An assessment of the factors affecting the efficacy of periodontal treatment carried out by postgraduate periodontology students.

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KEY WORDS

Periodontal disease

Treatment efficacy

Postgraduate Department

Tygerberg Dental Hospital

Influential factors

ABSTRACT

An assessment of the factors affecting the efficacy of periodontal treatment carried out by postgraduate periodontology students.

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Background: Periodontal disease is one of the most common diseases worldwide. Periodontal treatment aims to prevent disease progression and restore functional and aesthetic dentition. The purpose of studying periodontal treatment outcome is to assess treatment efficacy.

Treatment outcome of periodontal disease is affected by multiple patient-related factors, the type of treatment provided, and the expertise of the clinician.

Aim: The aim of the study was to determine the efficacy of periodontal treatment carried out at the postgraduate clinic in the Periodontology Department at the University of the Western Cape, Tygerberg Dental Hospital, between 2016 and 2018.

Methods: A retrospective record-based study of 100 patients was conducted. Patients' demographics, smoking practices, disease status and periodontal clinical parameters were collected, along with duration of treatment, frequency of follow up visits and the expertise of the clinician. Pre and post treatment data were analyzed by multilevel analysis.

Results: The results showed that all 100 patients demonstrated marked reduction in probing depth, plaque index, bleeding index and clinical attachment level. The overall mean pocket depth reduction was 0.31, the mean reduction in plaque scores and bleeding index were 37.2 and 36.4, respectively, and the mean clinical attachment gain was 0.42mm.

Conclusion: The non-surgical periodontal treatment in the postgraduate Periodontal Department at the University of the Western Cape, Tygerberg Dental Hospital, between 2016 and 2018 was proved to be effective with this study, 100% of participants showed marked reduction in clinical periodontal parameters. The main influential factor that impacted the treatment outcome was identified as the duration of treatment.

DECLARATION

I hereby declare that “an assessment of the factors affecting the efficacy of periodontal treatment carried out by postgraduate periodontology students” is my own work, that it has not been submitted for any degree or examination at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Dr. Mozn Abdalla

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I wish to extend my deep gratitude to all my Supervisors; Dr M.T.Peck for his initial assistance, Dr Anthea Jeftha for her support and guidance, and Mrs. Rayner, for her patience, assistance and ongoing encouragement during my research. Finally, a sincere thank you to Dr. Kimmie Dhansay for her assistance.

DEDICATION

To my loving parents who taught me to never stop learning – Thank you for everything.

To my amazing husband for his endless support and love – Thank you for believing in me.

To my two little angels who always brought a smile to my face – I am blessed to have you in my life.

To my sisters and brothers who were always there for me – Thank you for your love and support.

To my friends – I am grateful that you made my journey special and joyful.

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LIST OF ABBREVIATIONS

OHI: Oral hygiene instructions

CHX: Chlorhexidine

PPD: Probing pocket depth

CAL: Clinical attachment level

PI: Plaque index

BI: Bleeding index

SD: Systemic disease

MO: Month

CHAPTER 1: INTRODUCTION

Periodontal disease is the sixth most prevalent disease globally (Kassebaum *et al*., 2014, Franken *et al*., 2017, Nazir *et al*., 2017, and Tonetti *et al*., 2017).

Periodontal disease is classified into gingivitis and periodontitis. When the disease is confined to the gingival soft tissue, it is defined as gingivitis; when it involves clinical attachment including alveolar bone loss, periodontitis (Caton *et al*., 2018).

The term periodontal medicine was introduced in literature to describe the effect and association of periodontal disease on systemic health. Investigations have shown that periodontitis is linked to over 50 systemic diseases and conditions (Beck *et al*., 2019). Therefore, periodontal therapy is not only crucial for maintaining proper oral health, but also to improve the overall systemic health of periodontally involved individuals. Thus, providing the optimum periodontal care for periodontitis patients can reduce its associated systemic diseases, and can help lighten the financial burden on healthcare systems (Nazir *et al*., 2017).

Treatment outcome assessments are essential for monitoring treatment success, as well as for determining further treatment needs and establishing individualized supportive care programs for affected patients (Ling *et al*., 2012, Walton *et al*., 2015).

The scope of postgraduate periodontal training is substantial due to the prevalence of severe periodontal disease, and the requirements of complicated surgical procedures designed to improve the periodontal health (Van der Velden & Sanz, 2010). Therefore, investigating the efficacy of periodontal treatment among the postgraduate group is important to highlight the challenges and shortcomings in providing effective periodontal therapy.

Various studies have been conducted around the world to assess the treatment outcome in different dental fields. The aim of this study is to assess the efficacy of periodontal treatment carried out by postgraduate students at Tygerberg Dental Hospital and to analyze the factors affecting treatment outcome.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Periodontal disease can be broadly classified into gingivitis and periodontitis. With gingivitis, the disease is reversible and limited to the gums, whereas periodontitis involves a more severe irreversible form of the disease attributed to the destruction of the alveolar bone (Caton *et al.,* 2018).

The treatment of periodontal diseases is important because it has a direct influence on the patient's quality of life physically and mentally (Simona *el al*., 2014).

Periodontal treatment can be surgical or non-surgical, with the main goal to remove the aetiological pathogenic factors and promote regeneration of the periodontal tissue (Slots, 2013).

The most desirable outcome of periodontal treatment is periodontal regeneration, followed by restoration to a healthy periodontium for function and aesthetics. The periodontal treatment outcome is evaluated and assessed over time to measure the therapeutic success of the periodontal treatment by using different types of reported clinical outcomes, either from the patient, from the clinician, or from oral biomarkers (Kinney *et al*., 2017).

2.2 Periodontal Disease

The periodontium is the supporting structure of the tooth, composed of four principal components: the gingiva, cementum, periodontal ligament, and alveolar bone. It attaches the tooth to the surrounding tissue and allows sensation of touch and pressure (Palumbo, 2011).

The junctional epithelium is the tissue responsible for attachment of the teeth to the gingiva. It is located in a strategic interface between the gingival sulcus and the periodontal connective tissue. Due to its unique structural and functional adaptation, the junctional epithelium is able to control the constant microbiological challenge, playing a protective role against bacterial infection (Yajima-Himuro *et al*., 2014).

Periodontitis is defined as a host-mediated inflammatory response associated with microbial infection, resulting in loss of periodontal attachment. The pathophysiology of periodontitis is mediated through a molecular pathway associated with activation of host-derived proteinases that

target the periodontal ligament fibers, leading to apical migration of the junctional epithelium and apical spread of microbial biofilm (Tonetti *et al*., 2018).

A new classification of periodontal disease was proposed in June 2018 based on the world workshop held in Chicago in November 2017. According to the pathophysiology, this workshop classified periodontitis into three categories: necrotizing periodontitis, periodontitis as a manifestation of a systemic disease, and periodontitis, further characterized by the staging and grading system that relies on the severity of the disease and the rate of disease progression, respectively (Papapanou *et al*., 2018, Needleman *et al*., 2018).

This classification provides clinical value in customizing the diagnosis of periodontitis, taking into consideration the complexity of management, risk factors (smoking and diabetes mellitus), and prognosis of the disease to provide the suitable level of care for individual patients. It also makes research simpler by reducing the complexity of disease types associated with the previous classification (Tonetti *et al*., 2018).

2.3 Periodontal Therapy

The aim of periodontal therapy is to restore the natural dentition, periodontium, and peri-implant tissue, as well as to restore function, aesthetics, health, and comfort (Marroti *et al*., 2015).

Generally, there are four phases associated with periodontal therapy:

1. The systemic phase: This is the first line of treatment, it includes functional occlusal therapy, smoking cessation counseling, selective tooth extraction, and systemic disease control (Pihlstrom, 2001).
2. Initial non-surgical phase: Also known as the cause-related phase of treatment, whereby removal of the causative agent (plaque and calculus) is the main aim of treatment. Scaling and root planing are the applied treatment procedures to perform this task. This phase of treatment is considered as the fundamental phase, since it is the least invasive and the most cost-effective choice (Azodo *et al*., 2016).
3. Secondary constructive surgical phase: More drastic measures are used in this phase to restore the periodontium surrounding the affected tooth (e.g. when constructive surgery is performed to treat the intra-bony defects (Azouni *et al*., 2014).

4. Supportive periodontal phase: Previously known as the maintenance phase of the treatment, which is the last phase of treatment. Evidence has emphasized the importance of this phase in minimizing tooth loss and controlling disease progression (Renvert & Persson, 2004).

2.4 Efficacy of Periodontal Therapy

In order to fully understand periodontal therapy outcome, the following terms are defined and used herein, as follows:

Efficacy: the extent of a beneficial outcome that results from treatment under controlled ideal circumstances such as clinical trials (Jiao *et al*., 2016).

Treatment outcome: the evaluation carried out to assess the end results of treatment to determine the efficiency, effectiveness, safety, and practicability of the treatment in each individual case (Walter *et al*., 2012). The aim of studying periodontal treatment outcome is to evaluate treatment efficacy, which is assessed using one or more of the following factors:

Patient-reported outcomes (PRO), clinician-reported outcomes (ClinRO), observer-reported outcomes (ObsRO), performance outcomes (PerfO), and oral biomarkers (Tuti *et al*., 2012; Amit *et al*., 2017).

Several studies have been carried out in various fields of dentistry to measure treatment success rates and to assess the efficacy of postgraduate dental clinics in different countries around the world (Patil *et al*., 2016). For example, a study conducted in an endodontic clinic in France reported a success rate of 92% of treatment that was carried out by postgraduate students. This study highlighted the reliability of endodontic treatment when performed by trained and competent practitioners (Virginie *et al*., 2014).

In 2017, a study was conducted in Bosnia to investigate the efficacy of surgical periodontal therapy on 50 patients. Clinical parameters of plaque index (PI), bleeding index (BI), and probing pocket depth (PPD) were recorded at the baseline, as well as at 1-month and 6-month post-treatment. The study concluded that surgical periodontal therapy resulted in a significant reduction in probing pocket depth (Mirjana *et al*., 2017).

