



VASCULAR MORPHOLOGY OF THE MOUSE MOLAR PERIODONTIUM

RONNIE SAI TAT WONG D.M.D. (Phil.)

A research report submitted in partial fulfilment  
for the degree of Master of Dental Surgery.

Department of Dental Health  
Faculty of Dentistry  
The University of Adelaide  
South Australia

February, 1983

TABLE OF CONTENTS

		Page Number
	SUMMARY	v.
	SIGNED STATEMENT	viii.
	ACKNOWLEDGEMENTS	ix.
	LIST OF ILLUSTRATIONS	x.
CHAPTER 1	INTRODUCTION	1.1
CHAPTER 2	AIMS OF THE INVESTIGATION	2.1
CHAPTER 3	LITERATURE REVIEW	3.1
3.1	Techniques for the Study of Vascular Pathways	3.14
	(A) Histological Section Techniques	3.16
	(B) Histological Perfusion Techniques	3.16
	(C) Micro-angiographic Techniques	3.17
	(i) Contact Microradiography	3.17
	(ii) X-ray Projection Microscopy	3.18
	(iii) Stereo-angiography	3.18
	(D) Histo-angiographic Techniques	3.18
	(E) Micro- and Histo-angiographic Techniques	3.18
	(F) Microsphere Techniques	3.19
	(G) Vital-microscopic Techniques	3.19
	(H) Impression Techniques	3.19
	(I) Corrosion Cast Techniques	3.20
	(i) Silicone Rubber	3.20
	(ii) Latex	3.20
	(iii) Methyl Methacrylate	3.20
CHAPTER 4	MATERIALS AND METHODS	4.1
4.1	General Considerations	4.1
	(A) The Scanning Electron Microscope (SEM)	4.1
	(B) The Casting Media	4.2

	Page Number
(i) General Requirements	4.2
(ii) Preparation of Methyl methacrylate to a Controlled Viscosity	4.3
(iii) Viscosity	4.3
(iv) Preparation of the Casting Media	4.6
(C) Preparation of the Physiological Washout Solution	4.7
(D) Preparation of the Anaesthetic Agent	4.7
(E) Preparation of the Apparatus	4.7
(i) Items Required	4.7
(ii) Assembling the Apparatus	4.8
(a) Connections to the Glass Spout	4.8
(b) Connections to the Top Opening	4.10
4.2 Technical Procedure	4.10
(A) Washout	4.10
(B) Casting	4.14
(C) Corrosion	4.14
(D) Sectioning	4.15
(E) Coating	4.15
(F) Examination and Recording	4.16
CHAPTER 5 FINDINGS	5.1
5.1 Incisor Region	5.1
5.2 Palatal Region	5.9
5.3 Molar Region	5.10
(A) Vessels in the Gingival Region	5.16
(i) Outer Circular Vessel System	5.16
(ii) Inner Circular Vessel System	5.22
(B) Vessels in the Periodontal Ligament Region	5.27

	Page Number
(i) Cervical Third	5.33
(ii) Middle Third	5.33
(iii) Apical Third	5.47
5.4 Vessels in the Medullary Region	5.47
CHAPTER 6 DISCUSSION	6.1
6.1 Incisor Region	6.1
6.2 Palatal Region	6.3
6.3 Molar Region	6.4
(A) Vessels in the Gingival Region	6.4
(i) Outer Circular Vessel System	6.4
(ii) Inner Circular Vessel System	6.6
(B) Vessels in the Periodontal Ligament Region	6.9
(C) Composite Vascular Model	6.11
(D) Functional Considerations	6.14
6.4 Technical Considerations	6.16
(A) Experimental Animals	6.16
(B) The Casting Media	6.17
(C) The Washout Solution	6.18
(D) The Anaesthetic Agent	6.18
(E) Washout and Casting	6.18
(F) Corrosion	6.19
(G) Sectioning	6.20
(H) Casting	6.20
(I) Identification of Vessels	6.20
CHAPTER 7 CONCLUSIONS	7.1
CHAPTER 8 APPENDICES	8.1
8.1 Appendix 1: Dosages of Urethane Anaesthetic	8.1

8.2	Appendix 2: Chemical Reagents and Suppliers	8.2
8.3	Appendix 3: Instrumentation	8.4
CHAPTER 9	BIBLIOGRAPHY	9.1

SUMMARY

A study of the vascular networks around the palate and the molar socket of the male laboratory mouse was conducted using a perfusion technique for methyl methacrylate casting followed by coating of the vascular replica with gold. Examination and photography of the bulk specimens was carried out under the scanning electron microscope. Stereopair photographs of the areas of interest were examined under a viewer for three-dimensional imaging.

