary hypoplasia in UCLP patients (Ross, 1987; Mars & Houston, 1990). Several studies have also highlighted differences in dental arch relations when numerous surgical protocols were performed (Mars et al.,1992; Mølsted et al., 2005; Hathaway et al., 2011).

Mars et al. (1992) noted a disagreement among professionals regarding the various surgical approaches used to manage UCLP. Similarly, Rohrich et al. (2000) found that there was also no consensus on the appropriate timing and staging for repairing the soft and hard palate. It is thought that correcting the hard palate in the primary stage may hinder the growth of the upper jaw. The postponement of the hard palate surgery was reported to result in improved occlusion and development of the upper jaw (Lilja et al., 2006; Sinko et al.,2008)

Lilja et al. (2006) and Sinko et al., (2008) conducted studies examining the effects of delaying hard palate surgery on occlusion and maxillary development in patients with CLP. Both studies found that delaying hard palate surgery until the age of 5-6 years resulted in improved occlusion and maxillary growth compared to performing the surgery earlier (Lilja et al.,2006; Sinko et al., 2008).

The reason for this improvement is thought to be related to the fact that delaying surgery allows for natural growth and remodeling of the maxilla to occur, which can lead to better alignment of the teeth and improved occlusion. Additionally, delaying surgery may reduce the need for additional surgical procedures in the future. Nollet et al., (2005) through a meta-analysis study found that children who had undergone soft and hard palate repair prior to a specific age threshold had significantly lower Goslon scores, with a mean score of 2.9, in comparison to those who had delayed palatal closure, with a mean Goslon score of 2.3.

Postponed hard palate closure reduces a number of surgical operations, as well as negligible need for maxillary bone augmentation. As a result, the subsequent burden of care with regards to surgical intervention is reduced, as noted by Lilja et al. (2006). Nevertheless, Sell et al., (2001) highlighted that late palatal surgery led to speech impairment in UCLP patients. Moreover, presurgical orthodontics during early dental development can also adversely affect growth.

The main aim of presurgical orthopaedics in UCLP patients was to manage the tongue and cleft gap thereby not disturbing the development of the maxilla. Robertson, (1974) suggested that this approach could also aid in the realignment of the skeletal foundations of the cleft, providing sufficient base for surgical procedures. A well- developed alveolar symmetry gives good dental alignment. Mars et al. (1992) showed that centres that did not use presurgical orthopaedics had good occlusal outcomes as compared to centres where presurgical orthopaedics were used.

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Prahl et al. (2001, 2006) conducted randomized controlled trials (RCT)s which found that the use of presurgical orthopaedics did not provide any significant advantage for individuals with UCLP. Furthermore, Uzel & Alparslan (2011) found unsatisfactory outcomes regarding the effects of presurgical orthopaedics on various aspects such as maxillary arch growth, speech, facial growth, nasolabial appearance, and occlusion. The Eurocleft study reported that different cleft centres presented systematic differences in dental arch relationships but did not identify precise causal factors (Mølsted et al., 2005.)

1.4 Biological Development Clefts

Several factors can affect the growth and development of individuals with CLP such as the type of cleft, scar tissue after surgery, orthodontic/orthopaedic treatments, and alveolar bone grafting (Baek, 2002). Previous studies on the growth and development of these patients have mainly focused on analysing X-rays, dental models, and speech and hearing tests. (Asher-McDade et al., 1992). Semb, (1991) investigated the facial features of individuals who had undergone repair for UCLP. The findings revealed that these patients had a maxilla that was both shorter and further back, an elongated anterior face (although the upper facial height was shorter), and the lower jaw was further back.

The height of the back part of the face decreased, and there was a slight rise in the angle of the base of the skull and the distance between the eyes, whereas the nose appeared less prominent. Individuals who have CLP exhibit a distinct growth pattern in comparison to those who do not have clefts. Specifically, between the ages of 5 and 18, there is very little lengthening of the maxillary bone measured from one outline of the alveolar process to another. Among a sample of people who have a UCLP on one side, this dimension increased by only 1.4 mm, while in a non-cleft sample, it increased by approximately 10 mm, as measured by the Bolton standards templates (Broadbent et al., 1977).

Mølsted et al. (1992) conducted a study to assess and compare the craniofacial

morphology and nasolabial structure of 9-year-old patients with UCLP. It was found that Centre D deviated significantly from the others. Centres that used presurgical Orthopedics (Centres A and F) and extraoral strapping (D) did not show better treatment outcomes than the other centres. Brattström et al. (2005) followed the same group of individuals from the Mølsted et al. (1992) study at ages 12 and 17 and found a consistent relationship between the centres at all three ages. Two centres (D and F) had less favourable ratings for various variables such as soft tissue profile and facial proportions. Although the specific factors responsible for the variations could not be pinpointed, these centres had a more complex treatment regimen that involved presurgical Orthopedics (Brattström et al., 2005).

1.5 Development of clinical indices

A reliable method for evaluating dental arch relations is crucial to achieving the goals of predicting facial growth and dental arch alignment. This will also help in evaluating and comparing the effectiveness of various early management approaches for individuals with UCLP (Stonehouse-Smith et al., 2022). Several clinical indices are available to give an unbiased evaluation of the extent of dental misalignments in individuals with different types of OFCs.

Mars et al. (1987) developed the GOSLON (Great Ormond Street, London and Oslo) yardstick, which is a reliable scientific instrument used to classify dental alignments in individuals with UCLP during the late mixed dentition or early permanent dentition phase. The classification of treatment outcomes by the Goslon yardstick occurs across three dimensions: transverse, anteroposterior and vertical. It consists of five categories, groups 1-5. The assessors require training on how to score the UCLP models. (Figure 1.1) (Mars et al., 1987)

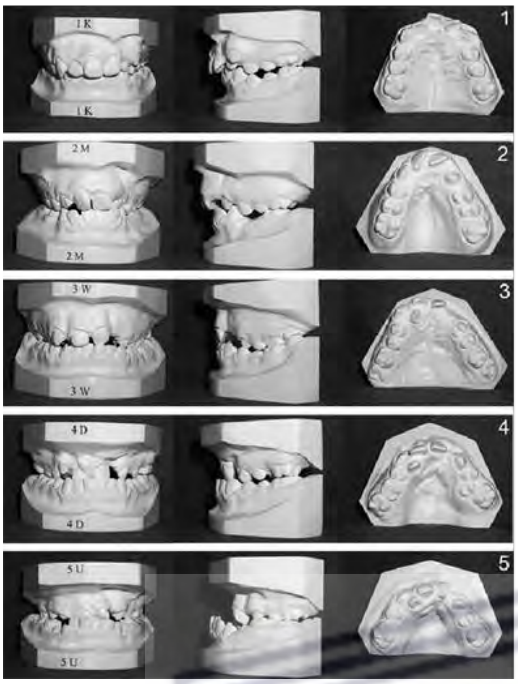
The format of the original Goslon Yardstick	
	Group 1 Excellent
	Group 2 Good
	Group 3 Fair
	Group 4 poor
	Group 5 Very poor

Figure 1.1: Goslon Yardstick Models (Mars et al., 1987)

- In Group 1 (excellent) UCLP models, individuals have a favourable dental alignment with a positive overjet and overbite, and their skeletal structure is generally considered valuable. This category is mostly comprised of Angle Class II division 1 malocclusion. Treatment is unnecessary in this group or may only require straightforward orthodontic treatment.
- Group 2 (good) It's a good dental Class I relationship and also simple orthodontic alignment.
- Group 3 (fair) UCLP models exhibit a fair dental alignment with an edge-to edge bite, and treating their dental Class III and multiple arch irregularities with orthodontic intervention can be challenging. However, a favourable treatment outcome is expected.
- Patients who are classified under Group 4 (poor) have a negative overjet that ranges from 3-5 mm and negative facial growth. This suggests that orthodontic treatment may not be sufficient, and they may need orthognathic surgery.

Mars et al. (1987) state that Group 5 (Very poor) models of UCLP exhibit a marked skeletal Class III relationship, which requires orthognathic surgery. The average Goslon score remains consistent across varying stages of dental growth and is

linked to cephalometric analysis. This provides a means of evaluating the results of facial growth (Mars & Houston, 1990). Although it is impossible to predict with complete certainty which patients will undergo maxillary retrusion during puberty, insufficient maxillary growth before puberty can be a sign of an unfavourable outcome. Patients with UCLP, who undergo two-stage palate repair have favourable surgical outcomes than one-stage palate reparation on the growth of the maxilla (Liao et al., 2010).

The application of the Goslon Yardstick demonstrated that a small proportion of patients who underwent early lip repair were categorized under groups 4 and 5, which signify unsatisfactory outcomes (Haque et al., 2015). Two distinct investigations revealed that 50% of patients who received primary lip and palatal surgery were classified under groups 4 and 5 according to the Goslon Yardstick (Hathorn et al., 1996; Susami et al., 2006).

According to Hathorn et al. (1996) and Susami et al. (2006), there appears to be a correlation between surgical interventions and unfavourable dental arch relationships in UCLP patients. Usually, the regular method involves suturing the lip before the baby reaches six months old and closing the roof of the mouth before they turn two years old. The surgeon's skill and experience are a challenging variable to measure (Heliövaara et al., 2017). To sustain competency, a minimum caseload is recommended not only for surgical skills but also for alignment of teeth (Shaw et al., 2001). Studies have suggested that surgeons who conduct a greater number of procedures are associated with favourable results (indicated by Goslon scores of 1 and 2), while those who perform a smaller number of procedures have demonstrated less satisfactory outcomes (indicated by Goslon scores of 3-5). (Love et al., 2012) (Sandy et al., 1998). Nonetheless, possessing a large number of operators doesn't always translate to having outstanding abilities and proficiency.

A study conducted across the United Kingdom (UK), which focused on the care and outcomes of individual born with UCLP, indicated that the majority of the 75 surgeons involved performed less than one UCLP surgery per year., and most of

the 105 orthodontists likely treated an insignificant volume of these patients (Sandy et al., 1998). Additionally, Clinical Standards Advisory Group (CSAG) research, they had seven high-volume surgeons but only four of those accomplished successful results (Bearn et al., 2001).