Another study examined the effectiveness of non-surgical periodontal treatment in China in 2016. This study involved 10,789 patients, where clinical parameters such as (PI), (BI) and (PPD) were compared before and after treatment. The study proved the effectiveness of non-surgical periodontal treatment in patients with periodontitis in a large Chinese population (Jiao *et al*., 2017).

A systematic review reported on the clinical efficacy of sub-gingival debridement in the treatment of chronic periodontitis in Amsterdam in 2002. This review included 26 studies that analyzed the values for plaque index (PI), bleeding on probing (BOP), probing pocket depth (PPD) and clinical attachment level (CAL). It concluded that sub-gingival debridement, in conjunction with supra-gingival plaque control, is an effective treatment in reducing probing pocket depth and improving the clinical attachment level (Van der Weijden *et al*., 2002).

According to the South African Dental Association, a severe form of periodontal disease was found in 5-20% of middle-aged adults, explaining the increasing demand for research and investigation of periodontal treatment in South Africa (Chikte *et al*., 2019).

2.5 Clinical Efficacy of Periodontal Therapy

Many periodontal measurements exist for assessing treatment outcome effectiveness, such as probing depth, bleeding on probing, and clinical attachment gain (Lamont *et al*., 2017). The heterogeneity of the various parameters used clinically to measure the periodontal treatment outcome resulted in difficulties in evaluating and comparing the effectiveness of the treatment. There is currently no definitive agreement on which outcome parameter should be measured when investigating interventions for periodontal disease (Lamont *et al*., 2017).

In general, clinicians measure the probing depth reduction because it reflects an alteration in the attachment level; it is also easy to measure. Moreover, probing depth is the most commonly used surrogate in clinical trials (Greenstein *et al*., 2000).

The outcomes used to assess the efficacy of periodontal treatment response are categorized into two groups:

i. True end point: a measure of quality of life whereby a tangible patient benefits from treatment is evaluated based on tooth survival (Hujoel *et al*., 2004).

ii. Surrogate end point: variable parameters used to assess the surrogate outcomes of the periodontal treatment such as pocket depth, clinical attachment level, bleeding index, and alveolar bone level (Greenstein, 2005).

Clinical trials utilize surrogate variables to determine if the therapy provides periodontal support for tooth stability, or reduce disease progression. However, there are different challenges associated with the use of those parameters. For example, small positive changes can be attributed to measurement error, whereby assumptions of treatment success based solely on minimal improvement may lead to misconceptions about treatment success (Machtei, 1997, Greenstein *et al*., 2000).

Furthermore, minimal improvement doesn't guarantee that treatment induced a periodontal condition that is compatible with health and long-term periodontal stability. Another misconception relies on the measurements of multiple outcome parameters, which can result in a situation where one parameter is positively influenced, while the other is negatively, or where no change is reported, consequently hindering the judgment of overall treatment success or failure (Hujoel *et al*., 2004, Baelum *et al*., 2015).

To avoid the above-mentioned confusion, specific criteria were developed to provide the clinician guidelines to measure periodontal treatment efficacy, such as:

i. Threshold: the minimal amount of change that is considered clinically significant after therapy (e.g., mean probing depth reduction or mean attachment gain) (Greenstein *et al*., 2000). In accordance with the 1996 world workshop, there should be at least 1mm pocket depth reduction and 0.5mm attachment gain to be considered clinically significant (Drisko, 2001).

ii. Cut-off point: such as, how often does the therapy resulted in pocket depth (≥ 5mm). This criterion is selected because it is usually a desired outcome for treatment; thus, eliminating the need for surgical intervention (Jeffcoat & Reddy, 1991).

iii. Percentage of improvement: provides the percentage of improvement compared to the initial severity of the disease. In severe cases, although the treatment result may not provide a clinically significant result, a clear percentage of improvement is more accurate when compared to the initial presentation (Greenstein *et al*., 2000).

iv. Suppression of disease progression: Because it is difficult to calculate the disease progression, a clinical attachment loss of 2mm is considered as an indicator of disease progression. This high threshold will eliminate the errors associated with measuring pocket depth and clinical attachment loss (Greenstein *et al*., 2000).

The American Academy of Periodontology reported the desired outcome of periodontal therapy as a significant resolution of clinical signs of gingival inflammation, reduction of pocket depths, clinical attachment gains (or at least stabilization of the attachment level) and the progress toward reduction of plaque to a level compatible with gingival health (Manresa *et al*., 2018). Periodontal treatment outcome is considered clinically successful with the absence of pocket depth (≥ 5mm) and BOP of ≤ 15%. The treatment outcome is defined as beneficial when the mean clinical attachment level and the mean probing pocket depth outcomes were improved (Van der Valden *et al.,* 2012, Sanz *et al*., 2015).

For the purpose of this study, any beneficial treatment that resulted in improvement of the mean clinical attachment level and the mean probing pocket depth outcomes was considered successful (i.e., reduction of mean probing pocket depth by 20% or more, or attachment gain of 10% or more than the mean attachment level at the initial visit).

2.6 Factors Affecting Periodontal Treatment Outcome

There are mainly three aspects affecting periodontal treatment outcome: patient, clinician experience and treatment protocol provided for the patient.

2.6.1 Patient aspect

Patient compliance, behavior, age, gender, smoking status, the presence of systemic diseases, medications, genetics and stress may influence the outcome of treatment, as well as local factors such as the presence of overhanging restoration or dental prosthesis, in addition to environmental factors (Michalowicz, 1994, Page & Kornman, 1997, Mascarenhas *et al*., 2003, Papantonopoulos *et al*., 2004, Pahkla *et al*., 2006, Wan *et al*., 2009, Kakudate *et al.,* 2010, Trombelli *et al*., 2015, and Marroti *et al*., 2015). These factors can also influence onset, rate of progression and severity of periodontal disease. Therefore, they should be evaluated in order to provide the proper treatment plan for each patient (Tariq *et al*., 2012).

2.6.2 Treatment protocol

The type of treatment provided (surgical or non-surgical), the duration of treatment, the number of visits, and the use of chemotherapeutic agents plays an important role in periodontal treatment outcome. In addition, the use of systemic antibiotic in conjunction with mechanical removal of bacterial pathogen will aid in the biological rationale of the treatment (Tarig *et al*., 2012).

The ideal time interval clinicians and dental schools should adopt for assessment of the initial response of the periodontal tissue to the non-surgical phase of treatment is 4-8 weeks (Segelnick *et al*.,2006).

2.6.3 Clinician experience

Advanced clinician skills will positively influence the periodontal treatment outcome (Van der Velden *et al.,* 2010, Sanz *et al*., 2012). The aim of postgraduate programs is to enable the students to practice periodontal therapy at a specialist level, which qualify them to investigate, analyze, treat and solve problems effectively and efficiently. Several studies showed that postgraduate students demonstrate contemporary knowledge and understanding of periodontal disease. This is demonstrated through positive and successful implementation of periodontal treatment used in their daily clinical practice (Van der Velden *et al*., 2010).

2.7 Conclusion

Recent literature has highlighted the lack of evidence-based studies of the periodontal treatment outcome, due partly to the presence of many different clinical indices to evaluate the treatment outcome. This multiplicity of outcome measurement indicators has created confusion when trying to compare different studies that affect both the clinician and the patient when trying to decide the best treatment option (Worthington *et al.,* 2013).

The objective of this study was to assess the efficacy of the periodontal treatment offered at the University of the Western Cape, Tygerberg Dental Hospital Postgraduate Periodontal Clinic. It is the first of its kind in South Africa to investigate the periodontal treatment outcome and evaluate the performance of postgraduate periodontal clinic at a local South African hospital.

CHAPTER 3: METHODS

3.1 Aim and Objectives

3.1.1 Study aim

The aim of the study was to determine the efficacy of periodontal treatment carried out at the postgraduate clinic in the Periodontology Department at the University of the Western Cape, Tygerberg Dental Hospital, between 2016 and 2018.

3.1.2 Study Objectives

1. To describe the baseline periodontal status of the patients (before treatment).
2. To determine the periodontal treatment provided for patients.
3. To identify the factors affecting the treatment outcome.
4. To describe periodontal status of the selected patients after treatment.

3.2 Study Design

The present study was a retrospective, descriptive, analytic study, in which clinical data were obtained from patients' files and postgraduate students' portfolios at the Periodontal Department at Tygerberg Dental Hospital.

Before and after treatment probing depth, bleeding index, plaque index and clinical attachment gain were compared and assessed accordingly; the final treatment outcomes were analyzed.

3.3 Inclusion Criteria

- Adult patients aged 18-80
- Patients diagnosed with periodontitis, who had at least one tooth with bleeding sites ≥ 4mm, or any PPD ≥ 5mm, which had been treated with the initial and/or surgical phase of treatment in the Postgraduate Periodontal Department at Tygerberg Dental Hospital.
- Patient with a follow up of at least 6 weeks after the initial phase of treatment.

3.4 Exclusion Criteria

- Patients younger than 18 years old, and older than 80.
- Patients who failed to attend a follow-up visit.
- Patients that were pregnant, or breastfeeding.
- Patients who had any kind of periodontal treatment conducted by a clinician other than from a Tygerberg postgraduate student in the last 3 months.
- Patients with missing data or records.

3.5 Sampling

Convenient sampling was employed to identify all patients who had visited the postgraduate clinic between 2016 and 2018 for the treatment of periodontitis; 100 patients were included in this study.

3.6 Data Extraction

3.6.1 Patient level

- Age.
- Gender (male versus female).
- Smoking status (non-smokers were classified as patients who never smoked or who did not smoke at the time of the initial visit; smokers were classified as patients who had quit smoking during the non-surgical phase of treatment, and patients who still smoked at the time of the last visit).
- Presence of family history of periodontal disease.
- Presence of systemic disease.