The findings indicated that the vascular network followed closely the configuration of the soft tissues. The palate showed areas of thickening of the vascular network which resembled the thickening of the rugae. Wavy, capillary-like vessels were found at the apex and the side slopes of the rugae. In the inter-rugal valley large venous-like vessels were the predominant feature. It can be hypothesized that the wavy pattern of the rugal capillaries plays an important role in permitting their elongation during masticatory shearing deformation of the gingivae. By contrast, the large venous-like vessels in the inter-rugal valley may absorb most of the compressive loads during function.

The gingival vessels encircling the neck of the molars consisted of two major systems. An outer circular vessel system located occlusally and connected to the mucosal vessels. The inner circular vessel group was situated adjacent to the gingival crevice and joined the axially aligned periodontal ligament vessels. The outer and inner systems were linked by anastomoses orientated in a radial direction. These patterns of the gingival vessels have not been previously described.

There were glomerular-like vascular formations radiating

towards the gingival crevice from the inner circular vessel system. These glomerular-like structures consisted of two short, fine stalks uniting to form globe-like endings. One of these fine stalks came from a terminal arterial vessel, while the other fine stalk attached to the single, venous circular vessel of the inner system. The junction of these fine stalks was enlarged and twisted. It is suggested that these glomerular-like structures may give rise to interstitial crevicular fluid and thus provide a self-cleansing function to the gingival crevice.

Large venous-like periodontal ligament vessels were demonstrated alongside the coronal third of the molar socket. These ligament vessels proper were connected to the inner circular vessel system by short axially aligned connecting vessels of the same size. The major periodontal ligament vessels were orientated in a palisade manner as they extended towards the apex where they joined to form a hammock-like cushion arrangement. There were three patterns of anastomoses between the palisading ligament vessels. They exhibited a polygonal intertwining arrangement in the occlusal third, a longitudinal loop-like orientation in the middle third and a circular hammock-like cushion at the apical region. Huge reservoir-like venous cushions were a characteristic feature of the interradicular furcations.

The medullary vessels linked the periodontal ligament vessels and gingival vessels at various levels. These medullary vessels formed a network intraosseously and eventually drained via large venous collecting vessels located in the bone opposite the level of the molar apices.

No information has been previously documented on mouse periodontal vascular casts. Some of the findings resulting from this investigation have not been reported in other species. This study

extends our knowledge of the periodontal microvascular bed and emphasizes data which differ from other studies in the literature.



SIGNED STATEMENT

This project is submitted in partial fulfilment of the requirements for the Degree of Master of Dental Surgery at The University of Adelaide.

This report contains no material which has been accepted for the award of any other degree or diploma in any University. To the best of my knowledge and belief, it contains no material previously published or written by another person except where due reference is made in the text of the report.

RONNIE SAI TAT WONG

ACKNOWLEDGEMENTS

I am most grateful to my supervisor, Dr. M.R. Sims, Reader in Orthodontics, for the continuous guidance and instruction given to me throughout my work.

I am also grateful to Dr. B.J. Gannon, Senior Lecturer in Human Morphology, Flinders University, for his expert advice concerning the corrosion cast technique.

I would like to express my gratitude to Dr. K. Bartusek, Officer-in-Charge of the Electron Optical Centre of the University of Adelaide, for access to and instruction in the use of the scanning electron microscope.

Valuable technical advice has been given to me by Lorraine McMahon of the Department of Dental Health of the University of Adelaide. To her I offer my sincere thanks.

Special thanks are given to Dr. W.J. Sampson, Dr. P.C.K. Cheng and Dr. P.N.C. Wong for their encouragement and assistance in many ways throughout the entire project, and to Brenda Purdie for typing the manuscript.