The Goslon Yardstick conventionally uses direct orthodontic cast study models that are made from dental impressions of the upper and lower jaw, which are then cut to a pink wax jaw registration (Mars et al.,1987). Nevertheless, Fowler et al. (2019) appraised the dependability of rating both cast models and their 3D electronic copies of UCLP models by utilizing both a Goslon Yardstick and a 10-cm visual analog scale (VAS). The researchers concluded that 3D digital models and plaster models are comparable and can be used for Goslon Yardstick assessment (Fowler et al., 2019).

Furthermore, the 10-centimeter VAS is a dependable approach to assessing dental arch connections, exhibiting a considerable level of reliability in comparison to the Goslon method (Fowler et al., 2019). The Goslon Yardstick is generally recognized as a standard instrument for evaluating children with UCLP at around the age of 10 (Jones et al., 2016), while more studies are necessary to confirm the clinical significance of VAS scores (Fowler et al., 2019).

1.6 Problem Statement

Chan et al. (2003) have shown that the Goslon Yardstick is a straightforward and practical instrument for evaluating the clinical outcomes of initial treatment for UCLP in children, taking into account all three spatial planes. Furthermore, Mars et al., (1992) have indicated that it aids in distinguishing between various levels of dental arch connections during each phase of growth, allowing for comparisons thereof (Sinko et al., 2008). Nevertheless, there is paucity of literature on the practical use of the Goslon Yardstick in SA. Therefore, the purpose of this research is to evaluate the dental arch relationship of UCLP patients receiving care at University of the Western Cape (UWC) Orthodontics clinics, providing a basis for comprehending the treatment outcomes of UCLP patients in the WC region of SA.

1.7 The aim of the study

The aim of this research was to assess the dental arch relationships of individuals with UCLP in the WC using the Goslon Yardstick.

1.8 Research objectives

The objectives of the study were as follows:

- To determine the dental arch relationships of the patients with UCLP using the Goslon yardstick.
- To determine the intra- and interrater agreement using the Goslon yardstick.
- To provide a sample which can be used in the future to compare a SA UCLP patient sample with the Oslo Good Practice Archives using the Goslon yardstick.

CHAPTER 2

LITERATURE REVIEW

In this chapter, a literature review was conducted to provide further information on previous studies related to the dentoalveolar relationships of children with UCLP. The review primarily focuses on the history of cleft indexes and also, the agreement between assessors both within and between them while using the Goslon yardstick was examined, and the treatment outcomes were compared using the Goslon yardstick.

2.1 History of cleft indexes

The commonest birth defects affecting the face amongst others is CLP (Kadir et al., 2017). Individuals born with UCLP typically require multiple surgeries and/or other complex procedures to address this congenital deformity (Barros et al., 2019). Complications related to UCLP include hypoplastic maxilla and a high incidence of prognathic mandible (Semb, 1991). Some other problems UCLP patients experience involve speech, hearing, and chewing (Marcusson A, 2001). Because of this, a multidisciplinary approach is required to manage patients born with UCLP, which usually involves corrective surgery of the lip at 3 months of age and palate repair between 6 and 14 months of age (Buj-Acosta et al., 2017).

Several studies have verified that an unskilled performance of the primary surgery can potentially hinder the future growth of the face and development of teeth. (Mars et al.,1987) and speech (Wyatt et al., 1996). Establishing a dependable method for assessing the dental arch relationship is essential for assessing and comparing the outcomes of early intervention for children born with UCLP. Traditional approaches for evaluating dental irregularities and arch relationships have various limitations, even when used for standard orthodontic issues, and they cannot be directly employed for malocclusions in children with CLP (Buj-Acosta et al., 2017).

Various occlusal indices have been developed specifically for assessing the dental arch alignment of patients with UCLP (Altalibi et al., 2013). Pruzansky and Aduss (1964) as well as Matthews et al. (1970) devised techniques that heavily rely on the existence and severity of crossbites.

Pruzansky and Aduss (1964) classified the occlusion into six groups: which included (1) absence of crossbite, (2) presence of canine crossbite only, (3) presence of buccal crossbite only, (4) presence of both anterior and buccal crossbite, (5) presence of both anterior and canine crossbite, and (6) presence of incisor crossbite only.

In contrast, Matthews et al. (1970) classified occlusion as follows: (1) Class A, where all segments of the maxilla are normally aligned with the mandible, (2) Class B (1), with lingual occlusion of the tooth adjacent to the cleft on the smaller segment, (3) Class B (2), with normal occlusion of the larger segment and lingual occlusion of the smaller segment, (4) Class B (3), where the maxillary arch is too small despite being well-formed, and (5) Class C, which represents a Class III occlusion in all segments of the maxilla and partial collapse of the small maxillary arch. However, this classification system failed to take into account important clinical variables such as open bites, and its reliability was often poor.

Huddart & Bodenham (1972) outlined a method where each upper tooth was given a score based on its alignment with the lower arch. This was a step forward from the previous techniques (Pruzansky and Aduss,1964; Matthews et al.,1970), but like all scoring systems of this kind, it is conceivable that the total score may not precisely reflect the gravity of the malocclusion: a minor, widespread irregularity may produce a higher score than a more severe, localized anomaly.

Mars and colleagues (1987) created a technique to classify malocclusions in children with UCLP that would accurately depict the severity of the malocclusion and the level of difficulty involved in the treatment (Mars et al.,1987). Mars et al. (1987) suggested the critical clinical characteristics that they believed were significant in defining malocclusions in the initial permanent dentition phase of children with UCLP.

These referred to relationships involving the anteroposterior arch, the transverse dimension and the vertical labial segment (Mars et al. 1987). After the models were evaluated and given a ranking, it was clear that the cases could be divided into five distinct groups. These groups were used to create the Goslon yardstick. The measurement system categorizes patients into 5 groups based on the expected outcomes of orthodontic treatment, either alone or in conjunction with orthognathic surgery. The groups range from excellent to poor.

The distribution of the groups was as follows: group 1 was classified as excellent, group 2 as good, group 3 as fair, group 4 as poor, and group 5 as very poor (Mars et al. 1987).

- Patients in groups 1 and 2 have occlusions that can be treated with simple orthodontic treatment or may not require treatment at all.

- Patients in group 3 exhibit Class III malocclusion and require complex orthodontic treatment. However, it is expected that they will achieve a favourable outcome.

- Patients in group 4 have reached the maximum limit of what can be achieved through orthodontic treatment alone to correct skeletal mal relationships. If there is unfavourable facial growth, orthognathic surgery will be necessary.

- Patients in group 5 need orthognathic surgery to correct skeletal mal-relationships if they are to have any chance of achieving satisfactory occlusal relationships (Mars, et al.,1987).

Although the Goslon yardstick (Mars et al.,1987) was initially developed to evaluate study models of 10-year-olds, it has been utilised for monitoring changes in dental arch relationships over time in children with UCLP, as demonstrated by (Noverraz et al., 1993).

Atack et al.(1997a) later created a strong and dependable index for assessing dental relationships in 5-year-old (5YO) patients with UCLP in their primary dentition. This index showed a clearer differentiation between group 1 and group 2 compared to the classification provided by Mars et al. (1987).

The 5YO Index provides the following general characteristics of study models for each group (Atack et al., 1997a):

- Category 1: Favourable characteristics, such as positive overjet, incisors with average inclination or retroclination, absence of crossbites or open bites, well-formed maxillary arch, and appropriate palatal vault anatomy.
- Category 2: Positive overjet, incisors with average inclination or proclination, presence of unilateral crossbite or tendency for crossbite, and potential for open bite around the cleft area.
- Category 3: Incisors with average inclination or proclination, edge-to-edge bite or reverse overjet with retroclined incisors, presence of unilateral crossbite, and potential for open bite around the cleft area.
- Category 4: Incisors with average inclination or proclination, reverse overjet, presence of unilateral crossbite, and potential for bilateral crossbite or open bite around the cleft area.
- Category 5: Proclined incisors with reverse overjet, bilateral crossbite, and unfavourable maxillary arch form and palatal vault anatomy (Atack et al., 1997a).

Furthermore, the 5YO index was subjected for validation, reliability and reproducibility against a large sample of children with UCLP. Atack et al. (1997b) concluded that the index was reproducible and reliable. However, due to the lack of a definitive method for validating the index, it is primarily based on face authenticity.

In 2003, Mossey and colleagues modified Huddart/Bodenham (MHB) classification to supposedly be a better tool than the Goslon and 5YO index in assessing maxillary arch narrowing in orofacial clefting (Mossey et al., 2003). The

Huddart/Bodenham (HB) classification was originally intended to be used as a tool for assessing primary dentition only, this refers to assessing premolars in a similar manner as primary molars (Huddart & Bodenham, 1972).

The MHB scores were then used to determine the total arch constriction score for a given model (Mossey et al., 2003). The MHB classification was found to be more objective and reliable and to meet their criteria in classifying maxillary arch constriction in orofacial clefting. It was also more versatile and more sensitive to interarch discrepancies (Gray & Mossey, 2005).

Later, in 2006, Mars and colleagues assessed the validity of the 5YO index by comparing it to the Goslon yardstick (Mars et al., 1978) for study models of 5YO children (Mars et al., 2006). Atack and colleagues (1997a) used Goslon yardstick in conjunction with the 5YO index to rate the patients based on their dental arch relationships.

The study categorised patients into five groups based on their dental arch characteristics and potential long-term outcomes (Mars et al., 2006):

- Group 1 had a favourable long-term outcome as they had a positive overjet with normally inclined or backward-inclined incisors, and there was no occurrence of crossbite or open bite.
- Group 2 had a good long-term outcome as they had a positive overjet with normally inclined or forward-inclined incisors, and they had a unilateral crossbite or a tendency towards it, with or without an open-bite tendency around the cleft site.
- Group 3 had a fair long-term outcome as they had an edge-to-edge bite with normally inclined or forward-inclined incisors or a reverse overjet with backward-inclined incisors, and they had a unilateral crossbite with or without an open-bite tendency around the cleft site.
- Group 4 had a poor long-term outcome as they had a reverse overjet with normally inclined or forward-inclined incisors, and they had a unilateral

crossbite with or without a bilateral crossbite tendency and an open-bite tendency around the cleft site.

- Finally, group 5 had a very poor long-term outcome as they had a reverse overjet with forward-inclined incisors, a bilateral crossbite, and poor maxillary arch form and palatal vault anatomy.

The Goslon scores at 5 and 10 years were comparable if few modifications are incorporated into the yardstick for assessing arch relationships in 5-year-old patients. The 5YO index marks cases too harshly and does not correlate with future ratings as the patient ages. The Goslon yardstick will give more reliable readings that relate to future outcomes than will the 5YO index. It was suggested that in 5-year-olds the Goslon yardstick group 3 should be rated group 2, and group 4 should become group 3 (Mars et al., 2006).