3.6.2 Periodontal indices

The following patient-related parameters: bleeding index (BI), Pocket Probing depth (PPD), Plaque index (PI) and clinical attachment level (CAL) were assessed at the initial visit (T0) (Pretreatment); the last evaluations (T1) (after treatment) were extracted for analysis:

- Pocket probing depth (PPD) values were recorded at six sites per tooth (mesiobuccal, mid buccal, distobuccal, mesiolingual, mid lingual, distolingual).
- Plaque index (PI) values were recorded at six sites per tooth (mesiobuccal, mid buccal, distobuccal, mesiolingual, mid lingual, distolingual).

- Bleeding index (BI) values were recorded 30 seconds after probing. Probing bleeding index was recorded at six sites per tooth (mesiobuccal, mid buccal, distobuccal, mesiolingual, mid lingual, distolingual).
- Clinical attachment level (CAL) was measured by the distance from the cementoenamel junction to the bottom of the periodontal pocket.

The mean values of these indices were calculated and compared from before and after the treatment

3.6.3 Treatment provided

The following treatment related factors were recorded:

- The type of treatment provided at the initial visit.
- Treatment provided at re-evaluation.
- The prescription of antibiotics and chlorohexidine,
- The type of the performed surgery in surgical cases (either respective or regenerative periodontal treatment).
- Number of visits.
- Duration of treatment.

Treatment of duration was collected in the data collection sheet as two separate entities; > 2 months and < 2 months.

3.6.4 Clinician level

The clinician's year of the study when the treatment was performed was recorded.

3.7 Analysis

Univariate analysis was obtained to determine the factors associated with the type of program, practitioner year of study, age and gender of the participants, duration of treatment, number of visits, and smoking status. Between means were evaluated using a t-test, Welch t-test or ANOVA. Multiple linear regressions were used to determine the relationship between these parameters.

3.8 Ethical Considerations

Approval to conduct this study was obtained from the Biomedical Research Ethics Committee of the University of the Western Cape (BM19/2/6). Please review Appendix E (ethical approval).

CHAPTER 4: RESULTS

Bivariate analysis was conducted to determine factors association with PPD, PI, BI and CAL using independent samples t-test, welch t-test and ANOVA test. A two-way repeated measures ANOVA was used to determine if there was a significant interaction between PPD, PI, BI and CAL and time with various factors collected. Inferential analysis was conducted using multiple linear regression analysis to determine factors associated with the outcome variables using a regression analysis. All tests were deemed significant at $p < 0.05$. All statistical tests were conducted using StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC with a p value of < 0.05 was considered significant.

4.1. Patient related factors

Gender:

Of the 100 patients, 48 were males and 52, females. The male to female ratio was 0.9:1. Females showed more decrease in probing depth, plaque index and bleeding index, as well as more increase in clinical attachment level after treatment compared to males. However, this finding was not statistically significant. Results are shown in Table 4.1.

Table 4.1: Comparison between male and female patients

Clinical Parameters	Pre-treatment		*p*-value	Post-treatment		*p*-value	Differences		*p*-value
	Male	Female		Male	Female		Male	Female	
PD	3.47	3.19	0.09	3.22	2.81	0.009	0.25	0.38	0.1466
PI	58.46	57.85	0.9	23.13	18.92	0.24	35.33	38.92	0.4591
BI	67.1	60.96	0.16	33.29	25.62	0.09	33.81	35.35	0.7384
CAL	-4.13	-3.81	0.02	-3.66	-3.22	0.11	0.46	0.38	0.6821

PD, Probing Depth; PI, Plaque index; BI, Bleeding Index, CAL, Clinical Attachment level.

Smoking:

Smoking history was found in 70 patients, while 30 patients were non-smoker. Non-smokers had more decrease in probing depth, plaque index and bleeding index, as well as more increase in clinical attachment level after treatment compared to non-smoker. However, this finding was not statistically significant. Results are shown in Table 4.2.

Table 4.2: Comparison between smoker and non-smoker patients

Clinical Parameters	Pre-treatment		*p*-value	Post-treatment		*p* - value	Differences		*p*-value
	Smoker	Non-smoker		Smoker	Non-smoker		Smoker	Non-smoker	
PD	3.39	3.29	0.60	3.16	2.94	0.20	0.23	0.36	0.2099
PI	60.73	57.03	0.45	21.5	20.7	0.84	39.23	36.33	0.5829
BI	68.1	62.11	0.21	31.9	28.19	0.46	36.2	33.93	0.6499
CAL	-3.94	-3.82	0.60	-3.63	-3.35	0.33	0.31	0.47	0.4477

PD, Probing Depth; PI, Plaque index; BI, Bleeding Index, CAL, Clinical Attachment level.

Systemic conditions:

Out of the 100 patients, 53 had systemic conditions, while 47 did not have systemic conditions. Patients who had systemic conditions showed more decrease in probing depth, plaque index and bleeding index, as well as more increase in clinical attachment level after treatment compared to patients who did not have a systemic condition. However, this finding was not statistically significant. Results are shown in Table 4.3.

Table 4.3: Comparison between systemic disease and non-systemic disease patients

Clinical parameters	Pre-treatment		*p*-value	Post-treatment		*p* - value	Differences		*p*-value
	SD	Non-SD		SD	Non-SD		SD	Non-SD	
PD	3.54	3.05	0.005	3.16	2.8	0.03	0.38	0.25	0.1606
PI	62.89	52.79	0.03	21.57	20.23	0.71	41.32	32.55	0.0689
BI	63.13	64.79	0.7	29.6	28.95	0.88	33.5	35.83	0.6164
CAL	-4.03	-3.66	0.11	-3.46	-3.40	0.81	0.56	0.26	0.122

SD, systemic disease; PD, Probing Depth; PI, Plaque index; BI, Bleeding Index, CAL, Clinical Attachment level

4.2. Treatment related factors

Concerning the aspect of treatment, 100% of patients were given oral hygiene instructions (OHI) and chlorohexidine (CHX) prescriptions, 96% were treated with scaling and root planing, while only 4% were treated only with scaling. Antibiotics were prescribed for 28% of patients. All these factors were not included in the results due to their insignificant statistical value. Duration of treatment was equally divided where 50% of patients were treated for more than 2 months and 50% were treated for less than 2 months.

Patients who underwent > 2 months duration of treatment showed higher decrease in probing depth, plaque index, bleeding index, and clinical attachment loss after treatment compared to patients who had < 2 months duration of treatment. This finding was statistically significant. Results are shown in Table 4.4 and Figure 4.1- 4.4.

As the number of dental visits increased by 1, there was decrease in probing depth, plaque index, and bleeding index, as well as increase in clinical attachment level. However, this finding was not statistically significant.

Table 4.4: Comparison between < 2 months and >2 months duration of treatment

Clinical parameters	Pre-treatment		*p*-value	Post-treatment		*p*-value	Differences		*p*-value
	<2 Mo	>2 Mo		<2 Mo	>2 Mo		<2 Mo	>2 Mo	
PD	3.15	3.5	0.02	3.04	2.97	0.65	0.11	0.53	<0.001
PI	56.36	59.92	0.46	25.24	16.64	0.01	31.2	43.28	0.0108
BI	63.48	64.34	0.84	38.2	20.4	0.0001	25.28	43.94	<0.001
CAL	-3.81	-3.9	0.7	-3.71	-3.16	0.04	0.1	0.74	0.0007

Mo, month; PD, Probing Depth; PI, Plaque index; BI, Bleeding Index, CAL, Clinical Attachment level.

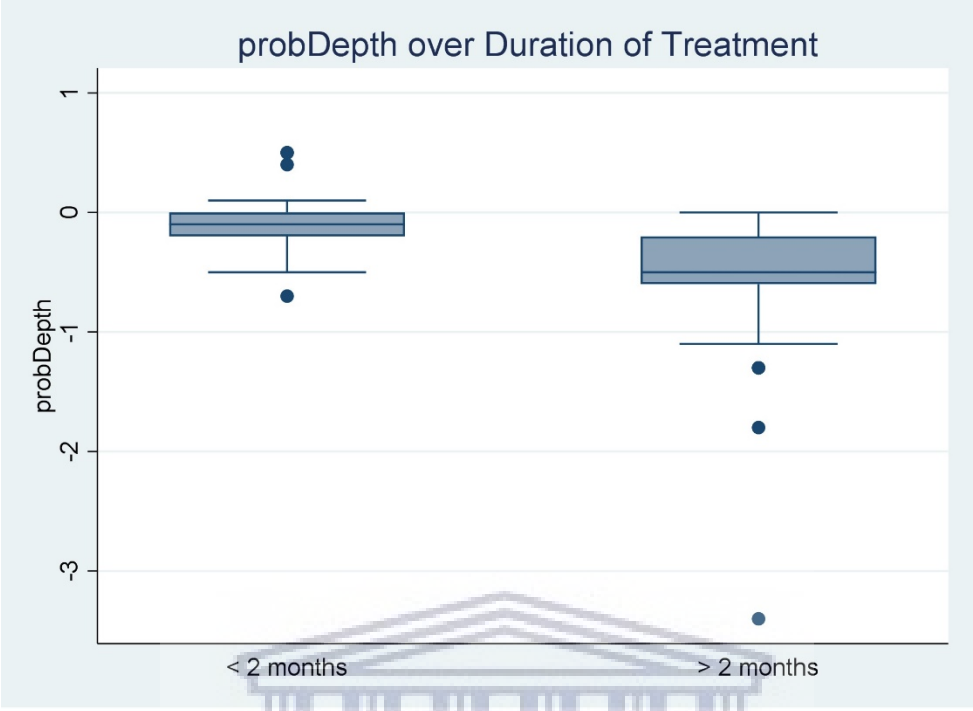

Figure 4.1:Comparison of the probing depth after treatment of patients treated for more than 2 months vs. patients treated for less than 2 months.

