

# The Diagnosis of White Spot Lesions in Orthodontic Patients



THE UNIVERSITY  
*of* ADELAIDE

A thesis submitted in partial fulfilment of the requirements for the  
degree of Doctor of Clinical Dentistry (Orthodontics)

by

**Dr Balya SRIRAM**

Orthodontic Unit

School of Dentistry

Faculty of Health Sciences

The University of Adelaide

July 2013

# 1. Thesis Abstract

**Objectives:**(i) To investigate the associations between the presence, number and severity of white spot lesions (WSLs) and patient characteristics. (ii)To investigate the associations between the presence, number and severity of WSLs and the saliva properties tested using the Saliva-Check BufferKit (GC Corp., Belgium).(iii) To evaluate the use of the DIAGNOdent pen (KaVo, Biberach, Germany) as an aid in the identification of WSLs in orthodontic patients.

**Method:** With ethics approval, 91 orthodontic patients had de-identified parameters recorded which included date of birth, sex, postcode, age at banding, time in bands, failure to attend (FTA) rate, type of bracket used, reported oral hygiene regimen and number of restored molars. All participants were examined for WSLs on their upper and lower anterior teeth using a visual index outlined by the International Caries Detection and Assessment System II (ICDAS II) and a laser-based caries detection device (DIAGNOdent pen).Of the 91 participants, 50 had saliva properties tested which included hydration, consistency, resting pH, stimulated flow, stimulated pH and buffering capacity.

**Results Paper 1:** Brushing fewer than 14 times a week and the presence of restored molars were significant variables for the development and severity of WSLswhen the severity was  $\geq$  ICDAS II grading of 2 ( $p < 0.05$ ).When WSLs were ICDAS II  $\geq 3$  grading, the FTA rate and

brushing fewer than 14 times per week were significant variables ( $p < 0.05$ ). The number of WSLs increased when participants brushed fewer than 14 times per week or had an increased FTA rate ( $p < 0.05$ ). Comparisons between ICDAS II scores and DIAGNOdent pen scores were statistically significant ( $p < 0.0001$ ).

**Results Paper 2:** When using the Saliva-Check Buffer Kit, the pH of stimulated saliva was a significant diagnostic variable in identifying WSLs ( $p < 0.05$ ). The pH of stimulated saliva and the quantity of saliva produced in 5 minutes were significant variables of WSL severity when the grading was greater than or equal to an ICDAS II score of 2 ( $p < 0.05$ ). When the grading was greater than or equal to an ICDAS II score of 3, the pH of unstimulated saliva was a significant variable ( $p < 0.05$ ). No relationship was found between the number of WSLs in a patient and the saliva properties tested with the Saliva-Check Buffer Kit.

**Conclusions:** A patient's report of brushings per week indicates the presence, severity and number of white spots they may experience. The number of restored molars may indicate the presence and severity of their white spot lesion experience. Patients who fail to attend appointments are likely to have a larger number of WSLs with greater severity. The DIAGNOdent Pen corresponds significantly to the ICDAS II system to grade WSLs in orthodontic patients. The pH of stimulated saliva, the pH of unstimulated saliva and saliva flow rate may indicate orthodontic patients who are susceptible to WSLs and may also indicate the severity

of the lesions. The Saliva-Check Buffer Kit is unable to distinguish between patients who have many or those who have few WSLs.