The Eurocran Yardstick index was created by the Eurocran project members between 2000 and 2004 to evaluate surgical outcomes in UCLP patients (Fudalej et al., 2011). It is essentially a modified version of both the Goslon yardstick and the 5YO index. The index is used for assessing study models and consists of three major components, namely, the degree of malocclusion in the anteroposterior and vertical dimensions and the shape of the palate.

The development of Eurocran involved the analysis of 118 cases from various European centres, where both the Goslon yardstick and the 5YO index were used for evaluation. The results showed that only one case received a grade of 5, while two cases received a grade of 1 by all examiners. As a result, the extremes on the 1-5 scale were considered redundant, and the grading options were reduced to four for the anteroposterior, vertical, and transverse dimensions. A three-grade scale was also used for rating the palatal form.

According to Haque et al. (2015), the Goslon yardstick, 5YO yardstick, Eurocran yardstick, HB index, and MHB index are essential tools for assessing the outcomes of treatments for CLP patients. The Goslon yardstick is widely used for evaluating dental arch relationships in patients with UCLP, as noted by Altalibi et al. (2013).

All dental indices have adequate reliability, and there are significant correlations between them at all ages.

However, the reliability of the Eurocran palatal index has been questioned by Heliövaara et al. (2022). As per the findings of Jones et al. in 2016, there was a lack of evident predictive validity observed in the Eurocran palatal index. Finally, Haque et al. (2015) suggest that the 5-year-old yardstick is the most appropriate index for evaluating 5-year-old patients with CLP.

According to Jones et al. (2016), the Goslon yardstick provides less severe evaluations of treatment outcomes compared to the 5YO index, and the MHB index is the most critical of the three. They suggest that the Goslon yardstick is the best tool for evaluating UCLP models of 10-year-olds and is considered the gold standard in this regard (Jones et al., 2016).

2.2 Intra and inter- examiner agreements:

Various authors have used different indices and achieved different outcomes in their studies (Jones et al., 2016; Heliövaara et al., 2022). Hathorn et al. (1996) employed the Goslon yardstick to evaluate a series of patients with UCLP. Dental models of 32 patients consecutively treated for UCLP at Frenchay Hospital in Bristol, UK were examined using the Goslon yardstick. The intra-examiner agreement was high, with all judges obtaining a score of more than 0.89. Furthermore, the inter-examiner agreement was also high, with coefficients of more than 0.88, indicating very good agreement among all examiners.

Susami et al. (2006) conducted a study on 24 Japanese UCLP patients who had not yet undergone orthodontic treatment or alveolar bone grafting. They evaluated the dental arch relationships using the Goslon yardstick and calculated the intra- and inter- examiner agreements using weighted kappa statistics. The findings of the study revealed strong agreement within each examiner, as demonstrated by kappa

values of 0.78, 0.98, and 0.94 for the three evaluators, indicating a high level of reproducibility. The agreement between different evaluators ranged from 0.67 to 0.77, demonstrating a good level of agreement among all evaluators.

Rizell and colleagues (2021) carried out RCTs under the Scandcleft project to examine how upper jaw dental agenesis affects craniofacial growth and dental arch alignment in 8-year-old children. They reported similar results to other studies using the Goslon yardstick, with moderate to very good levels of agreement among examiners. Intra- rater reliability was good to very good, ranging from 0.62 to 0.89, while inter-rater reliability varied from moderate to good, ranging from 0.60 to 0.80.

The Vienna concept was used to treat patients with UCLP, and the Goslon yardstick was employed by Sinko et al. (2008) to evaluate the outcomes. The intra- and inter-examiner agreements were assessed by repeating the Goslon scoring in the morning and afternoon. The inter-rater agreement between the two researchers was found to increase from 0.49 to 0.57 after the morning calibration. In addition, the intra-rater agreement was determined to be 0.66 for Dr. Mars and 0.87 for Dr. Sinko.

According to Sinko et al. (2008), the agreement between the two investigators in scoring Goslon models increased from "moderate" to "very good" from the morning to the afternoon. Therefore, they concluded that standardising the rating process among different centres worldwide and training investigators to score well-documented Goslon models can be advantageous.

2.3 Comparison of treatment outcome

According to Haque et al. (2015), the Goslon yardstick is utilized to assess and compare the outcomes of various early treatment approaches for children with CLP in the long term, such as presurgical orthopaedic treatment and diverse surgical procedures. Mars et al. (1987) came up with a system to classify malocclusions in UCLP patients based on the severity of the malocclusion and the level of difficulty in correcting it.

To develop this system, they examined 55 sets of study models of children with UCLP who were in the early permanent dentition and had not received any orthodontic treatment other than correction of anterior crossbites during the early mixed dentition stage. The study compared the results of this group with two groups from Great Ormond Street Hospital: group A, which included children who received presurgical orthopaedic treatment, and group B, which included those who did not receive this treatment due to it not being a standard practice at the time of treatment. The results showed that the Oslo sample had lower scores compared to the two Great Ormond Street (GOS) groups. In the GOS models, 15 were in group 1, 28 were in group 4, and 28 were in group 5. However, there was no significant difference between the two GOS groups. The Oslo models were categorized as 47 in group 2 and 29 in group 3.

Mars et al. (1992) conducted a study to evaluate dental arch relationships in six European centres using the Goslon yardstick. The centres were labelled A to F and had different methods of lip and palate repair, early Orthopaedics, and surgeons involved. The study found that nearly half of the subjects from centre D were placed in groups 4 or 5, and similar poor results were found in centres C and F. Johnson and colleagues (2000) conducted a study in Western Australia to evaluate dental arch relationships in children with UCLP. According to their findings, 77% of the participants were categorized as Goslon grade 1, 2, or 3, while 23% were classified as having poor/very poor outcomes. These results were similar to the data obtained in the UK as a whole.

Mølsted et al. (2005) conducted the Eurocleft Intercentre study to evaluate the long-term treatment outcomes in UCLP patients. The study used the Goslon yardstick to assess dental arch relationships at ages 9 (Mars et al., 1992), 12, and 17 years (Mølsted et al., 2005.). At age 12, Centres A, B, and E had better mean score ratings than Centres D and F. At 17 years of age, Centres F and D had 50% of their mean score cases equivalent to a poor or very poor outcome, whereas Centres E and A had fewer than 10% in this category. At age 9, nearly 50% of patients from Centre D were placed in Groups 4 or 5, and similar results were found in Centres C and F.

The CSAG discovered that a considerable number of 5-year-old models (37%) and 12-year-old models (39%) in the UK were categorized as 'poor' or 'very poor' (Bearn et al., 2001). In contrast, Hathorn et al. (1996) found that most of the Fenchay cases were categorised as unfavourable (Group 3, 4, and 5) on the Goslon yardstick, with 30.6% in Group 3, 36.1% in Group 4, and only 19.4% in Group 5. When comparing favourable and unfavourable Goslon categories, Groups 1 and 2 comprised 13.9% of the total sample, whereas Groups 4 and 5 constituted 55.5%. A similar study conducted by Zreaqat et al. (2009) found comparable results when analysing UCLP models of Malay children.

The Americleft Inter-Centre Study (Long et al.,2011.) was based on the Eurocleft study (Shaw et al., 1992) and assessed dental arch relationship, craniofacial structure, and nasolabial growth outcome measures. Among the five centres, Centre B had the worst mean score because it had the highest proportion of Goslon scores of 4 and 5 (Russell et al., 2011). In the Scandcleft RCTs, Heliövaara et al. (2017) used the 5-year index score to evaluate dental arch relationships in UCLP patients who underwent four different primary surgery protocols. The mean 5-year score for the entire sample was 2.77, with Trial 2, Arm C having the lowest mean index score of 2.52, and Trial 3, Arm D having the highest mean index score of 2.94.

Heliövaara et al. (2020) used the Goslon yardstick to evaluate dental arch relationships in 8-year-olds. The percentage of patients in the excellent and good categories (categories 1 and 2) varied from 31.9% (Trial 3, Arm D) to 55.1% (Trial 2, Arm C), while the percentage of patients in the poor and very poor categories (categories 4 and 5) ranged from 18.8% (Trial 2, Arm C) to 37.7% (Trial 3, Arm A). Heliövaara et al., (2022) compared dental arch relationships at 5, 8, and 10 years and found that the mean Goslon scores were 2.77 (at 5 years) (Heliövaara et al., 2017), 2.90 (at 8 years) (Heliövaara et al., 2020), and 2.54 (at 10 years).

The distribution of index scores became slightly more unfavourable as the age increased from 5 to 8 years, according to Heliövaara et al. (2022). By the age of 10, there was an increase in the percentage of index scores 1 and 2 as evaluated by

both the Eurocran index and the Goslon Yardstick, according to the study findings. For all patients at all ages, the percentages of those categorised as excellent and good (1, 2) ranged from 39.3% to 61.9%, while the percentage of those categorised as poor (4) ranged from 15.1% to 25% in the Eurocran and 5-year-old indices, as well as in the Goslon Yardstick categories. Furthermore, Heliövaara et al. (2022) found that the percentage of patients falling into the category of "very poor" (group 5) remained consistent at 4.4% to 4.6% from the age of 5 to 10 years according to the 5YO index and Goslon Yardstick.

The common protocol and alternative protocols did not show any noteworthy variations in the average 5-, 8-, and 10-year index scores, as per the results of the trials conducted in studies by Heliövaara et al. in 2017, 2020, and 2022. According to a study by Rizell et al. 2021, children born with UCLP have a higher occurrence of dental agenesis than those without a cleft. In 2021, Rizell and colleagues conducted a study to investigate how maxillary dental agenesis affects the growth of the craniofacial region and the dental arch relationship in 8-year-old children with UCLP (Rizell et al., 2021). The purpose of the study conducted by Rizell et al., (2021) was to examine how maxillary dental agenesis affects the growth of the face and the relationship between the dental arches in children who are 8 years old as part of the Scandcleft RCTs.

The findings of the study revealed that the group of children who had agenesis of two or more maxillary teeth showed a greater proportion of individuals with Goslon scores of 4-5 (47.2%) compared to those who had no agenesis or only one maxillary tooth affected (26.1% and 26.3%, respectively). Rizell et al. (2021) also found a notable distinction in the Goslon scores distribution among groups with varying counts of maxillary teeth affected.