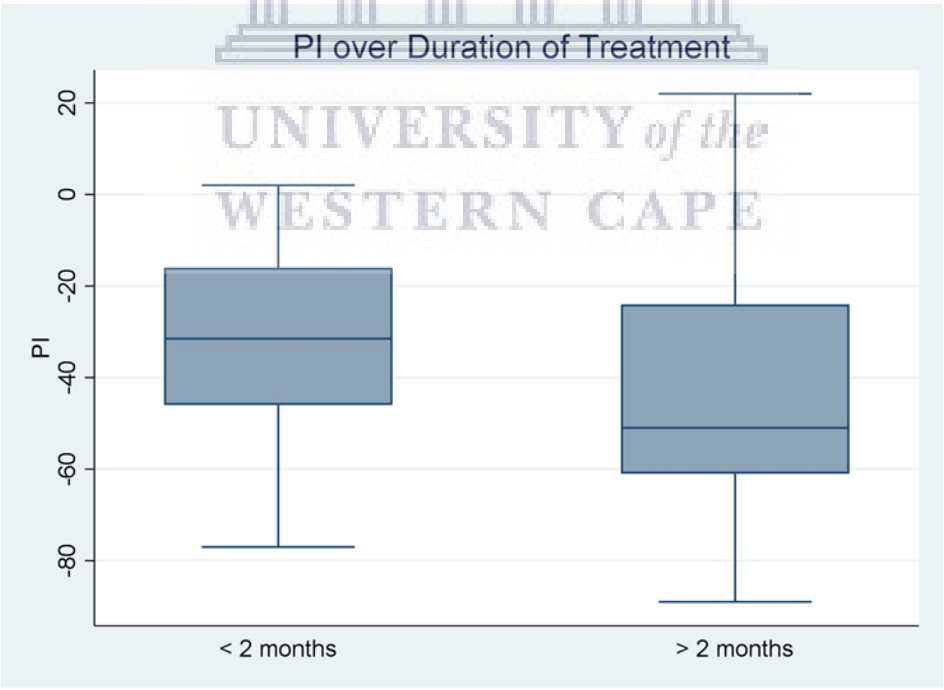

Figure 4.2: Comparison of the plaque index after treatment of patients treated for more than 2 months vs. patients treated for less than 2 months.

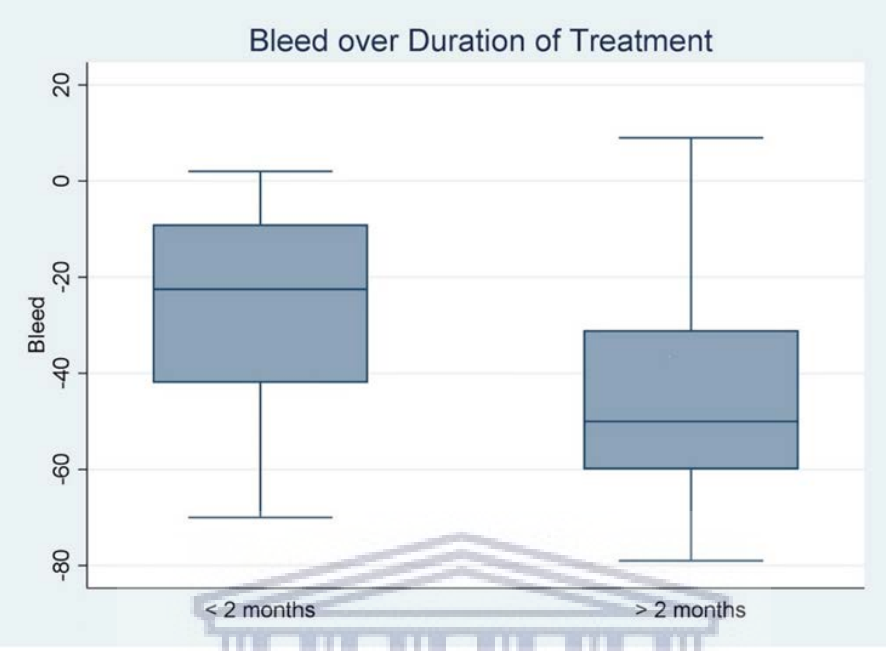

Figure 4.3: Comparison of the reduction in bleeding index after treatment of patients treated for more than 2 months vs. patients treated for less than 2 months.

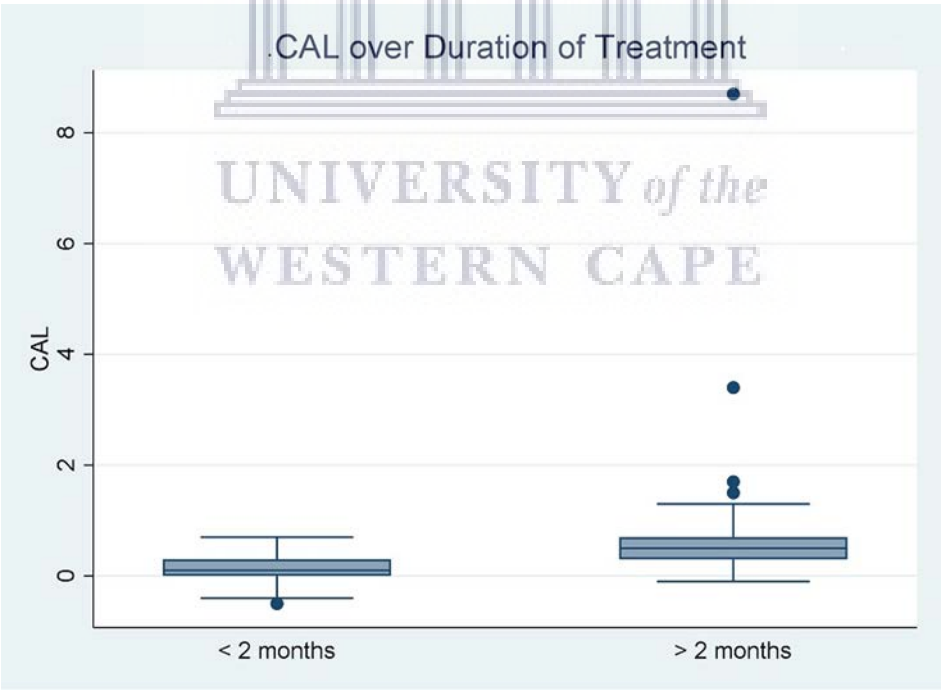

Figure 4.4: Comparison of the clinical attachment level after treatment of patients treated for more than 2 months vs. patients treated for less than 2 months.

4.3 Clinician related factors

Regarding the clinician aspect, 68% of the patients were treated by first-year students, 17% were treated by second-year students, 14% by third-year students, and only 1% were treated by fourth-year students. The minimum participation from the fourth-year students may be explained by the fact these students usually perform the surgical phase of treatment in their final year of the program. Overall, patients of dentists who were in their 2nd, 3rd and 4th year of training displayed a lower bleeding index score compared to patients of dentists in their first year of training. In addition, dentists in their fourth year of training showed the greatest reduction in bleeding score in their patients compared to dentists in their first year of training However, this finding was not statistically significant. Results are shown in Table 4.5.

Table 4.5: Comparison between practitioner year of the program

Clinical parameters	Pre-treatment			*p*-value	Post-treatment			*p*-value	Differences			*p*-value
	1	2	3+		1	2	3+		1	2	3+	
PD	3.25	3.56	3.39	0.34	2.98	3.17	2.95	0.67	0.27	0.39	0.44	0.318
PI	58.0	56.5	60.2	0.97	23.0	16.5	16.4	0.35	35.0	40.0	43.7	0.3961
BI	63.4	66.7	62.9	0.93	33.4	22.1	18.6	0.05	29.9	44.5	44.2	0.011*
CAL	-3.91	-3.9	-3.53	0.60	-3.49	-3.50	-2.96	0.46	0.41	0.35	0.57	0.794

Mo, month; PD, Probing Depth; PI, Plaque index; BI, Bleeding Index, CAL, Clinical Attachment Index

CHAPTER 5: DISCUSSION

The effectiveness of the non-surgical periodontal treatment on patients with periodontitis, at the Postgraduate Periodontal Clinic at Tygerberg Dental Hospital was proven with this record-based retrospective study.

The overall mean pocket depth reduction was 0.31mm, and the mean clinical attachment gain was 0.42mm. The results corroborate a study in 2017 undertaken to investigate the effectiveness of non-surgical periodontal treatment in a large Chinese population that included 10,789 patients and whereby the overall mean pocket depth reduction was 0.6mm (Jiao *et al*., 2017). A systematic review of the efficacy of non-surgical periodontal treatment reported a mean pocket depth reduction of 0.64mm (Van der Weijden & Timmerman, 2002). The value of the mean pocket depth reduction in this study was lower than that reported by the Chinese study and the systematic review. This can be explained by the large difference in the sample size between the Chinese study and this study, in addition to the variation of treatment aspect as the majority of the non-surgical periodontal treatment in the Chinese study were finished within 2-4 appointments, while in this study the majority of cases had the non-surgical phase of periodontal treatment performed in one visit.

5.1 Probing pocket depth

Males had higher initial mean probing pocket depth than females (3.47 and 3.19, respectively). After treatment, the mean probing pocket depth of males was improved and reduced to 3.22 (0.25 difference) but still remained higher than that of females, which was reduced to 2.81(0.38 difference). Although this difference was statistically insignificant, it implies that females had initial shallower probing pocket depth and responded better to treatment than males.

This finding is consistent with a study conducted at the University of Minnesota in 2004 to investigate the existence of gender differences in the postulated relationship between periodontal disease, tooth loss and subclinical atherosclerosis. The results revealed that the percentage of periodontal sites with PD ≥ 5mm was 10% in males versus 6% in females, and that the gender differences reported were attributed to treatment bias, practice differences, or sociocultural determinants (Desvarieux *et al*., 2004).

Another study was undertaken to detect the effect of gender factor on periodontal health status clinically, whereby a non-significant statistical difference was observed between males and females. The study revealed that there was no significant effect of gender on periodontal health of patients (Alam *et al*., 2012).