LIST OF ILLUSTRATIONS

	Page Number
Figure 1. Periodontal vasculature of the rat molar (Kindlova and Matena, 1962)	3.4
Figure 2. Blood supply of the marginal periodontium in the monkey (Kindlova, 1965).	3.8
Figure 3. Distribution of the rat incisor capillary networks during amelogenesis (Iwaku and Ozawa, 1979).	3.15
Figure 4. Ultraviolet light and vial arrangement for the partial polymerization of monomer.	4.4
Figure 5. Modified Ostwald viscometer.	4.5
Figure 6. Perfusion apparatus.	4.9
Figure 7. Long needle in Dwellcath cannula.	4.12
Figure 8. Dwellcath cannula secured within aorta.	4.13
Figure 9. Frame specifications.	4.17
Figure 10. Diagram of peridontal vessels viewed in a longitudinal section through the mouse maxillary incisor.	5.2
Figure 11. Vascular system surrounding the coronal two-thirds of a maxillary incisor.	5.3
Figure 12. Stereopair photographs of vessels in the middle third of the incisor periodontal ligament.	5.4 5.5
Figure 13. Stereopair view of vessels between the incisor enamel and cementum zones.	5.6 5.7
Figure 14. Vessels of the rugae.	5.8
Figure 15. Stereopair of rugal vessels alongside the first and second molars.	5.11 5.12
Figure 16. Right mandibular cast showing molar sockets.	5.13
Figure 17. Left maxillary cast showing molar sockets.	5.14
Figure 18. Right mandibular first molar demonstrating socket components.	5.15
Figure 19. Diagram of mouse molar gingival vessels.	5.17

		Page Number
Figure 20.	Schematic arrangement of buccal and lingual gingival vessels.	5.18
Figure 21.	Stereopair view of the inner and outer circular vessels of a maxillary second molar.	5.19 5.20
Figure 22.	Stereopair view of the glomerular capillary loops.	5.23 5.24
Figure 23.	Stereopair photographs of vessels in the gingival third of the periodontal ligament.	5.25 5.26
Figure 24.	Stereopair photographs of the interdental region between mandibular first and second molar.	5.28 5.29
Figure 25.	Stereopair view of the bisecting vessel in the interdental triangular region between maxillary first and second molar.	5.30 5.31
Figure 26.	Sagittal view of the gingival, periodontal, medullary and pulp vessels in a mandibular socket.	5.32
Figure 27.	Stereopair photographs of the polygonal anastomoses in the buccal cervical third of the mandibular first molar.	5.34 5.35
Figure 28.	Stereopair photographs of the intertwining polygonal anastomoses in the cervical third of the mandibular first molar.	5.36 5.37
Figure 29.	Stereopair photographs of vessels in the middle third of the periodontal ligament.	5.39 5.40
Figure 30.	Stereopair view of the precapillary sphincter of a mandibular first molar.	5.41 5.42
Figure 31.	Stereopair view of the huge periodontal ligament vessel in the interradicular region of the mandibular first molar.	5.43 5.44
Figure 32.	Stereopair photographs of vertical branches from the huge periodontal ligament in the interradicular region of a mandibular first molar.	5.45 5.46
Figure 33.	Stereopair photographs of the vascular network in the apex of a maxillary socket.	5.48 5.49
Figure 34.	Stereopair photographs of the vascular network in the apex of a mandibular socket.	5.50 5.51

		Page Number
Figure 20.	Schematic arrangement of buccal and lingual gingival vessels.	5.18
Figure 21.	Stereopair view of the inner and outer circular vessels of a maxillary second molar.	5.19 5.20
Figure 22.	Stereopair view of the glomerular capillary loops.	5.23 5.24
Figure 23.	Stereopair photographs of vessels in the gingival third of the periodontal ligament.	5.25 5.26
Figure 24.	Stereopair photographs of the interdental region between mandibular first and second molar.	5.28 5.29
Figure 25.	Stereopair view of the bisecting vessel in the interdental triangular region between maxillary first and second molar.	5.30 5.31
Figure 26.	Sagittal view of the gingival, periodontal, medullary and pulp vessels in a mandibular socket.	5.32
Figure 27.	Stereopair photographs of the polygonal anastomoses in the buccal cervical third of the mandibular first molar.	5.34 5.35
Figure 28.	Stereopair photographs of the intertwining polygonal anastomoses in the cervical third of the mandibular first molar.	5.36 5.37
Figure 29.	Stereopair photographs of vessels in the middle third of the periodontal ligament.	5.39 5.40
Figure 30.	Stereopair view of the precapillary sphincter of a mandibular first molar.	5.41 5.42
Figure 31.	Stereopair view of the huge periodontal ligament vessel in the interradicular region of the mandibular first molar.	5.43 5.44
Figure 32.	Stereopair photographs of vertical branches from the huge periodontal ligament in the interradicular region of a mandibular first molar.	5.45 5.46
Figure 33.	Stereopair photographs of the vascular network in the apex of a maxillary socket.	5.48 5.49
Figure 34.	Stereopair photographs of the vascular network in the apex of a mandibular socket.	5.50 5.51