2.4 Surgical variables

According to a study by Shi and Losee in 2015, in cases of CLP, after the primary lip repair, a reduction in maxillary length and a backward movement of the upper jaw were noted, regardless of whether the cleft palate was surgically corrected or not (Shi and Losee, 2015). Meanwhile, a European inter-center study conducted by

Shaw and colleagues in 2001 revealed that out of 201 cleft teams, 194 distinct treatment protocols were being used for the management of unilateral clefts alone (Shaw et al., 2001).

Mars and Houston (1990) demonstrated that early lip and palate repair resulted with poor arch relationship. This was similar to the use of presurgical orthopaedics with extra oral traction for correction of the septal deviation and primary alveolar bone grafting with macerated rib was conducted.

Fowler and colleagues (2019) looking at the casted plaster and 3D digital UCLP models to determine the reliability of a Goslon and 10-cm VAS, reported that most New Zealand (NZ) models were in Goslon group 4 (54.3%) and 3 (22.8%) and whilst for the Oslo models majority of the models were in group 2(57.1%) and Group 3(25.7%) (Fowler et al., 2019). Surgeons in both Oslo and New Zealand performed the initial surgery to repair the cleft lip of their patients when they were between three to six months old. In contrast, the surgery to repair the cleft palate was conducted at around 12 months old in New Zealand, but in Oslo, it was delayed until the child reached approximately 18 months old (Fowler et al., 2019).

The Scandcleft RCTs, which focus on primary surgery for UCLP, are a longitudinal study that assessed dental arch relationships at the age of five (Heliövaara et al., 2017) 8 Years (Heliövaara et al., 2020) and 10 years (Heliövaara et al., 2022).Surgical protocols for the Scandcleft RCTs were as follows : In each trial of the Scandcleft study, a standardised surgical protocol was established as the reference method and compared to a common protocol.

In the study (Heliövaara et al., 2017), a standardized protocol was followed for the surgical procedure, which consisted of closing the lip and soft palate at 3-4 months. and the hard palate at 12 months. The timing of hard palate repair was the only. differing factors in the first trial. It was performed at 36 months. The second trial involved a comparison between the protocol used in the first trial, where the lip was repaired at 3-4 months and the hard palate was repaired at 12 months, and a modified version where the hard and soft palates were also repaired at 12 months

(Heliövaara et al., 2022). Semb et al. (2017) conducted a third trial that involved repairing the lip and hard palate at 3-4 months and the soft palate at 12 months using a modified surgical protocol.

Heliövaara et al. (2017) discovered that there were no significant statistical distinctions in dental arch relationships between the standard surgical protocol and the alternative protocol in the trials. According to the study by Heliövaara et al. (2017), different surgical protocols, such as varying the timing, staging, or sequencing of hard and soft palate repair, did not result in significant differences in dental arch relationships in children who underwent lip repair at 3-4 months and were evaluated at 5 years of age.

Similarly, Heliövaara et al., (2017), Heliövaara et al., (2020) and Heliövaara et al. (2022) reported that there were no notable disparities in dental arch measurements at 5, 8, and 10 years old between the two groups in Trial 1, where hard palate closure was carried out at either 12 or 36 months. Fowler et al., (2019) found that the Oslo models, in which the palatal reparation was delayed until about 18 months, had good Goslon scores, while the NZ models, with early palate repair around 12 months, had worse scores. Postponing the surgical closure of the palate could heighten the likelihood of difficulties in the development of speech, as per Willadsen et al. (2022). In Trial 1, Arm B (hard palate closure at 36 months), Heliövaara et al., (2020) found that children had further cleft speech traits compared to those in Arm A (hard palate closure at 12 months).

2.5 Summary of Literature review

Occlusal indices for assessing the dental arch alignment of patients with UCLP are evolving. Old approaches for evaluating dental irregularities and arch relationships were only structured for adult patients. Mars and colleagues (1987) came up with a reliable technique to classify malocclusions in children with UCLP. Since then, other researchers have attempted to improve the Goslon yardstick. Jones et al., (2016) applaud the Goslon yardstick being the best tool for evaluating UCLP models of 10-year-olds and considered it as the gold standard in this regard.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter is centred around the research methodology and context, including the study design and location, sample selection and technique, criteria for inclusion and exclusion, as well as the tools, measures, and procedures used for data collection and analysis. Ethical considerations are also addressed.

3.1 The Study Design

The study was conducted retrospectively using quantitative cross-sectional descriptive methods, based on reviewing records.

3.2 Study Setting

The UWC is an academic institution situated in Bellville near Cape Town, SA with different faculties. The Faculty of Dentistry is situated in Tygerberg and offers clinical dental training in Groot Schuur, Mitchells' Plain, Red Cross War Memorial Children and Tygerberg Oral and Dental Hospitals.

The institution provides both undergraduate and postgraduate training to enable students to become oral hygienists, dentists and specialists in various fields of dentistry. It also provides various oral health care services i.e., scaling and polishing, dental restorations, tooth exodontia, construction of dentures and also management of special cases such as patients with oral lesions, patients with facial fractures and children who present with CLP.

The Faculty of Dentistry is comprised of eight departments, which are the Departments of Oral Hygiene, Maxillofacial and Oral Surgery, Maxillofacial and Oral Pathology, Maxillofacial and Oral Radiology, Community Dentistry, Orthodontics and Paediatric Dentistry, Periodontology and Oral Medicine, and Conservative Dentistry and Prosthodontics.

Approximately 80 fresh patients visit on a daily basis, with 40 referrals from other medical facilities, and around 300 patients returning for follow-up appointments and evaluations.

3.3 Study sample

The research was carried out on models of patients aged from 8 to 15 years old., with UCLP, from January 1990 to October 2022 in the orthodontic clinics of the UWC. Sample Size

A convenient sample was selected, and this included available ULCP study models from January 1990 to October 2022. Brink et al. (2008) describe convenient sampling as accidental or availability sampling, which entails selecting readily accessible subjects or objects for the research.

3.4 Inclusion criteria.

The inclusion criteria comprised of all study models of patients from the ages of eight to 15 years with UCLP from January 1990 to October 2022 in the orthodontic clinics of the UWC. Prior to ABG and orthodontic treatment.

Selection criteria were:

- UCLP study models of patients who did not have syndromes.
- Patients with no Symonarts bands.
- Patients who did not undergo any orthodontic intervention or alveolar bone grafting.

3.5 Exclusion criteria.

This study did not include study models of UCLP patients with syndromes.

3.6 Data collection

The hospital records of patients between the ages of eight to 15 years with UCLP, from January 1990 to October 2022, were obtained from the archives of the Department of Orthodontics at UWC (including Tygerberg, Mitchell Plain, and Red Cross War Memorial Children's Hospitals) to establish the type of cleft, side of cleft, patient's date of birth, gender and date of the casted models. To identify the type and side of the cleft, the LAHSAL code (Kriens, 1989) was utilized. The code stands for Lip, Alveolus, Hard palate, soft palate, Alveolus, Lip.

Each model was given a unique number. Three assessors, including the principal investigator, used the Goslon Yardstick (see Annexure A) to assess UCLP study models.

A master replica of the Goslon Yardstick was available. The Yardstick consists of twenty sets of models which display the different characteristics applied to each category. A number of models are required as no one set would display all the characteristics of each category. The yardstick is used to match each case with an example to determine which category it is allocated to. Group 1 has three sets of models, group 2 has 6 sets of models, group 3 has 3 sets of models, group 4 has 3 sets of models and group 5 has 3 sets of models (Figure 2.1). In order to minimize recall bias assessors took 10% of the total sample to calculate the inter and intra examiner reliability 2 weeks apart from the initial scoring.

Figure 3.1: Full set of GOSLON Yardstick reference models

3.7 Measurements and Data Analysis

Prior to the start of data collection, consent and necessary permissions were obtained to gain access to the research site.

Data was recorded in a Microsoft Excel spreadsheet, and subsequently cleaned and transferred to SPSS software for analysis. To achieve the study's goal, descriptive statistics were presented.

Parametric analysis techniques were employed to analyse continuous data (age), which was reported as either mean (standard deviation) or median (minimum-maximum). Frequency tables were constructed, displaying age, gender, cleft side, and Goslon categories in numbers and percentages. The results were summarized using proportions, histograms, and pie charts.

To evaluate the reliability among examiners, both intra- and inter-examiner agreements were measured using weighted kappa scores. For categorical data, it is recommended, 0.60 kappa value and more indicates good agreement, and 0.80 value and more represents an excellent depth of agreement (Landis & Koch, 1977).

3.8 Ethical Consideration

a) Permission to conduct the study.

To carry out this research, the investigator acquired written ethical clearance from the Biomedical Science Research Ethics Committee of UWC (BMREC) and the Western Cape Department of Health (WCDH). Approval to access the research site was also officially obtained from the Head of the Department of Orthodontics (refer to Annexure B) and the Dean of UWC (refer to Annexure C). Approval was granted by the BMREC with reference number: BM20/10/24 (see Annexure D) and WCDH with reference number: WC_202202_030 respectively (see Annexure E).

b) Anonymity and confidentiality

To maintain confidentiality and protect the personal rights of the patients in this study, no names or other identifying information were used. Rather than using patient identifiers, a distinct case number was assigned to each study model, and any such identifiers were eliminated and stored separately, accessible only to the researcher. The researcher ensured that all data collected for the study were securely kept confidential and locked up in a secured site.

CHAPTER 4

PRESENTATION OF RESULTS

"In Chapter 3, we provided an overview of our research methodology, including the data collection procedures and tools used. The present chapter will concentrate on the quantitative data gathered to examine dental arch relationships in SA children with UCLP and will delve into the three key research objectives in detail."

4.1 Sample size

A total of 71 UCLP models between January 1990 to October 2022 were retrieved from the archives of the orthodontic clinics of the UWC. Of these, 68 satisfied the inclusion criteria on evaluating the dental arch relationships of children with UCLP in WC, SA.

4.2 Sample Characteristics

Figures 4.1 to 4.2 provide a summary of the sample characteristics. The mean age of the study participants was 11.5 years, with a range of ages from 7.5 to 15.6 years old. The majority of the models fell within the age range of 11 to 13 years old, as shown in table 4.1. Female participants accounted for over half of the sample (52.94%) as shown in figure 4.1, and the cleft was on the left side in 75% of cases, as illustrated in figure 4.2.