Initially, the pocket depth was higher in smokers than in non-smokers (3.39 and 3.29, respectively), however these numbers reduced after treatment. Smokers' pocket depth reduced to 3.29 (0.23 difference) but still remained higher than that of non-smokers whose pocket depth reduced to 2.94 (0.26 difference).

This outcome corresponds to a cross-sectional study in India conducted in 2011, which evaluated the periodontal health status among cigarette smokers and non-smokers. This study included 400 males (200 cigarette smokers and 200 non-smokers) aged 18-65 years, and concluded that deep pockets of ≥ 6mm were found in 41% of smokers and in 26% of non-smokers, and the difference between the two groups was statistically significant (Gautam *et al*., 2011).

Participants with systemic conditions initially had deeper pockets than systemically healthy individuals (3.54 and 3.05 respectively). It was reduced to 3.16 in after-treatment patients with systemic conditions (0.38 difference), but remained higher than systemically healthy individuals whose pocket depth reduced to 2.8 (0.25 difference).

This may be explained by the bidirectional relationship between periodontal disease and systemic conditions, which has been well-established in the literature (Kim & Amar, 2006), (Weidlich *et al*., 2009), (Arigbede *et al*., 2012), (Nagpal & Izumi, 2015), (Winning & Linden, 2017), (Kane, 2017). Multiple studies that aimed to assess the relationship between systemic condition and periodontal disease confirm the existence of such a relation. For example, in a 2006 study conducted to evaluate the association between high blood pressure and deep periodontal pockets in Sweden, fifty-four subjects had known hypertension, and 141 had previously unknown diastolic blood pressure >90mmHg. This study found that prevalence of periodontal pockets ≥ 5mm were associated with prevalent established hypertension or high blood pressure readings (Engström *et al*., 2007).

In this study, the statistically significant finding was the duration of treatment. The best responses were found in patients with treatment duration of more than 2 months, whereby pocket depth

reduced from 3.5 to 2.9 (0.53 difference) compared to patients with treatment duration less than 2 months, whereby pocket depth reduced from 3.15 to 3.04 (0.1 difference). Therefore, treatment with duration more than 2 months was more beneficial in reducing probing pocket depth compared to treatment of less than 2 months in duration.

This sequel is in harmony with a study conducted in Israel in 2003 to evaluate probing pocket depth changes following 2 years of periodontal maintenance therapy, including the adjunctive use of chlorohexidine. The study included 595 patients, whereby all participants showed a continuous decrease in pocket depth of 0.95 over the 2-year period (Soskolne *et al*., 2003).

Worth mentioning is the duration of treatment and frequency of periodontal maintenance visits, which may reflect the patient compliance and dedication to treatment; patients with longer duration of treatment are usually more dedicated to their periodontal treatment, which positively impacts the periodontal treatment outcome (Oruba *et al*., 2014).

Moreover, as the number of dental visits increased by 1, the probing depths decreased by (0.359 units) highlighting the beneficial outcome of regular maintenance care. A similar outcome was reported in a study that examined periodontal and dental conditions in individuals after periodontal therapy in a private practice in Geneva. The study of 100 patients who had been treated for periodontal disease and who were in maintenance for ≥ 2 years, and concluded that the longer the duration of maintenance phase of treatment (i.e., the more frequent the recall visits, the greater the reduction in probing pocket depth (Müller *et al*., 2019).

5.2 Plaque index

Males had higher pre-treatment plaque index than females (58.46% and 57.85%, respectively). The after-treatment plaque index in males dropped to 23.13% (35.33 difference) but remained higher than that of females, whose plaque index dropped to 18.92% (38.92). This proposes that females had better oral hygiene behavior than males.

This result is in conformity to several studies conducted in the past decades that compared oral hygiene behavior between males and females. For example, a worse hygiene behavior was reported in males in a study carried out by Alcouffe in 1989, who compared the oral hygiene behavior of 56 women and 28 men, reporting better oral hygiene in females. This was explained by the fact

that women in western countries demonstrate better "spontaneous" oral hygiene practice than men (Alcouffe *et al*., 1989).

Strauss and Stefanou in 2014 investigated 573 patients with diabetes, and found that females practice daily interdental cleaning more often than men (Strauss & Stefanou, 2014).

Furthermore, another study assesses the effects of oral self-care on periodontal health indicators among adults with diabetes. Women reported brushing their teeth more frequently, and levels of plaque were significantly lower than those of men (Karikoski *et al.* 2001).

A more recent study in 2014 identified predictors of compliance during non-surgical and supportive periodontal therapy. The results showed that self-efficiency to improve oral hygiene habits is the only main contributing factor to improve the periodontal status of patients, regardless of their gender (Delatola *et al.*, 2014)

Smokers had a higher pre-treatment plaque index than non-smokers (60.7% and 57%, respectively). After treatment, the smokers' plaque index dropped to 21.5% (39.2 difference) while the non-smokers' levels dropped to 20.7% (36.33 difference). This recognition designates that smokers had a higher plaque index than non-smokers and inferior oral hygiene status. This outcome concurs with a study set to examine the clinical and cytological gingival changes in smokers and non-smokers where the plaque index of 90 patients (45 men and 45 women) was investigated. The plaque index was higher in smokers with a statistically significant difference between the examined groups (Petrovic *et al*., 2013).

Conversely, this conclusion contradicts a study conducted in 1985 to investigate the effects of cigarette smoking on the rate of plaque formation. In that study, no significant association emerged between wet weight of accumulated plaque and cigarette smoking; interestingly, the mean plaque calcium in smokers was found to be higher than that in non-smokers, which might explain why more calculus was found in smokers (Macgregor *et al*., 1985).

Patients with a systemic condition had lower plaque index than systemically healthy patients (52.35 and 62.89, respectively). The plaque index in after-treatment patients with systemic condition reduced to 20.41 (31.93 difference), while the plaque index in patients with no systemic condition dropped to 21.57 (41.32 difference); the difference between the 2 groups was statistically

insignificant. This stipulates that periodontal patients with a systemic condition had a lower plaque index, and that they responded better to treatment.

A growing body of literature indicates that there is a relationship between periodontal pathogens and systemic disease. Although the existence of plaque and its metabolic by-product in the oral cavity may affect the immune response all over the body, consequently promoting the development of systemic conditions, a cause-and-effect relationship has not yet been established, and consequently requires further investigation (Bui *et al*., 2019).

This clinical outcome is in dispute with a 2007 study carried out in Spain with the purpose of comparing the local efficacy of non-surgical periodontal therapy between type-2 diabetic and non-diabetic patients. The study, which investigated 20 subjects (10 diabetic and 10 non-diabetic) concluded that both groups showed clinical improvement and responded well after therapy in a very similar manner (Navarro *et al*., 2007).

Interestingly, an increase in age by 1 year displayed a decrease in plaque index scores of 0.209 units. This indicates that older participants demonstrated better oral hygiene practices, a finding that corresponds with a study that investigated the prevalence of dental plaque among adults in India in 2016. In that study, 220 males and 158 females (mean age 30.9) were examined and revealed that plaque scores decreased as the patients' age increased in groups aged between 18 and 47 (Sreenivasan *et al*., 2016), which may have been caused by the increased dental awareness and knowledge in older patients.

The remarkable detection was the effect of the duration of treatment on plaque index; patients treated for more than 2 months had their plaque index reduced from 59.92% to 16.649% (-43.28 difference), whereas it reduced from 56.36% to 25.24% (-31.12) in patients treated for ≤ 2 months. Moreover, as the number of visits increased, the plaque index decreased by 0.1159 units, which emphasizes the importance of supportive periodontal therapy on the final treatment outcome.

5.3 Bleeding index

Males had a higher bleeding index compared to females in both initial and after-treatment measurements. While the initial bleeding index was 67.1% to 60.96%, respectively, the bleeding index in after-treatment males dropped to 33.29% (difference of 33.81), whereas that in females

dropped to 25.62% (difference of 35.35). This indicates that females had an overall better periodontal health status, and responded better to treatment than males.

This outcome correlates to a study that assessed gender differences in the occurrence of gingival disease among dental students, in which 209 dental students (59 males and 150 females) were examined. The study revealed that the bleeding index was higher in males compared to females (0.9 to 0.5, respectively) and that the existence of gender difference in the occurrence of gingival disease can be explained by oral health behaviors and hygiene status (Sanadi *et al*., 2017).

Smokers had a higher bleeding index than non-smokers (68.1% and 62.11%, respectively). After-treatment smokers' bleeding index dropped to 31.9% (36.2 difference), whereas that of non-smokers was reduced to 28.19% (33.93 difference). This result contradicts the expected reduction in gingival bleeding and vascular hyperemic reactions in smokers caused by the vasoconstrictive effect of nicotine, which has been well documented in literature (Mullally *et al*., 2004, Pejčić *et al*., 2007, Zee, 2009, Malhotra *et al*., 2010, and Petrovic *et al*., 2013). For instance, a study conducted in Malaysia with the main objective of examining the relationship between smoking cigarettes and the overt signs of gingival inflammation (such as bleeding upon probing in otherwise healthy smokers), smokers demonstrated a relatively low mean bleeding index and a higher plaque index than non-smokers. The study concluded that the duration of smoking in years was associated with reduced gingival bleeding (Al-Bayaty *et al*., 2013).

On the contrary, the former finding is in conformity with a 2014 study conducted in Brazil to investigate the effects of smoking on bleeding on probing after non-surgical periodontal therapy. Non-surgical periodontal treatment was performed on 30 patients (15 smokers and 15 non-smokers). After therapy, the subjects were evaluated every 2 weeks for biofilm control over a 3-month period. The study showed a significant reduction in the mean percentage of sites with bleeding on probing in smokers and non-smokers after non-surgical periodontal treatment, with no significant difference between groups. Additionally, smokers showed less reduction than non-smokers in bleeding on probing with moderate and deep periodontal pockets. The authors explained that smoking could negatively affect the BOP reduction at deeper sites more than 6mm (Ardias *et al*., 2014).