## TABLE OF CONTENTS

Thesis Abstract.....	2
List of Figures and Tables.....	7
Declaration.....	9
Acknowledgements.....	10
Literature Review.....	11
White Spot Lesions in Orthodontic Treatment.....	11
Clinical Evaluation of White Spot Lesions.....	18
The Effect of Orthodontic Appliances on the Oral Environment	26
Saliva Properties and Dental Caries.....	28
The Saliva-Check Buffer Kit.....	33
The Efficacy of the Saliva-Check Buffer Kit in Caries Prediction .....	35
Other Saliva Tests Used to Determine Caries Risks in Orthodontic Patients.....	37
Management of White Spot Lesions.....	38
Conclusion.....	48
References.....	50
Statement of Purpose .....	71
Aims and Hypothesis .....	73
Article 1.....	75
The DIAGNOdent pen and Patient Factors to Diagnose White Spots in Orthodontic Patients	
Abstract.....	76
Introduction.....	77
Materials and Methods.....	80

Results.....	88
Discussion.....	95
Conclusions.....	101
References.....	102
Article 2.....	108
Saliva Tests to Determine the Risk of White Spot Lesions During Orthodontic Treatment	
Abstract.....	109
Introduction.....	110
Materials and Methods.....	113
Results.....	118
Discussion.....	126
Conclusions.....	128
References.....	130
Concluding Remarks.....	134
Appendix.....	136
Saliva-Check Buffer Kit.....	136
Information Sheet for Participants.....	141
Standard Consent Form.....	142
Consent Form for Minors.....	143
Independent Complaints Information.....	144

# LIST OF FIGURES AND TABLES

## LITERATURE REVIEW

### *Tables*

1. The ICDAS II Caries Scoring System 21

## ARTICLE 1

### *Figures*

1. Summary of Methodology 81
2. Central Incisors Divided into “Mini-Quadrants” 85

### *Tables*

1. The ICDAS II Caries Scoring System 86
2. Type of WSLs 89
3. Severity of WSLs 89
4. The Relationship Between Patient Factors and the Presence of WSLs 90
5. The Relationship Between Patient Factors and the Severity of WSLs  $\geq$  ICDAS II Grade 2 92
6. The Relationship Between Patient Factors and the Severity of WSLs  $\geq$  ICDAS II Grade 3 93
7. The Relationship Between Patient Factors and the Number of WSLs 94
8. Least Squares Means 95

## **ARTICLE 2**

### *Figures*

1. Presentation of White Spot Lesions	111
2. Buffering Capacity Points	115
3. Central Incisors Divided into “Mini-Quadrants”	116

### *Tables*

1. The ICDAS II Caries Scoring System	117
2. Score of WSLs	119
3. Relationship Between the Presence of WSLs and the Saliva-Check Buffer Kit	120
4. Relationship Between the Severity of WSLs $\geq$ ICDAS II Grade 2 and the Saliva-Check Buffer Kit	122
5. Relationship Between the Severity of WSLs $\geq$ ICDAS II Grade 3 and the Saliva-Check Buffer Kit	123
6. Relationship Between the Number of WSLs a Patient Experiences and the Saliva-Check Buffer Kit	125

## **APPENDIX**

### *Figures*

1. Labial Gland Saliva Secretion	137
2. pH Colour Chart	138
3. Buffering Capacity Points	139



## 2. Thesis Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution in my name and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent for this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library catalogue and also through web search engines, unless permission has been granted by the University to restrict access for a period of time

Dr Balya Sriram

22<sup>nd</sup> July 2013

### 3. Acknowledgements

I would like to thank the following people for their academic support over the duration of my candidature

Professor Wayne Sampson, P.R. Begg Chair in Orthodontics, The University of Adelaide.

Associate Professor Craig Dreyer, Orthodontics, The University of Adelaide.

Dr Neville Gully, Senior Lecturer in Microbiology, The University of Adelaide.

Associate Professor John Kaidonis, Craniofacial Biology, The University of Adelaide.

Thomas Sullivan, Statistician, Data Management & Analysis Centre, Discipline of Public Health, The University of Adelaide.

The Australian Orthodontic Society Research Foundation for their financial assistance.

The Australian Dental Research Foundation for their financial assistance.

To David Bachmayer, for being my mentor since I had my braces.

To my parents Dak and Kalpana, and my sister Divya for their ongoing emotional support .

To my husband Ruchit, for providing me with strength and encouragement throughout my journey.