Table 4.1: Model age distribution (n=68)

Age (in years)	Frequency	Percentage
7.5 -10 yrs.	23	34%
11-13 yrs.	32	47%
14yrs &above	13	19%

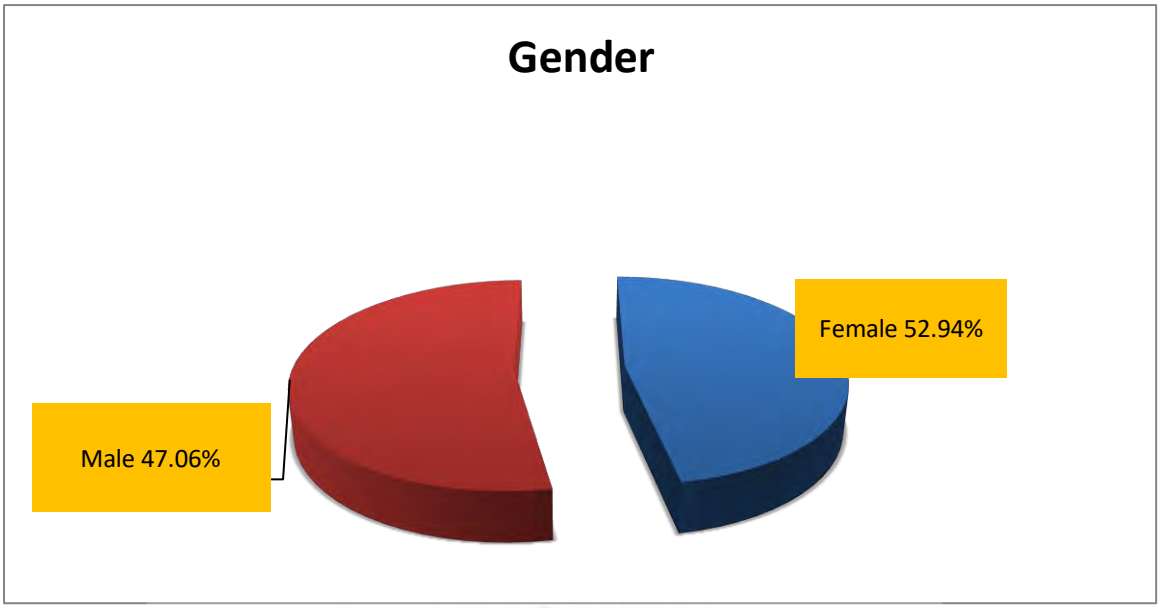


Figure 4.1: Gender distribution of models (n=68)

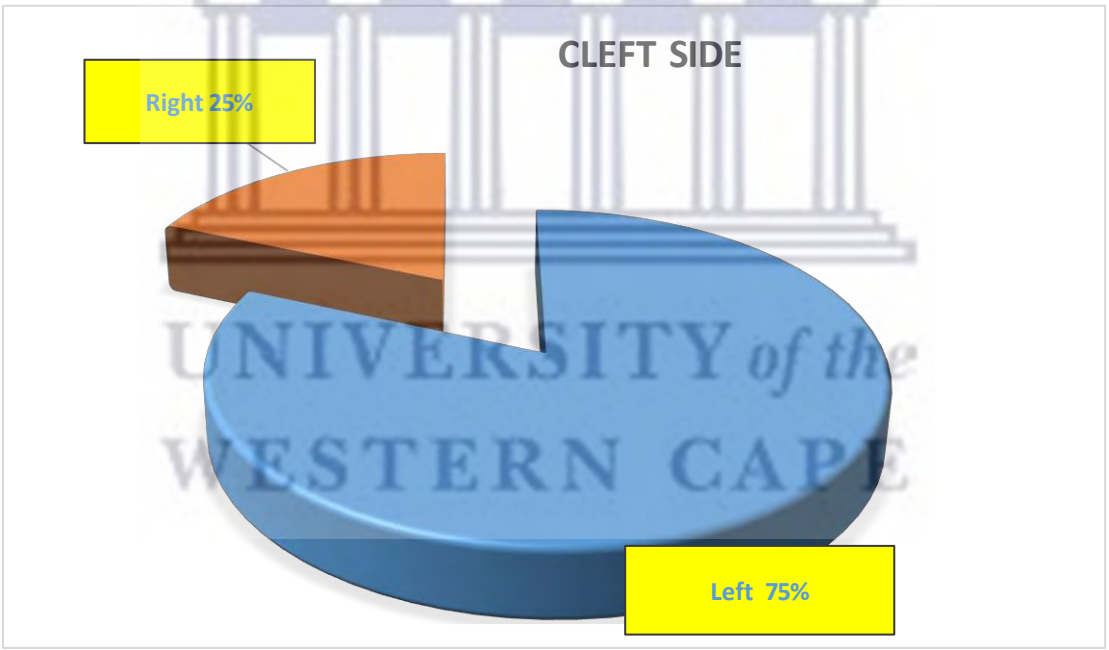


Figure 4.2: Cleft Side distribution of models (n=68)

4.3 The first Objective:

was to assess the dental arch relationships of individuals with UCLP by utilizing the Goslon yardstick.

Table 4.2 shows the Goslon mean scores for the WC UCLP models (mean 2.91). Distribution of the Goslon grades of the three assessors on the WC UCLP models are demonstrated in Table 4.3.

Assessor 1 scored majority (36.8%) of the sample into Goslon category 2, assessor 2 scored most (35.3%) of models in Goslon category 3, whilst 3rd assessor scored equal distribution of models in group 2 (33.8%) and 3 (33.8%) (see table 4.3)

Table 4.2 Average Goslon Score

Goslon Score	Mean	Min	Max
	2.91	2.86	2.94

Table 4.3 Goslon grade distribution of the three assessors

Goslon Group	Assessor 1 n (%)	Assessor 2 n (%)	Assessor 3 n (%)
1	06 (8,8 %)	07 (10,3 %)	04(5,9%)
2	25 (36,8 %)	18(26,5%)	23(33,8%)
3	19(27,9 %)	24(35,3 %)	23(33,8%)
4	08 (11,8 %)	10(14,7%)	09(13,2%)
5	10(14.7%)	09(13,2%)	09(13,2%)

4.4 The second objective:

was to assess the level of agreement among raters, both within and between them, using the Goslon yardstick to evaluate dental arch relationships in UCLP patients.

Table 4.4 and 4.5 present the reliability of evaluating dental arch relationships among children with unilateral cleft lip and palate in SA, for inter-rater and intra-rater agreement. The inter-rater agreement Kappa values ranges from .649 (between assessor 1 and 2) to .788 (between assessor 2 and 3), as shown in Table 4.4. The intrarater Kappa ranged from .681 (Assessor 2) to .792 (Assessor 3) (Table 4.5).

Table 4.4: Interrater Agreement (Weighted Kappa)

Assessor	Kappa	Standard Error	95% Confidence Intervals
1 versus 2	.649	.055	.540 to .757
1 versus 3	.708	.055	.599 to .816
2 versus 3	.788	.046	.698 to .878

Table 4.5: Intrarater Agreement (Weighted Kappa)

Assessor	Kappa	Standard Error	95% Confidence Intervals
1	.757	.085	.591 to .923
2	.681	.112	.462 to .900
3	.792	.089	.618 to .965

4.5 The third objective:

was to create a reference group for future comparisons between WC, SA UCLP patients and the Oslo Good Practice Archives, specifically by using the Goslon score to evaluate the dental. arch relationships of UCLP patients in the WC.

Many of the models were in Goslon category 2 (n 22) and 3 (n 22) and there was equal distribution for category 4 (n 9) and 5 (n 9.3) (Figure 4.3).

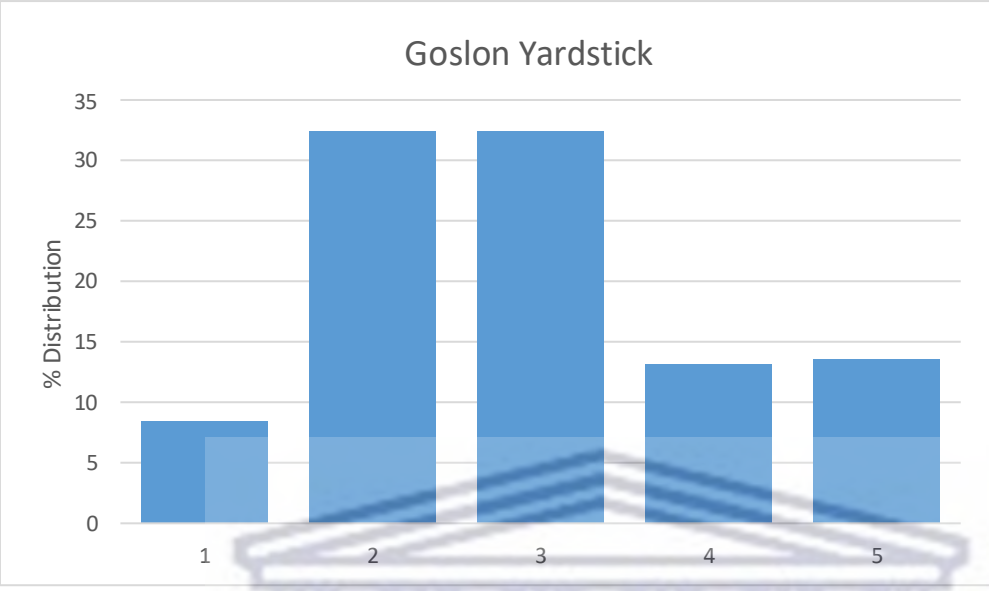


Figure 4.3: Western Cape Goslon Sample (n=68)

CHAPTER 5

DISSCUSION

This concluding chapter will examine the findings from Chapter 4 and discuss them in relation to the literature review. The study's limitations will also be discussed, and conclusions will be drawn based on the results. The latter part of the chapter will include recommendations based on the study's findings.

5.1 Sample Characteristics

Shaw et al. (1992) suggested the necessary sample sizes for detecting differences in various outcomes when evaluating UCLP. According to their study, the rating of dental arch relationship (Mars et al.,1987) required the smallest sample size for identifying differences between groups. In the group of 9-year-olds, a discrepancy of 0.5 points on the Goslon scale was sufficient to differentiate the highest and moderately rated facilities from the moderately and poorly rated ones.