Periodontal patients with a systemic condition initially had a lower bleeding index than those with no systemic condition (63.13% and 64.79%, respectively). In after-treatment patients with a

systemic condition, the bleeding index dropped to 29.6% (33.53 difference), while that in healthy patients dropped to 28.95% (35.83 difference). Although this result was statistically insignificant, it suggests that healthy patients without a systemic condition had inferior periodontal health status as opposed to systemically involved patients.

This observation can be attributed to the fact that the involvement of the periodontal tissue occurs at an earlier stage in systemically involved individuals compared to healthy individuals, pressuring them to seek the appropriate periodontal therapy at an early stage, thus allowing better control of the disease. In addition to the previously mentioned bidirectional relationship between systemic health and periodontal condition, better control of the systemic condition will help to control the periodontal disease, and vice versa.

In this study, the statistically key factor that favorably impacted the reduction in bleeding index was the treatment duration for more than 2 months. The bleeding index in patients treated with the non-surgical phase of treatment for more than 2 months dropped from 64.34% to 29.6% (43.94 difference), while patients treated for ≤ 2 months had their bleeding index reduce from 63.48 to 38.2 (25.28 difference). Therefore, treatment of a duration longer than 2 months had a profound effect on bleeding reduction compared to treatment of ≤ 2 months duration.

Furthermore, as the number of visits increased, the bleeding index decreased by 2.37 units, stressing the crucial role of the maintenance phase of periodontal therapy in the overall treatment success (Manresa *et al.*, 2018).

Regarding the clinician aspect, patients of dentists who were in their 2nd, 3rd and 4th year of training displayed a lower bleeding index score compared to patients of dentists in their first year of training, this fact can be attributed to the advanced skills and expertise the students gain as they progress further in the program.

5.4 Clinical attachment level

Males had more pre-treatment clinical attachment loss than females (levels of -4.13 and -3.81, respectively). After-treatment male's clinical attachment gain was 0.46, whereas that of females was 0.38. Even though this finding was statistically invaluable, it demonstrates that males had more clinical attachment loss than females.

This result complies with a study conducted to assess the variables related to clinical attachment loss in Korean adults older than 40 years of age. The difference in clinical attachment loss was statistically significant between both sexes, and the study suggests that both older males and patients who smoked were significant risk factors for the increase of clinical attachment loss (Rheu *et al*., 2011).

Conversely, a study in Brazil in 2008 that consisted of a younger age group to research clinical attachment loss, and its association with risk indicator, revealed that in young population, neither gender nor smoking habits showed any correlation with clinical attachment loss (Cortelli *et al*., 2008).

Smokers had a lower clinical attachment level than non-smokers (-3.9 and -3.8, respectively). The clinical attachment level of after-treatment smokers improved to -3.6 (0.31 attachment gain), but remained lower than non-smokers whose level improved to -3.1 (0.47 attachment gain). This specifies that non-smokers had more attachment level, and responded better to treatment.

This finding verifies a study in USA in 2001 to examine the patterns of attachment loss in adult periodontitis patients who were current or past smokers, or who had never smoked. The study showed that current smokers had greater attachment loss than past smokers or those who never smoked. Furthermore, increasing age and smoking status were independently significantly related to mean attachment level, and the effect of these parameters was additive (Haffajee *et al*., 2001). Another study in concurrence with this finding was performed in 2016 to investigate the effects of cigarette smoking on periodontal health following supportive therapy. The study reported the negative effect of smoking on periodontal health following 12 months of supportive periodontal therapy (Bunæs *et al*., 2016).

In patients with systemic conditions and a pre-treatment attachment level of -4.03. their attachment level after treatment, improved to -3.46 (0.56 attachment gain). On the other hand, systemically healthy individuals whose initial pre-treatment attachment level was at -3.66 improved to -3.34 after treatment (0.26 attachment gain). This proposes that participants with systemic conditions initially had more clinical attachment loss than their counterparts (healthy participants), but responded better to treatment.

This outcome is in accordance with a study conducted to investigate the association of systemic sclerosis and periodontitis. In that study, the strength of the association of systemic sclerosis with attachment loss was statistically significant (Pischon *et al*., 2016). Another study (Botero *et al*., 2012) examined the periodontal clinical attachment loss associated with diabetes disclosed that periodontitis patients with diabetes displayed more clinical attachment loss than non-diabetic periodontitis patients.

Additionally, the 2-way relationship between some systemic diseases and periodontal disease have also been investigated in literature. For example, a study aimed at monitoring the effects of scaling and root planing on glycemic control in patients with type-2 diabetes mellitus examined 15 well-controlled, 15 moderately-controlled, and 15 poorly controlled diabetic subjects before and after treatment with non-surgical periodontal therapy. The results showed that after the initial phase of periodontal treatment, all patients demonstrated significant improvement in clinical attachment level. Furthermore, improvements in the metabolic control in type-2 diabetes mellitus patients have also been reported by Soorya *et al*., (2014). This can justify the enhanced response to treatment in the systemically involved patients, since the control of the systemic condition might positively influence the periodontal status, and vice versa.

The most impressive outcome was the effect of duration of treatment on the improvement of clinical attachment level; patients who had been treated for more than 2 months showed more clinical attachment gains than those treated ≤ 2 months (0.74 and 0.1, respectively). Therefore, treatments with duration longer than 2 months had a greater impact on clinical attachment level compared to treatments of less than 2 months in duration.

CHAPTER 6: LIMITATION

The findings of this study must be seen in the light of some limitations; the first being sample size. As a result of the variable periodontal parameters, the initial assumption was to include a larger sample size. However, during the data collection, many patients' files were excluded from the study due to missing data and incomplete information.

The second limitation was the lack of documentation on the surgical phase of treatment in the department. Only a few completed surgically treated patients' files were found; therefore, they were excluded from the statistical analysis due to insufficient statistical value.

Finally, the third limitation was the absence of previous similar research in the department, which might have helped to highlight the lack of proper data storage and record-keeping in the Postgraduate Periodontal Department at Tygerberg Dental Hospital.

Despite all these limitations, the outcome of this research is in agreement with previous studies conducted around the world to investigate the efficiency of non-surgical periodontal treatment (Van der Weijden & Timmerman, 2002; Jiao J *et al*., 2017). Although most findings were statistically insignificant, the results proved the efficiency of the non-surgical periodontal treatment in the Postgraduate Periodontal Department at Tygerberg Dental Hospital.

In conclusion, this study recommends improving the record-keeping procedure in the department, and suggests using computer-based patient records. Moreover, it will be worthwhile to evaluate the periodontal treatment outcome in the undergraduate department in future investigations in order to compare and analyze the results and shortcomings from both undergraduate and postgraduate departments, thus providing a guideline towards better periodontal care in the hospital.

CHAPTER 7: CONCLUSION

This study is the first of its kind to investigate the periodontal treatment outcome in a local South African hospital, the result which proved the efficacy of the non-surgical periodontal treatment in the Postgraduate Periodontal Clinic at Tygerberg Dental Hospital.

The overall reduction in probing pocket depth, bleeding index, plaque index, and clinical attachment gain was reported in 100% of the patients. Furthermore, the main influential factor that impacted the treatment outcome was identified as the duration of treatment.

Patients with longer treatment duration showed remarkable improvements compared to patients with shorter treatment durations. In addition, it was reported that an increased number of visits marked reductions in periodontal parameters.

This result emphasizes the significance of the supportive periodontal therapy to secure better treatment outcomes.

REFERENCES

Abiko, Y., Shimizu, N., Yamaguchi, M., Suzuki, H., and Takiguchi, H., 1998. Effect of aging on functional changes of periodontal tissue cells. *Annals of periodontology*, 3(1), pp.350-369.

Alam, M.N., Mishra, P. and Chandrasekaran, S.C., 2012. Gender basis of periodontal diseases. *Indian J Basic Appl Med Res*, *2*(1), pp.128-135.

Al-Bayaty, F.H., Baharuddin, N., Abdulla, M.A., Ali, H.M., Arkilla, M.B. and ALBayaty, M.F., 2013. The influence of cigarette smoking on gingival bleeding and serum concentrations of haptoglobin and alpha 1-antitrypsin. *BioMed research international*, pp.684154-684154.

Alcouffe, F., 1989. Oral hygiene behavior: differences between men and women. *Clinical preventive dentistry*, *11*(3), pp.6-10.

Ardais, R., Mario, T.D.G., Boligon, J., Kantorski, K.Z. and MOREIRA, C.H.C., 2014. The effect of smoking on bleeding on probing after non-surgical periodontal therapy: a quasi-experimental study. *Brazilian oral research*, 28(1), pp.1-7.

Arigbede, A.O., Babatope, B.O., and Bamidele, M.K., 2012. Periodontitis and systemic diseases: A literature review. *Journal of Indian Society of Periodontology*, *16*(4), p.487.

Baelum, V. and López, R., 2016. Defining and predicting outcomes of non-surgical periodontal treatment: a 1-yr follow-up study. *European journal of oral sciences*, 124(1), pp.33-44.

Baiju, R.M., Peter, E., Varghese, N.O. Anju, P., 2017. Patient Reported Outcome Assessment of Periodontal Therapy: A Systematic Review. *Journal of clinical and diagnostic research: JCDR*, 11(8), p. ZC14.

Beck, J.D., Papapanou, P.N., Philips, K.H. and Offenbacher, S., 2019. Periodontal medicine: 100 years of progress. *Journal of dental research*, *98*(10), pp.1053-1062.

Berwick, D.M., Nolan, T.W. and Whittington, J., 2008. The triple aim: care, health, and cost. *Health affairs*, 27(3), pp.759-769.

Botero, J.E., Yepes, F.L., Roldán, N., Castrillón, C.A., Hincapie, J.P., Ochoa, S.P., Ospina, C.A., Becerra, M.A., Jaramillo, A., Gutierrez, S.J., and Contreras, A., 2012. Tooth and periodontal clinical attachment loss are associated with hyperglycemia in patients with diabetes. *Journal of periodontology*, *83*(10), pp.1245-1250.

Bui, F.Q., Almeida-da-Silva, C.L.C., Huynh, B., Trinh, A., Liu, J., Woodward, J., Asadi, H., and Ojcius, D.M., 2019. Association between periodontal pathogens and systemic disease. *Biomedical journal*. *42*(1), p.27.

Bunæs, D.F., Lie, S.A., Åstrøm, A.N., Mustafa, K., and Leknes, K.N., 2016. Site-specific treatment outcome in smokers following 12 months of supportive periodontal therapy. *Journal of clinical periodontology*, *43*(12), pp.1086-1093.

Chikte, U., Pontes, C.C., Karangwa, I., Kimmie-Dhansay, F., Erasmus, R.T., Kengne, A.P., and Matsha, T.E., 2019. Periodontal Disease Status among Adults from South Africa—Prevalence and Effect of Smoking. *International Journal of Environmental Research and Public Health*, *16*(19), p.3662.

Cortelli, J.R., Cortelli, S.C., Aquino, D.R., and Roman-Torres, C.V.G., 2008. Clinical attachment loss and its association with risk indicators in Brazilian adolescents and young adults. *Brazilian Dental Science*, 11(2).

Delatola, C., Adonogianaki, E. and Ioannidou, E., 2014. Non-surgical and supportive periodontal therapy: predictors of compliance. *Journal of clinical periodontology*, *41*(8), pp.791-796.

Desvarieux, M., Schwahn, C., Volzke, H., Demmer, R.T., Ludemann, J., Kessler, C., Jacobs Jr, D.R., John, U., and Kocher, T., 2004. Gender differences in the relationship between periodontal disease, tooth loss, and atherosclerosis. *Stroke*, *35*(9), pp.2029-2035.

Drisko, C.H., 2001. Non-surgical periodontal therapy. *Periodontology 2000*, *25*(1), pp.77-88.

Eberhard, J., Jepsen, S., Jervøe-Storm, P.M., Needleman, I., and Worthington, H.V., 2015. Full-mouth treatment modalities (within 24 hours) for chronic periodontitis in adults. *Cochrane Database* Systematic Review, (4).

Ellen, R.P., 1998. Periodontal disease among older adults: what is the issue? *Periodontology 2000*, 16(1), pp.7-8. p. ZC14.

Engström, S., Gahnberg, L., Högberg, H., and Svärdsudd, K., 2007. Association between high blood pressure and deep periodontal pockets. *Upsala journal of medical sciences*, *112*(1), pp.95-103.

Frencken, J.E., Sharma, P., Stenhouse, L., Green, D., Laverty, D., and Dietrich, T., 2017. Global epidemiology of dental caries and severe periodontitis–a comprehensive review. *Journal of Clinical Periodontology*, *44*, pp.S94-S105.

Gautam, D.K., Jindal, V., Gupta, S.C., Tuli, A., Kotwal, B., and Thakur, R., 2011. Effect of cigarette smoking on the periodontal health status: A comparative, cross-sectional study. *Journal of Indian Society of Periodontology*, *15*(4), p.383.

G. Caton, J., Armitage, G., Berglundh, T., Chapple, I.L., Jepsen, S., S. Kornman, K., L. Mealey, B., Papapanou, P.N., Sanz, M., and S. Tonetti, M., 2018. A new classification scheme for periodontal and peri-implant diseases and conditions–Introduction and key changes from the 1999 classification. *Journal of periodontology*, 89, pp.S1-S8.

Gojkov-Vukelic, M., Hadzic, S. and Pasic, E., 2017. Evaluation of efficacy of surgical periodontal therapy with the use of bone graft in the treatment of periodontal intrabony defects. *Medical Archives*, *71*(3), p.208.

Greenstein, G. and Lamster, I., 2000. Efficacy of periodontal therapy: statistical versus clinical significance. *Journal of periodontology*, 71(4), pp.657-662.

Greenstein, G., 2005. The use of surrogate variables to reflect long-term tooth survivability. *Journal of periodontology*, *76*(8), pp.1398-1402.

Haffajee, A.D. and Socransky, S.S., 2001. Relationship of cigarette smoking to attachment level profiles. *Journal of Clinical Periodontology*, *28*(4), pp.283-295.

Hebling, E., 2012. Effects of human ageing on periodontal tissues. *Periodontal diseases-a clinician's guide*, p.343.

Hujoel, P.P., 2004. Endpoints in periodontal trials: the need for an evidence-based research approach. *Periodontology 2000*, *36*(1), pp.196-204.

Huttner, E.A., Machado, D.C., De Oliveira, R.B., Antunes, A.G.F. and Hebling, E., 2009. Effects of human aging on periodontal tissues. *Special Care in Dentistry*, 29(4), pp.149-155

Jeffcoat, M.K. and Reddy, M.S., 1991. Progression of probing attachment loss in adult periodontitis. *Journal of periodontology*, *62*(3), pp.185-189.

Jiao, J., Shi, D., Cao, Z.Q., Meng, H.X., Lu, R.F., Zhang, L., Song, Y. and Zhao, J.R., 2017. Effectiveness of non-surgical periodontal therapy in a large Chinese population with chronic periodontitis. *Journal of clinical periodontology*, 44(1), pp.42-50.

Kakudate, N., Morita, M., Yamazaki, S., Fukuhara, S., Sugai, M., Nagayama, M., Kawanami, M. and Chiba, I., 2010. Association between self-efficacy and loss to follow-up in long-term periodontal treatment. *Journal of clinical periodontology*, *37*(3), pp.276-282.

Kane, S.F., 2017. The effects of oral health on systemic health. *Gen Dent*, *65*(6), pp.30-4.

Karikoski, A., Ilanne-Parikka, P. and Murtomaa, H., 2001. Oral self-care and periodontal health indicators among adults with diabetes in Finland. *Acta Odontologica Scandinavica*, *59*(6), pp.390-395.

Kassebaum, N.J., Bernabé, E., Dahiya, M., Bhandari, B., Murray, C.J.L. and Marcenes, W., 2014. Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. *Journal of dental research*, *93*(11), pp.1045-1053.

Kim, J. and Amar, S., 2006. Periodontal disease and systemic conditions: a bidirectional relationship. *odontology*, *94*(1), pp.10-21.

Kinney, J.S., Morelli, T., Oh, M., Braun, T.M., Ramseier, C.A., Sugai, J.V., and Giannobile, W.V., 2014. Crevicular fluid biomarkers and periodontal disease progression. *Journal of clinical periodontology*, *41*(2), pp.113-120.

Lamont, T.J., Clarkson, J.E., Ricketts, D.N., Heasman, P.A., and Ramsay, C.R., 2017. Core outcomes in periodontal trials: study protocol for core outcome set development. *Trials*, ***18****(1)*, pp. 436.

Linden, G.J., Lyons, A., and Scannapieco, F.A., 2013. Periodontal systemic associations: review of the evidence. *Journal of periodontology*, 84(4-s), pp. S8-S19.

Ling, W., Farabee, D., Liepa, D., and Wu, L.T., 2012. The Treatment Effectiveness Assessment (TEA): an efficient, patient-centered instrument for evaluating progress in recovery from addiction. *Substance abuse and rehabilitation*, 3, p.129.

Macgregor, I.D.M., Edgar, W.M. and Greenwood, A.R., 1985. Effects of cigarette smoking on the rate of plaque formation. *Journal of Clinical Periodontology*, 12(1), pp.35-41.

Machtei, E.E., 1997. Outcome variables for the study of periodontal regeneration. *Annals of periodontology*, 2(1), pp.229-239.

Malhotra, R., Kapoor, A., Grover, V., and Kaushal, S., 2010. Nicotine and periodontal tissues. *Journal of Indian Society of Periodontology*, 14(1), p.72.

Manresa, C., Sanz-Miralles, E. C., Twigg, J., & Bravo, M. (2018). Supportive periodontal therapy (SPT) for maintaining the dentition in adults treated for periodontitis. *Cochrane Database of Systematic Reviews*, (1).

Mascarenhas, P., Gapski, R., Al-Shammari, K., and Wang, H.L., 2003. Influence of sex hormones on the periodontium. *Journal of clinical periodontology*, 30(8), pp.671-681.

Mariotti, A. and Hefti, A.F., 2015. Defining periodontal health. *BMC Oral Health*, *1*(15), pp.1-18.

Michalowicz, B.S., 1994. Genetic and heritable risk factors in periodontal disease. *Journal of periodontology*, 65, pp.479-488.

Mombelli, A., 1998. Ageing and the periodontal and peri-implant microbiota. *Periodontology 2000*, 16(1), pp.44-52.

Mullally, B.H., 2004. The influence of tobacco smoking on the onset of periodontitis in young persons. *Tobacco induced diseases*, *2*(2), p.53.

Müller Campanile, V., Megally, A., Campanile, G., Gayet-Ageron, A., Giannopoulou, C., and Mombelli, A., 2019. Risk factors for recurrence of periodontal disease in patients in maintenance care in a private practice. *Journal of clinical periodontology*, *46*(9), pp.918-926.

Nagpal, R., Yamashiro, Y. and Izumi, Y., 2015. The two-way association of periodontal infection with systemic disorders: an overview. *Mediators of inflammation*, pp.793898-793898.

Navarro-Sanchez, A.B., Faria-Almeida, R. and Bascones-Martinez, A., 2007. Effect of non-surgical periodontal therapy on clinical and immunological response and glycaemic control in type-2 diabetic patients with moderate periodontitis. *Journal of clinical periodontology*, *34*(10), pp.835-843.

Nazir, M.A., 2017. Prevalence of periodontal disease, its association with systemic diseases and prevention. *International journal of health sciences*, *11*(2), p.72.