For detecting a 0.5 Goslon scale point difference with 5% probability and 80% power in 9-year-olds, the sample sizes required were 42 UCLP cases for a two-group assessment, 63 cases for a five-group versus one reference comparison, and 77 cases for a six-group mutual comparison (Shaw et al.,1992). We retrieved 71 cases of UCLP from the orthodontic clinics at the UWC for our study. Among them, 68 cases met the criteria for assessing dental arch relationships in SA patients with UCLP. Our sample size in comparison to Shaw et al. (1992) s findings we were able to detect differences in various outcomes when evaluating UCLP in one group.

Hlongwa et al. (2019) estimated the prevalence of CLP in WC to be 146 for a period of two years. This gives us an equal distribution of 73 CLP for two years. In our study we retrieved UCLP from 1990 to 2022 which is for the past 22 years. We estimated UCLPs to be 25% of the CLP per year. Then 22 years multiplied by 73 CLP equals to 1606 and 25% of 1606 gives us 401.5 of UCLP for the entire Western Cape province over

a period of 22 years. In our study we had 71 UCLP models and this was only based on two cleft hospitals in the entire province.

The Goslon Yardstick index was created by Mars et al. (1987) to evaluate dental relationships in patients with UCLP who were in the late mixed dentition stage (around 10 years old), using cast study models. To examine the dental arch relationships in children with UCLP, Lilja et al. (2006) carried out a study spanning 20 years. The study included UCLP study models from 94 children at 5 years, 97 at 10 years, 59 at 16 years, and 46 at 19 years of age. In our study, the mean age of the UCLP study models was 11.5 years, with a range of 7.5 to 15.6 years, and this was not a longitudinal study.

The Warsaw sample consisted of more male (n 42) plaster models as compared to female models (n 19) of 61 successively treated patients (42 boys, 19 girls) with a non-syndromic UCLP (Fudalej et al., 2009). Similar findings were reported by Miteff et al. (2018) most of their sample were more males (38) than females (28). Our WC sample was made of 68 plaster models sequentially treated children (n (32) males, n (36) females) with a non-syndromic complete UCLP.

According to Zreaqat et al. (2009), 62.2% of the UCLP models they studied in Malay children had a left-sided cleft, while 37.8% had a right-sided cleft. Children with UCLP at Princess Margaret Hospital for Children, Perth, Western Australia presented with more clefts on the left side (43) as compared to the right side (23) (Miteff et al., 2018). This is similar to our study sample majority (n (51) 75%) of the UCLP cases were left sided and less on the right side (n (17) 25%). Although left-sided clefts are frequently reported in literature, the cause of this phenomenon remains unidentified (Daskalogiannakis et al., 1997).

5.2 Objective 1:

To determine the dental arch relationships of the patients with UCLP using the Goslon yardstick.

The Goslon yardstick has been the most commonly utilized index to evaluate dental arch relationships in UCLP since 1984. (Altalibi et al., 2013). In the Scandcleft study, (Heliövaara et al., 2020) reported the Goslon mean of 2.90 for the 8-year-olds UCLP models. Nicholls et al. (2014) had similar results assessing dental study casts (mean 2.96). Our findings (with a value of 2.91) are consistent with previous research (Heliövaara et al., 2020), (Nicholls et al., 2014).

In our Western Cape sample the majority of the models were in Goslon category 2 (32.4%) and 3 (32.4%). The findings of our study align with those of previous research. Specifically, a UK study found that 37% of UCLP models were ranked as good outcomes (group 2), 31% were considered fair (group 3), and 32% were classified as poor/very poor (groups 4 and 5) (Morris et al.,2000). However, the Japanese study (Susami et al., 2006) and the study of Malay children (Zreaqat et al., 2009) reported poorer Goslon scores, with 13.2% and 31.7% of models in group 4 and 13.9% and 6.1% of models in group 5, respectively.

5.3 Objective 2:

To determine the intra- and interrater agreement using the Goslon yardstick.

Due to its high reliability and ease of use, the Goslon yardstick is a commonly used method for evaluating cleft dental arch relationships in research. However, it requires comprehensive examiner training and calibration, as noted by (Mars et al.,1987). Studies by Susami et al. (2006) and Mølsted et al. (2005) have shown that the Goslon yardstick has demonstrated high levels of reliability both within and between raters. Therefore, it has become a common tool for comparing treatment outcomes between different cleft centres, as demonstrated in studies by (Noverraz et al. (1993), Mars et al. (2006), and Love et al. (2012).

In our study Goslon showed a very good kappa score for interrater agreement fluctuated between 0.649 to 0. 788.The intrarater Kappa ranged from 0.681to 0.792. The Scandcleft RCTs examined 5-year-old individuals with unilateral cleft lip and palate (UCLP) using models. According to Heliövaara et al. (2017), the consistency of ratings within and between different raters was of high quality, with scores ranging from 0.71 to 0.94 and 0.70 to 0.87, respectively.

Mølsted et al. (2005) reported good to very good intra- and interrater kappa scores ranged0.71–0.94 and 0.70–0.87, respectively. However, Heliövaara et al., (2020) reported good to very good (0.62 and 0.89) Intra kappa score and moderate to good (0.60 and 0.80) inter-rater kappa score for 8-year-olds. The mean interrater reliability for the Americleft Study was .86 and the mean intra-rater kappa score was .91, also demonstrating good consistency among the different raters (Hathaway et al., 2011).

In our Western cape sample, we used Landis and Koch (1977) agreement categories from kappa calculations to interpret our findings. Landis and Koch (1977) established six levels of agreement categories based on the kappa values: less than 0.20 (poor), 0.21-0.40 (fair), 0.41-0.60 (moderate), 0.61-0.80 (good), 0.81-1.00 (very good), and 1.00 (perfect agreement).

5.4 Objective 3:

To provide a sample which can be used in the future to compare a South African UCLP patient sample with the Oslo Good Practice Archives using the Goslon score on evaluating the dental arch relationships of the patients with UCLP in the Western Cape assessor.

Bellardie (2022) suggested that when showcasing unit or center results for nomogram and peer assessment rating, it is advisable to employ bar charts with a traffic light system, resembling the display of Goslon outcomes. In our study we used bar charts with traffic light approach to categories UCLP that will need straightforward orthodontic treatment or none (green), those with fair results that requires maxillary osteotomy to advance the maxilla(yellow) and those who have sub-standard or very poor results, equivalent to those who need orthognathic surgery(red).

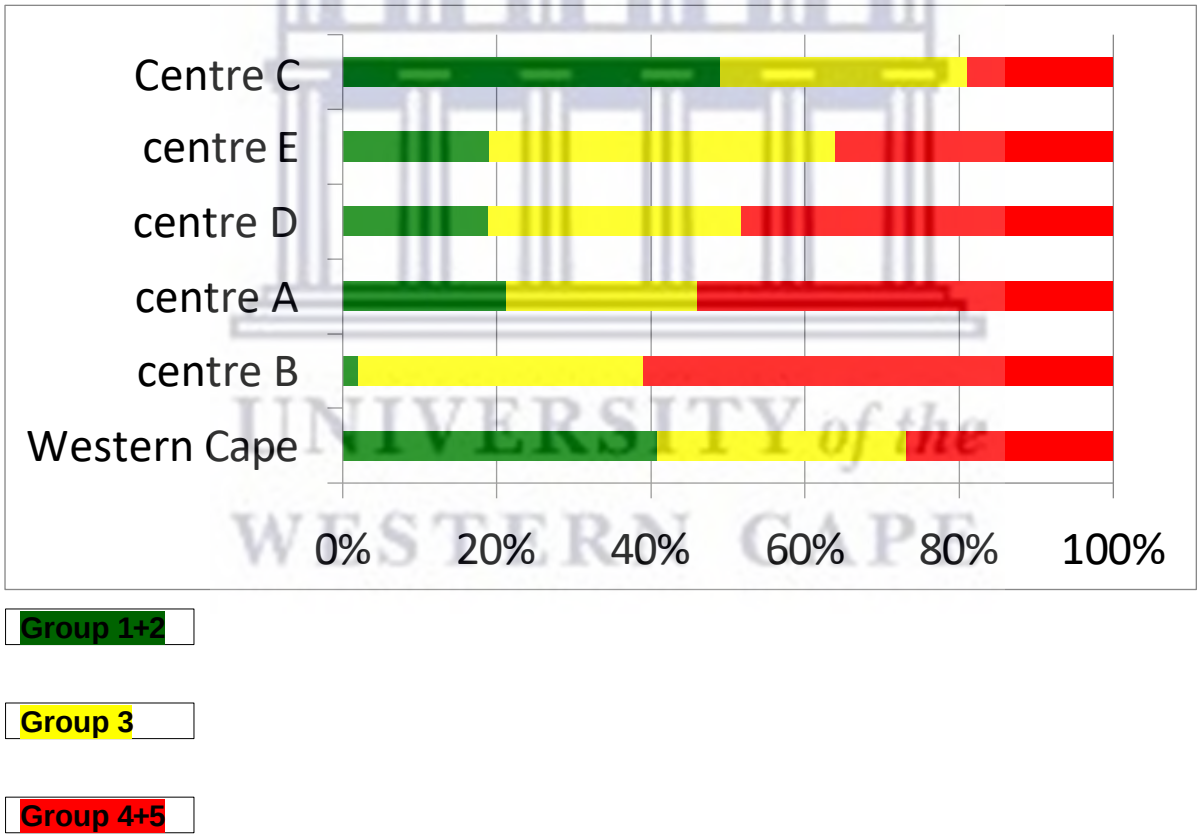


Figure 5.1 Western Cape VS Americleft (Hathaway et al., 2011).

In our research, 40.8% of models fell within the combined category of group 1 and group 2, a proportion higher than that observed in other Americleft centers except for center C. Americleft center C, 49% of UCLP models were group 1 combined with group 2 (Hathaway et al., 2011) (Figure 5.1). UCLP models in Goslon category one and two needs straightforward orthodontic treatment or none (Mars et al.,1987).

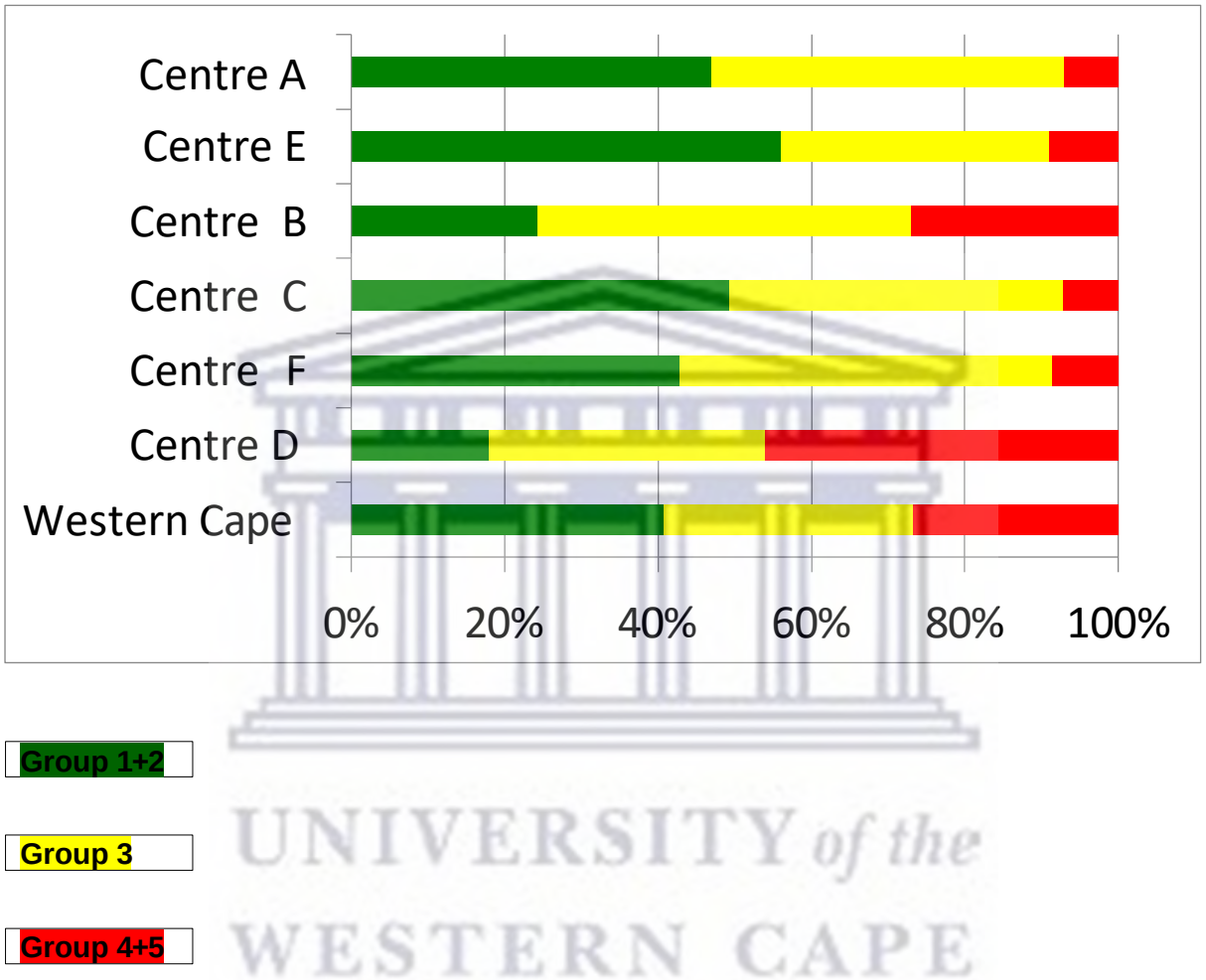


Figure 5.2 Western Cape VS Eurocleft (Molsted et al.,2005)

The Eurocleft Intercenter study indicated center A, E and C achieved very good outcomes with no need for maxillary osteotomy or orthognathic surgery with percentages more than 50% (Mølsted et al.,2005) (see Figure 5.2). Whilst the Western cape sample and Eurocleft center F achieved 40% better results without any need for orthognathic surgery.

Both Centre B and D had more than 26 % of the ULCP models in Goslon category 3 (Fair) (Mølsted et al.,2005). Whilst in our study 32.4% of the ULCP models were in this fair category that requires maxillary osteotomy to advance the maxilla to obtain a better dentoalveolar relationship (see Figure 5.2).

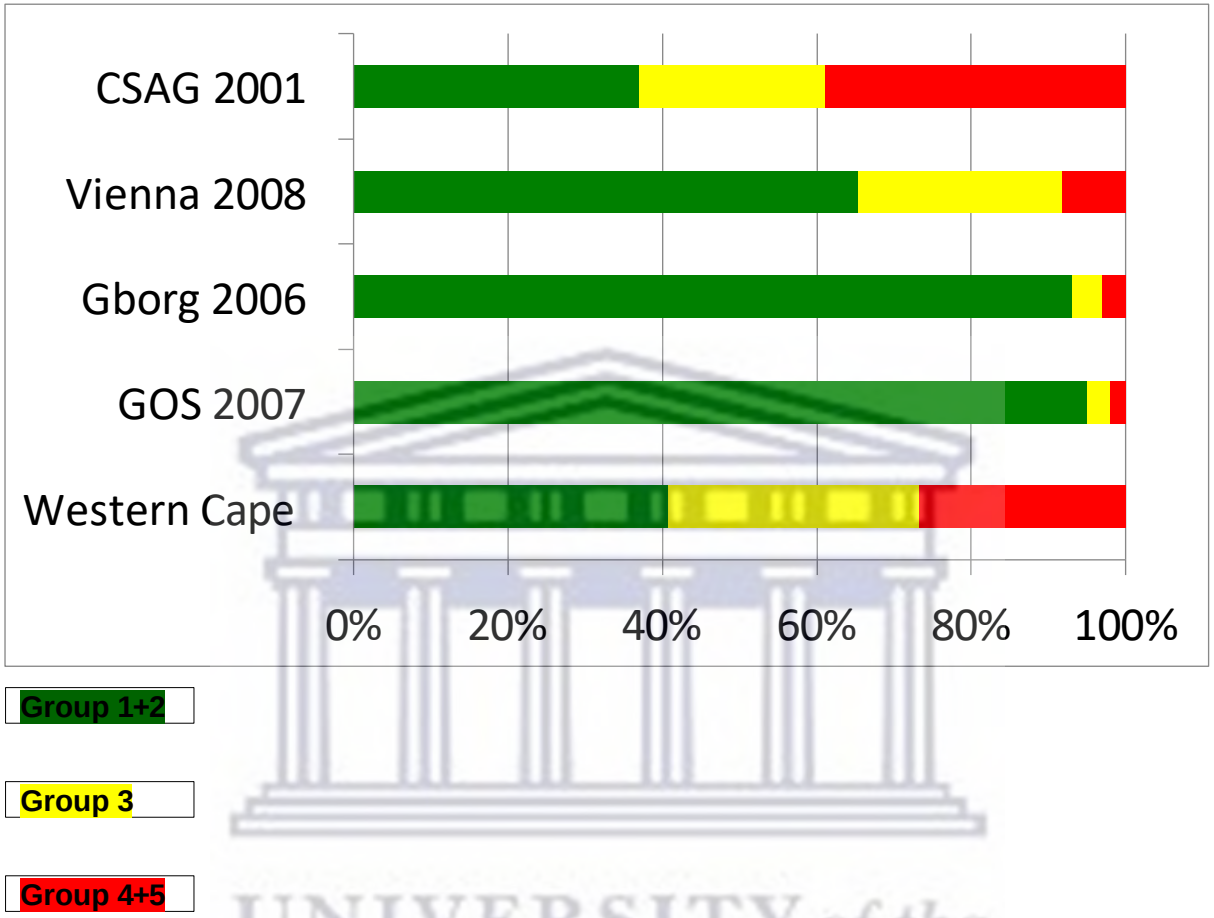


Figure 5.3 Western Cape VS Multiple Centers (CSAG 2001, Vienna 2008, Gothenborg 2006, Gos 2007)

The study conducted by CSAG found that 39% of UCLP models were categorised in group 4 and 5 on the Goslon scale, indicating a significant proportion with a poor or very poor outcome that may require orthognathic surgery. (Williams et al., 2001). In Our study only 26.8 % UCLP models were in Goslon category 4 and 5 (see Figure 5.3)

5.5 Limitations

The findings of this study, being cross- sectional in nature, cannot be extrapolated to the entire population of SA. This research did not look into the surgical variables (surgical techniques, timing, sequence of procedure, skill of individual surgeons, ancillary interventions) that can impact outcomes of UCLP.

5.6 Conclusions

This study evaluated the dental arch relationship of people born with UCLP in the Western Cape (WC) province using the Goslon Yardstick. The main finding revealed that Western Cape (WC) province had Goslon score of 2.9 which is a fair result compared to the Goslon scores of Gothenborg and the better units in Six center, Americleft. The majority of the models were in the good and fair Goslon Yardstick categories. The inter and intra Kappa statistics confirm good to very good reliability.

5.7 Recommendations.

The results indicate a need for further investigation of the dental arch relationship of people with UCLP on a national level.

It is recommended to implement a user-friendly software system to maintain patients' records in electronic format. Nicholls et al., (2014) reported high degree of reproducibility and repeatability for Goslon scoring using digital models.

Further studies are needed to look at surgical variables (surgical techniques, timing, sequence of procedure, skill of individual surgeons, ancillary interventions) that can impact outcomes of UCLP. In the future initiation of multicentred RCTs would be paramount, however that will need the establishment of better infrastructure and research capability.

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7. ANNEXURES

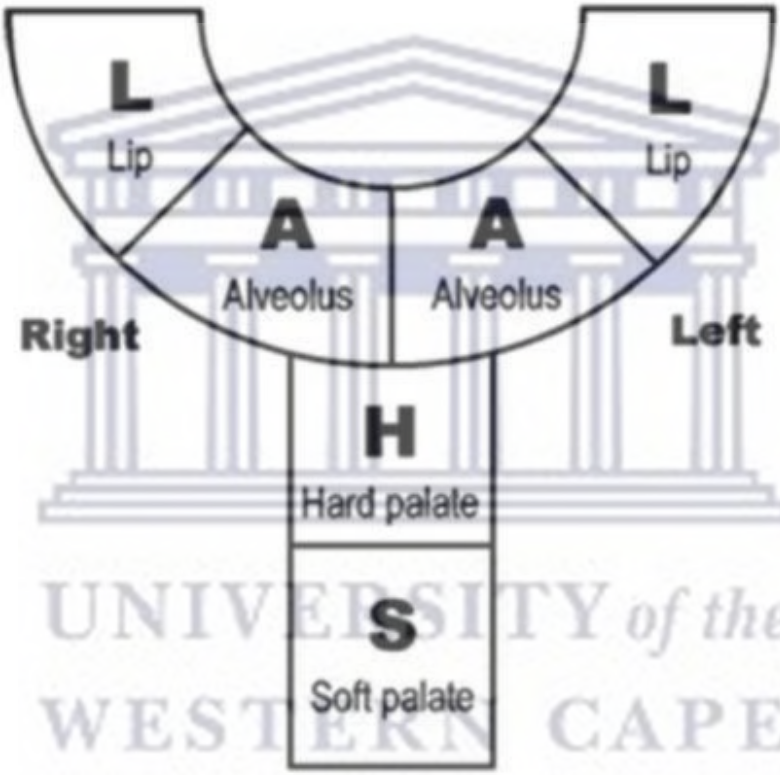
7.1 Annexure A: Proforma

Patient code……

Age	

Gender	Male	Female

The Type and side of Cleft



(LAHSHAL, 1989)

Type of surgery	Lip	Hard Palate	Soft palate

GOSLON YARDSTICK

Categories	Description	Mark X
Group 1 Excellent	Class I or II antero-posterior jaw relationship. Increased horizontal overjet. Mild cross-bite is accepted if Class II jaw relationship. If moderate to severe open bite: score 2. Occlusion can easily be corrected with straightforward orthodontics.	
Group 2 Good	Class I antero-posterior jaw relationship. Incisors in overjet or can easily be corrected with stable result. Mild crossbite accepted, but if moderate to severe open bite: score 3. Occlusion can easily be corrected with straightforward orthodontics.	
Group 3 Fair	Edge-to-edge or mild Class III antero-posterior jaw relationship. Crossbite is accepted. If moderate to severe open bite: score 4. Malocclusion requires complex orthodontics but possible to reach acceptable results.	
Group 4 Poor	Class III antero-posterior jaw relationship. Crossbite and mild to moderate open bite accepted. Malocclusion at the limits of orthodontic treatment without orthognathic surgery. If subsequent poor facial growth: will need orthognathic surgery.	
Group 5 Very poor	Severe Class III antero-posterior jaw relationship. Malocclusion requires orthognathic surgery.	

7.2 Annexure B: Letter to request permission to the head of the Department of Orthodontics, Faculty of Dentistry, University of the Western Cape.

University of the Western Cape
Department of Orthodontics
Francie van Zijl Avenue,
Tygerberg,
7505

29 January 2021

Prof AMP Harris
The Head of Department of Orthodontics
Faculty of Dentistry
University of the Western Cape

Dear Prof AMP Harris

RE: PERMISSION REQUEST TO CONDUCT A RESEARCH STUDY

I am doing a Master of Dentistry in Orthodontics at the University of the Western Cape, and I like to request your permission to conduct research in the Department of Orthodontics at the faculty of Dentistry, University of the Western Cape. The proposed title of my study is: Assessment of Dental Arch Relationships in South African patients with Unilateral Cleft Lip and Palate. The aim of the study was to evaluate the dental arch relationships of Western Cape patients with UCLP using the Goslon yardstick. Should you require any clarification regarding the aforementioned, you can kindly contact me on: Tel/Cell: 0824079192 E-mail: 3883105@myuwc.ac.za or mpatikana@gmail.com.

I would be grateful if my request was accepted.

Thanking you in advance.

Yours Sincerely

Dr ML Galane

7.3 Annexure C: Letter to request permission to the Dean /CEO of the faculty of Dentistry, University of the Western Cape.

University of the Western Cape
Faculty of Dentistry
Francie van Zijl Avenue,
Tygerberg,
7505
29 January 2021

Prof N Myburgh
the Dean/CEO
Faculty of Dentistry
University of the Western Cape

Dear Professor N Myburgh

RE: PERMISSION REQUEST TO CONDUCT A RESEARCH STUDY

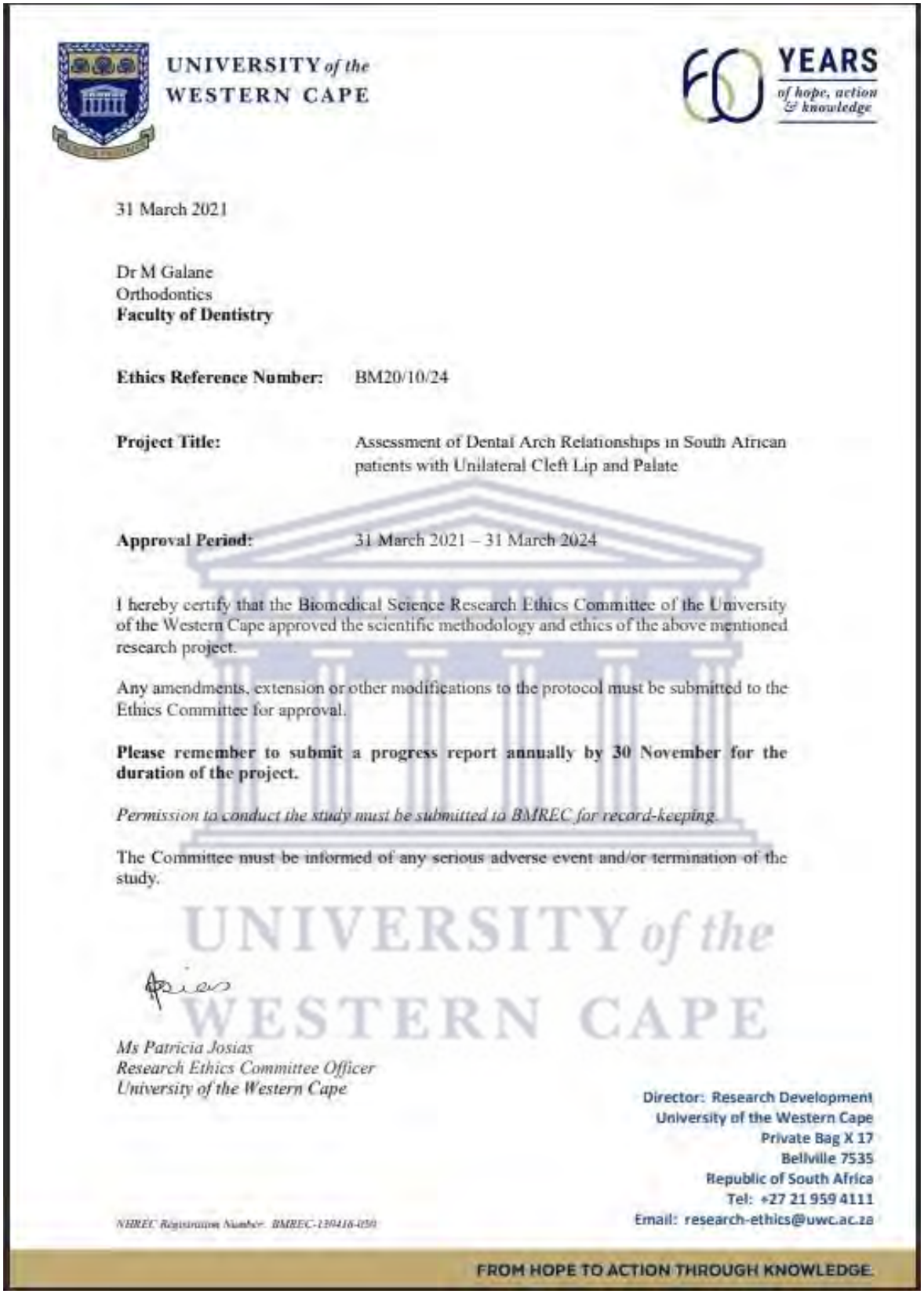
I am doing a Master of Dentistry in Orthodontics at the University of the Western Cape, and I like to request your permission to conduct research in the Department of Orthodontics at the faculty of Dentistry, University of the Western Cape. The proposed title of my study is: Assessment of Dental Arch Relationships in South African patients with Unilateral Cleft Lip and Palate. The aim of the study was to evaluate the dental arch relationships of Western Cape patients with UCLP using the Goslon yardstick. This study will be conducted under the supervision of Prof HH Bellardie, a consultant in the Orthodontics department focusing of patients with cleft lip and palate. Should you require any clarification regarding the aforementioned, you can kindly contact me on: Tel/Cell: 0824079192 E-mail: 3883105@myuwc.ac.za or mpatikana@gmail.com.

I would be grateful if my request will be accepted. Thank you for your assistance.

Yours Sincerely

Dr ML Galane

7.4 Annexure D: Permission letter from the Biomedical Science Research Ethics Committee of the University of the Western Cape.



UNIVERSITY *of the* WESTERN CAPE

60 YEARS *of hope, action & knowledge*

31 March 2021

Dr M Galane
Orthodontics
Faculty of Dentistry

Ethics Reference Number: BM20/10/24

Project Title: Assessment of Dental Arch Relationships in South African patients with Unilateral Cleft Lip and Palate

Approval Period: 31 March 2021 – 31 March 2024

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report annually by 30 November for the duration of the project.

Permission to conduct the study must be submitted to BMREC for record-keeping.

The Committee must be informed of any serious adverse event and/or termination of the study.

UNIVERSITY *of the* WESTERN CAPE

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: BMREC-130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE

7.5 Annexure E: Permission letter from the Tygerberg Hospital Health Research Policy and Protocol.

Western Cape Government

TYGERBERG HOSPITAL
Reference:
Research Projects
Enquiries:
Dr E van der Merwe
Manager: Medical services
Erike.vandermerwe@westerncape.gov.za | Tel: 021 938 4430

Ethics Reference: BM20/10/24

NHRD Reference: WC_202202_030

Title: Assessment of Dental Arch Relationships in South African patients with Unilateral Cleft Lip and Palate.

Dear Dr Mpatikana Galane

PERMISSION TO CONDUCT YOUR RESEARCH AT TYGERBERG HOSPITAL

1. In accordance with the Tygerberg Hospital Health Research Policy and Protocol of **April 2018**, permission is hereby granted for you to conduct the above-mentioned research here at Tygerberg Hospital for a year based on your HREC approval.
2. Researchers, in accessing the Provincial Health facilities, are expressing consent to provide the department with an electronic copy of the final feedback within six months of completion of research. This can be submitted to the Provincial research Co-Ordinator (Health.Research@westerncape.gov.za).

DR E VAN DER MERWE

MANAGER: MEDICAL SERVICES