Neely, A.L., Holford, T.R., Löe, H., Ånerud, Å., and Boysen, H., 2001. The natural history of periodontal disease in man. Risk factors for progression of attachment loss in individuals receiving no oral healthcare. *Journal of Periodontology*, 72(8), pp.1006-1015.

Oruba, Z., Pac, A., Olszewska-Czyż, I., and Chomyszyn-Gajewska, M., 2014. The significance of motivation in periodontal treatment: the influence of adult patients' motivation on the clinical periodontal status. *Community dental health*, *31*(3), pp.183-187.

Page, R.C. and Kornman, K.S., 1997. The pathogenesis of human periodontitis: an introduction. *Periodontology 2000*, *14*(1), pp.9-11.

Pahkla, E.R., Koppel, T., Naaber, P., Saag, M., and Loivukene, K., 2006. The efficacy of non-surgical and systemic antibiotic treatment on smoking and non-smoking periodontitis patients. *Stomatologija*, *8*(4), pp.116-121.

Palumbo, A., 2011. The anatomy and physiology of the healthy periodontium. *Gingival diseases: Their aetiology, prevention and treatment*, pp.139-154.

Papantonopoulos, G.H., 2004. Effect of periodontal therapy in smokers and non-smokers with advanced periodontal disease: results after maintenance therapy for a minimum of 5 years. *Journal of periodontology*, *75*(6), p.839.

Pejčić, A., Obradović, R., Kesić, L. and Kojović, D., 2007. Smoking and periodontal disease: a review. *Med Biol*, 14(2), pp.53-9.

Petersen, P.E., 2003. The World Oral Health Report 2003: continuous improvement of oral health in the 21st century–the approach of the WHO Global Oral Health Programme. *Community Dentistry and oral epidemiology*, 31, pp.3-24

Petrovic, M., Kesic, L., Obradovic, R., Savic, Z., Mihailovic, D., Obradovic, I., Avdic-Saracevic, M., Janjic-Trickovic, O., and Janjic, M., 2013. Comparative analysis of smoking influence on periodontal tissue in subjects with periodontal disease. *Materia socio-medica*, 25(3), p.196.

Pihlstrom, B.L., 2001. Periodontal risk assessment, diagnosis and treatment planning. *Periodontology 2000*, 25(1), pp.37-58.

Pischon, N., Hoedke, D., Kurth, S., Lee, P., Dommisch, H., Steinbrecher, A., Pischon, T., Burmester, G.R., Buttgereit, F., Detert, J., and Riemekasten, G., 2016. Increased periodontal attachment loss in patients with systemic sclerosis. *Journal of periodontology*, 87(7), pp.763-771.

Preshaw, P.M., 2015. Detection and diagnosis of periodontal conditions amenable to prevention. *BMC Oral Health*, *1*(15), pp.1-11.

Renvert, S. and Persson, G.R., 2004. Supportive periodontal therapy. *Periodontology 2000*, 36(1), pp.179-195.

Rheu, G.B., Ji, S., Ryu, J.J., Lee, J.B., Shin, C., Lee, J.Y., Huh, J.B., and Shin, S.W., 2011. Risk assessment for clinical attachment loss of periodontal tissue in Korean adults. *The journal of advanced prosthodontics*, 3(1), pp.25-32.

Saminsky, M., Halperin-Sternfeld, M., Machtei, E.E., and Horwitz, J., 2015. Variables affecting tooth survival and changes in probing depth: a long-term follow-up of periodontitis patients. *Journal of clinical periodontology*, 42(6), pp.513-519.

Sanadi, R.M., Chelani, L.R., Suthar, N.J., Khuller, N., and Basavaraj, P., 2017. Gender-based differences in occurrence of gingival disease among dental students: A survey. *Dentistry and Medical Research*, 5(1), p.17.

Sanz, I., Alonso, B., Carasol, M., Herrera, D. and Sanz, M., 2012. Non-surgical treatment of periodontitis. *Journal of Evidence Based Dental Practice*, 12(3), pp.76-86.

Segelnick, S.L. and Weinberg, M.A., 2006. Reevaluation of initial therapy: When is the appropriate time?. *Journal of periodontology*, *77*(9), pp.1598-1601.

Shah, E.B., Modi, B.B., Shah, M.A., and ave, D.H., 2017. Patient Centered Outcomes in Periodontal Treatment–An Evidenced-based Approach. *Journal of clinical and diagnostic research*: JCDR, 11(4), pp. ZE05.

Simona, G., Silvia, M. and Carina, B., 2014. Quality of life regarding patients with periodontal disease in Iasi, Romania. Procedia-Social and Behavioral Sciences, 127, pp.15-20. Simona, G., Silvia, M. and Carina, B., 2014. Quality of life regarding patients with periodontal disease in Iasi, Romania. *Procedia-Social and Behavioral Sciences*, 127, pp.15-20.

Slots, J., 2013. Periodontology: past, present, perspectives. *Periodontology 2000*, 62(1), pp.7-19.

Soorya, K.V., Suchetha, A., Lakshmi, P., Sapna, N., Apoorva, S.M., and Divya Bhat, D.B.M., 2014. The effect of scaling and root planing on glycaemic control, periodontal status and gingival crevicular fluid TNF-α levels in an Indian population-to reveal the ambivalent link. *Journal of clinical and diagnostic research*: JCDR, 8(11), p ZC22.

Soskolne, W.A., Proskin, H.M. and Stabholz, A., 2003. Probing depth changes following 2 years of periodontal maintenance therapy including adjunctive controlled release of chlorhexidine. *Journal of periodontology*, 74(4), pp.420-427.

Sreenivasan, P.K., Prasad, K.V.V. and Javali, S.B., 2016. Oral health practices and prevalence of dental plaque and gingivitis among Indian adults. *Clinical and experimental dental research*, 2(1), pp.6-17.

Strauss, S.M. and Stefanou, L.B., 2014. Interdental cleaning among persons with diabetes: relationships with individual characteristics. *International journal of dental hygiene*, 12(2), pp.127-132.

Tariq, M., Iqbal, Z., Ali, J., Baboota, S., Talegaonkar, S., Ahmad, Z. and Sahni, J.K., 2012. Treatment modalities and evaluation models for periodontitis. *International journal of pharmaceutical investigation*, 2(3), p.106.

Tonetti, M.S., Greenwell, H. and Kornman, K.S., 2018. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of periodontology*, 89, ppS159-S172

Tonetti, M.S., Jepsen, S., Jin, L. and Otomo-Corgel, J., 2017. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. *Journal of clinical periodontology*, 44(5), pp.456-462.

Tonetti, M.S., Van Dyke, T.E. and Working Group 1 of the Joint EFP/AAP Workshop, 2013. Periodontitis and atherosclerotic cardiovascular disease: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. *Journal of Clinical Periodontology*, 40, pp. S24-S29.

Touboul, V., Germa, A., Lasfargues, J.J., and Bonte, E., 2014. Outcome of endodontic treatments made by postgraduate students in the dental clinic of Bretonneau Hospital. *International journal of dentistry*, pp.684979-684979.

Trombelli, L., Franceschetti, G. and Farina, R., 2015. Effect of professional mechanical plaque removal performed on a long-term, routine basis in the secondary prevention of periodontitis: a systematic review. *Journal of clinical periodontology*, *42*, pp. S221-S236.

Van der Velden, U. and Sanz, M., 2010. Postgraduate periodontal education. Scope, competences, proficiencies and learning outcomes: Consensus report of the 1st European workshop on periodontal education–position paper 3 and consensus view 3. *European Journal of Dental Education*, 14, pp.34-40.

Van der Weijden, G.A. and Timmerman, M.F., 2002. A systematic review on the clinical efficacy of subgingival debridement in the treatment of chronic periodontitis. *Journal of clinical periodontology*, *29*, pp.55-71.

Walton, M.K., Powers III, J.H., Hobart, J., Patrick, D., Marquis, P., Vamvakas, S., Isaac, M., Molsen, E., Cano, S., and Burke, L.B., 2015. Clinical outcome assessments: Conceptual Foundation–Report of the ISPOR clinical outcomes assessment–emerging good practices for outcomes research task force. *Value in Health*, *18*(6), pp.741-752.

Wan, C.P., Leung, W.K., Wong, M.C., Wong, R.M., Wan, P., Lo, E.C., and Corbet, E.F., 2009. Effects of smoking on healing response to non-surgical periodontal therapy: a multilevel modelling analysis. *Journal of clinical periodontology*, *36*(3), pp.229-239.

Weidlich, P., Cimões, R., Pannuti, C.M. and Oppermann, R.V., 2008. Association between periodontal diseases and systemic diseases. *Brazilian oral research*, *22*, pp.32-43.

Winning, L. and Linden, G.J., 2017. Periodontitis and systemic disease: association or causality? *Current oral health reports*, *4*(1), pp.1-7.

Worthington, H.V., Clarkson, J.E., Bryan, G., and Beirne, P.V., 2013. Routine scale and polish for periodontal health in adults. *Cochrane Database Syst Rev*, 11.

Yajima-Himuro, S., Oshima, M., Yamamoto, G., Ogawa, M., Furuya, M., Tanaka, J., Nishii, K., Mishima, K., Tachikawa, T., Tsuji, T., and Yamamoto, M., 2014. The junctional epithelium originates from the odontogenic epithelium of an erupted tooth. *Scientific reports*, *4*(1), pp.1-7.

Zee, K.Y., 2009. Smoking and periodontal disease. *Australian dental journal*, *54*, pp.S44-S50.

APPENDICES

Appendix A

UNIVERSITY of the WESTERN CAPE

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23 April 2019

Dr M Abdalla
Faculty of Dentistry

Ethics Reference Number: BM19/2/6

Project Title: An assessment of the factors affecting the efficacy of periodontal treatment carries out by postgraduate periodontology students.

Approval Period: 16 February 2019 16 February 2020

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 in good time for annual renewal.

The permission to conduct the study must be submitted for record purposes.

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

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

BMREC REGISTRATION NUMBER -130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE.