A comparison of posterior palatal seal creation in complete dentures by students at the University of Pretoria and private practitioners

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A comparison of posterior palatal seal creation in complete dentures by students at the University of Pretoria and private practitioners

by

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Research submitted in Partial fulfilment of the requirements for the degree

MChD (Prosthodontics)

In the

School of Dentistry

Faculty of Health Sciences

University of Pretoria

South Africa

Supervisor

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2015

Declaration

I hereby declare that this mini-thesis, submitted by me in partial fulfilment of the requirements for the degree of MChD (Prosthodontics) at the University of Pretoria, has not been submitted for a degree at any other University.

Mary-Rose Lekay-Adams Date

Dedications

I dedicate this to my friends and family, especially my children, Ethan and Carmen and to my mother, Laeticia Lekay, for all their love and support throughout my studies.

Abstract

Aims:

The aim of this study was to investigate the methods used by private practitioners and students to fabricate a posterior palatal seal in dentures and determine how many clinicians carry out this procedure themselves.

Materials and methods:

The laboratory slips, final impressions and final casts at jaw registration, try-in and finish stages of complete dentures of 50 student cases from the University of Pretoria and 10 cases from 5 private dental laboratories respectively were examined to determine the presence, position and dimensions of the post dam. Photographs and impressions were taken with polyvinyl siloxane impression material in cases where the post dam were marked and/or scribed. The impressions were sectioned with a scalpel and measurements were recorded with the aid of an Iwansson gauge and Carl Zeiss microscope. Depth and width was recorded at the midpalatal suture, right and left posterolateral, and right and left hamular notch areas of the scribed post dams.

Results:

In the private laboratory cases one of the 50 cases had the post dam marked at the secondary impression stage. In the student laboratory cases, 20% were marked at the secondary impression stage, 14% at the jaw registration and 12% at the try-in stages. Only 4% were scribed, all at the try-in stages. Measurements for post dam dimensions could only be made in 2 cases.

Conclusions:

Results of this study revealed a dismal lack of compliance and appreciation of the importance of the post dam by both students and experienced dental clinicians.

Key words: Post dam, posterior palatal seal, physiological limits, denture retention, vibrating line, “ah” line.

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Preface

The Research Committee at the School of Dentistry, Faculty of Health Sciences at the University of Pretoria has approved this study.

Research Committee protocol approval number: **DENT 2014/01**

The Faculty of Health Sciences research and Ethics Committee at the University of Pretoria has approved this study.

Ethics clearance certificate protocol number: **43/201427471056**

Chapter 1

INTRODUCTION

Over the last few decades the rate of tooth loss has significantly declined in industrialised countries, however, it is region specific, and significantly influenced by socio-economic factors. Overall tooth loss tends to increase with age, and when coupled with an increase in the mean age of most populations, will result in the total proportion of edentulous patients remaining significantly high. Traditionally the accepted first choice of treatment for edentulous patients has been mucosa supported complete dentures.[1] Implant supported prostheses have gained popularity in recent years, even to the extent that the McGill consensus in 2002 recommended the two implant supported overdenture as the minimum standard of care.[2] This proposal was supported by the York consensus in 2009.[1] However, due to the economic reality their routine prescription for the majority of edentulous patients remains unrealistic. Carlsson and Omar[3]concluded in their review on the future of complete dentures: "Improving the conventional management of edentulous patients is a necessity and requires a keener focus by researchers, educators and clinicians".

Bearing these recommendations in mind, we in South Africa must also take cognisance of the regulations by the Health Professions Act 56 of 1974 which states that dental graduate students should recognise the importance of primary oral health care and be sensitive to oral health needs of the country.[4] Our students and clinicians need to focus primarily on providing the majority of people with aesthetically pleasing, well-fitting, functional conventional dentures, while at the same time maintaining acceptable standards of completion.

Denture retention is resistance to dislodgement of the denture base from the supporting tissues.[5] A properly constructed denture with satisfactory retention aids significantly to the patient's comfort and psychological wellbeing, whilst a lack of retention can lead to social isolation due to fear, apprehension and embarrassment caused by loose dentures.[6] Thus, all factors that contribute to retention should be executed accurately and meticulously during the clinical and laboratory stages of denture construction.

Retention can be influenced by both patient and denture factors, the latter being largely dependent on the skill and experience of the clinician and technician. Patient aspects include the conformation and condition of the supporting anatomic structures, biological influences such as the quality and quantity of saliva, as well as individual adaptive capabilities. The clinician has very little control over many of these, such as extensively resorbed ridges, thick ropy saliva, xerostomia, or poor muscular control. However, certain undesirable anatomic features such as tori, flabby ridges or bony exostoses can be altered by surgical intervention prior to denture construction. The clinician generally has control over aspects relating to the fabrication of the denture itself, and can manipulate certain procedures in order to improve retention.

The success of complete dentures depends largely on the relation between the denture and the anatomic structures that support and limit them.[7] Failure to have accurately adapted denture bases, correct thickness, shape and extension of denture flanges, adequate posterior palatal seal, polished and occlusal surfaces located in the neutral zone and/or balanced occlusal surfaces may result in loss of retention.[8]

In a maxillary denture, border seal in the posterior region is created by developing a posterior palatal seal.[6,9] Hundreds of dentures have failed due to improper establishment of

the distal palatal length and to lack of a posterior palatal seal.[6] Skinner[10] demonstrated the importance of the posterior palatal seal experimentally and stated: “The most effective addition to increase retention is the post dam”. Despite these literature based recommendations regarding the relevance of the post dam, a general observation is that the practice of including the posterior palatal seal is often neglected by clinicians and dental students. Thus, this study was undertaken to focus on the understanding and clinical execution of this particular feature by students and clinicians during complete denture construction.

Chapter 2

LITERATURE RIVIEW

2.1. The posterior palatal seal (PPS) defined

The posterior palatal seal (PPS) area is defined as the soft tissue at or beyond the junction of the hard and the soft palate on which pressure can be applied by the prosthesis, within physiological limits, to aid in retention.[5] The seal is achieved by incorporating a post dam (PD), a raised area or ridge, along the posterior border on the fitting surface of the maxillary denture. The ridge displaces the yielding tissues in this area in a way that maintains the seal between the denture and the tissues when the soft palate or dentures move during function.

By terminating the distal border of the denture in soft displaceable tissue, the seal is unlikely to break during functional movements of the soft palate, as the tissues in this area tend to move with the denture. The PD essentially creates a partial vacuum that resists dislodgement of dentures by horizontal and lateral torqueing forces, thus aiding in retention and stability of a maxillary denture.[6] The *post dam* creates a *posterior palatal seal* and these terms are often used interchangeably.

2.2. Functions of the PPS

In addition to enhancing retention and stability, the PD also serves the following functions:

(i) it provides close adaptation of the denture base with the mucosa preventing food and debris from getting under the denture;

(ii) it ensures firm contact between the denture base and the soft tissue during functional movements of the stomatognathic system, which diminishes or eliminates gagging;

(iii) it creates sunken distal borders which are less conspicuous to the tongue; and

it provides a thick border that compensates for volumetric shrinkage during polymerization of the polymethyl methacrylate (PMMA), which in turn increases the strength of the denture and prevents denture warpage.[6,11-14]

2.3. Position of the PPS

In order for the PD to enhance border seal and increase denture stability, it must be accurate and physiologically compatible with the tissues at rest and during function.[15] Therefore, the posterior limit of a maxillary denture is placed in the immovable but displaceable part of the soft palate located just anterior to a line of demarcation called the "vibrating" or "ah" line and laterally extends over both hamular notches. The "vibrating line" is located at or near the junction of the hard and soft palate but varies in relation to the hard palate in different mouths in accordance with the antero-posterior contour of the soft palate. The position of the vibrating line must therefore be determined clinically.[7,15]

2.4. Anatomy of the PPS area

In 1942, Edwards and Boucher[7] dissected several frozen human skulls and assigned names to certain structures, which had not yet been described in anatomic textbooks. They felt that this terminology was needed in order to relate anatomic structures of the mouth more closely with landmarks on impressions or dentures, and as such, had practical applications in prosthetic dentistry.

Throughout the anatomical descriptions that follow, it is important to remember that despite a marked consistency in the general pattern of tissues, the human body is subject to many variations due to ethnic, hereditary and environmental conditions. As Jackson and Blount[16] stated, "Even among individuals of the same race, sex and age, variations occur in all their physical traits, including innumerable details of both the gross and microscopic structure". Therefore, in order to construct a denture and place the PPS accurately, the clinician must be cognizant of the anatomic and physiologic limitations of each patient.

The shape and dimensions of the PPS is affected by soft tissues (including the muscles and ligaments along with their attachments), mucous membranes, submucous tissue, and the underlying bone. The PPS area is unique because the tissues of the soft palate have certain characteristic that are different from other border tissues.

2.4.1. The bones of the hard palate

The bones of the palate consist of the palatine process of the maxilla anteriorly and the horizontal plates of the palatine bones posteriorly. These bones are separated from each other by the intermaxillary, the interpalatine, and the palatomaxillary suture (from anterior to posterior). The free posterior border of the horizontal plates of the palatine bones has a median posterior projection called the posterior nasal spine.[17]

2.4.2. The palatal mucosa

The hard palate is covered by mucosa, which is firmly attached to the periosteum in the vault of the palate. The regions lateral to the vault contains neurovascular bundles and minor salivary glands. The posterior part of the hard palate has a thicker and more displaceable soft tissue covering than the anterior region, except in the midline due to the

presence of the median palatine suture, which is thinly covered by mucoperiosteum only. In addition, there are far fewer mucous glands here, thus the tissues are less yielding and the PPS must be shallower and thinner centrally.[7,15,17]

2.4.3. The soft palate

The soft palate extends from the posterior border of the bony palate. A dense connective tissue aponeurosis forms the framework of the anterior part of the soft palate where it is attached to the posterior border of the hard palate. Laney and Gonzales[18]stated, "Essentially, the posterior border of the maxilla is borne by the palatine aponeurosis". The anterior part of the soft palate contains no muscle and is therefore less movable than the posterior part. The aponeurosis serves as the attachment of several muscles and supports a thick layer of palatine glands and adipose tissue that form the bulk of tissue in this region. The muscles in the posterior aspect of the soft palate include the tensor veli palatine, levator veli palatine, musculous uvulae, palatoglossus and palatopharyngeus (Fig. 1). The posterior aspect of the soft palate slopes strongly downwards and is freely mobile. The oral mucosa of the soft palate contains numerous mucous salivary glands, small aggregates of lymphoid tissue, blood vessels, nerves and lymphatics.[17] The differences in displaceability of tissues in the PPS region of the soft palate are largely due to the abundance of mucous glands in this area.[11] Due to the nature of the underlying tissues, the soft palate and the region between the midline and the residual ridge in the posterior part of the hard palate are compressible and extremely elastic.

The depth of soft tissue in the soft palate increases from its anterior attachment towards the uvula. The increased displaceable tissue and muscle activity in this region makes it more difficult to record this area accurately during impression taking. Thus if a denture extends

too far posteriorly onto this area of muscle activity, the accuracy of fit may be compromised and the denture may either be dislodged or cause trauma during downward movement of the soft palate.[19]

The soft palate acts like a dual valve system that separates the nasopharynx from the nasal cavity and the oropharynx from the oral cavity. The soft palate must have freedom of movement in three planes, i.e. superoinferiorly, mediolaterally and anteroposteriorly to function effectively. If a denture extends into this part of the soft palate it must still allow for three-dimensional freedom of movement.[20]

During rest or quiet nasal breathing, the soft palate lies in an oblique direction, but during swallowing, it elevates from its resting position into a raised position that is continuous with the plane of the hard palate posteriorly to close the partition between the oral and nasal cavities.[11] Thus, any upward and backwards movement of the soft palate may result in loss of contact between the denture and the tissue, and subsequently loss of denture retention. Most of the muscles of the soft palate are far removed from their attachment to the bony palate by the aponeurosis. The exceptions are the uvula muscle with its origin at the posterior nasal spine; and the palatoglossus muscle, which is attached to the aponeurosis on each side of the uvula muscle. The area of these attachments extends approximately 4 mm on each side of the midline.[19]

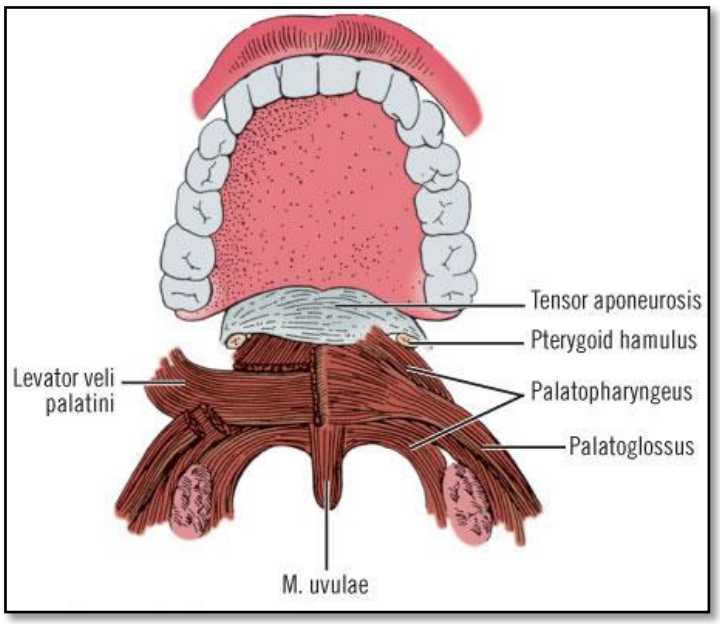


Figure 1. Aponeurosis and muscles of the soft palate (modified from Hollinshead[21])

2.4.4. The hamular notch area

The anterior part of the soft palate flows laterally into the pterygomaxillary notch. The hamular notch (pterygoid hamulus) is located between the maxillary tuberosity and the pyramidal process of the palatine bone. This trough is the lateral indication of extension of the PPS, and does not contain any muscles or ligaments that could interfere with the indentation from the raised PPS in this area.[7] The most inferior fibres of the internal pterygoid muscle form the floor of the hamular notch. The medial boundary of the hamular notch is formed by the pterygoid hamulus and the tendon of the tensor veli palatine muscle. The submucosal covering is quite shallow and provides only a thin cushion between the tendon of the muscle and the denture base. The fleshy portion of the tensor veli palatine passes between the medial pterygoid plate and the internal pterygoid muscle approaching the tendon at nearly right angles as it passes around the pterygoid hamulus. These structures are far from the denture border, and do not exert much influence on it.

A variable area for denture adaptation lies between the pterygoid hamulus and the posterior border of the hard palate to which the aponeurosis is attached. The attachment of the pterygomandibular raphe to the maxillary tuberosity behaves like an active frenum and may affect border seal. The tendon of the tensor palatine muscle is also frequently active, but is protected by a bursa as it hooks around the hamular process.[18]

The tip of the pterygoid hamulus can be palpated 2 to 3 mm posteromedial to the distal limit of the maxillary ridge, but it may even be located in line with or distal to the crest of the ridge. The significance of this variation is that it affects the length and direction of the pterygomaxillary seal. The pterygomaxillary seal occupies the entire width of the hamular notch. The seal extends from the hamular notch for about 5 to 7 mm anteromedially, although the direction must be determined by palpation and not on the master cast. An excessive pterygomaxillary seal may impinge upon and be displaced by the tendon of the tensor palatine muscle, but this is highly unlikely due to the abundance of yielding tissue overlying the ligament which bridges the notch. The nature of the soft tissue in this region allow for displacement by the PPS up to a depth of about 0.5mm.[22]

2.5.Location, dimensions and shape (based on a historical overview)

The concept of providing a PPS in dentures has been practiced for years yet the origin of this procedure is not well documented in dental history, and seems to be based on empirical or anecdotal evidence, as there are very few studies that verify the effect of PPS on denture retention (Mauk, 1932 cited by Avant[23]). In addition, there are many proposed configurations and little consensus as to the preferred shape, location and dimensions of the post dam.

Pendleton 1944 (cited by Laney and Gonzalez[18]) showed the width of the seal area to range from 1 to 12 mm anteroposteriorly. According to Hardy and Kapur[6]the posterior palatal seal can be extended 4 mm or more forward from the distal border of the denture in some areas and narrower in others such as the hamular notches where it should be about 2mm wide. The depth can also vary according to the displaceability of the underlying soft tissues, being thicker over tissues lateral to midline where there is more resilience, and thinner in the midline where there is little tendency for tissues to yield, or about one half the amount the tissues can be displaced. These authors also recommended the cross-sectional shape where the depth is maximum at the centre and tapers to zero towards the anterior and posterior borders.

Hickey et al[24] stated that the posterior extent of the upper denture must pass through the hamular notches on each side and as far back as the vibrating line. The posterior palatal seal is formed by a small narrow bead at the end of a denture that extends about 2mm in front of the vibrating line. The width is determined by the distance between the vibrating line and the junction of the hard and soft palate.

Laney and Gonzalez[18] proposed that a lip shaped area with the widest portions in the posterolateral regions of the palate is most advantageous to obtain a good seal. The widest portion of the seal in the posterolateral area rarely extends more than 5 or 6 mm.[18,25] According to Calomeni et al[25] the width in the midline should not be more than 2mm and the maximum depth posteriorly should be 1 to 1,5mm tapering forward to 0 mm at the anterior limit. The depth ranges between 1 and 4 mm by determining the total possible displacement of the tissues and making the maximum depth not more than two thirds of

this displacement.[18] Both suggest that the cross-section should be deepest at the posterior aspect then taper anteriorly towards the anterior limit.

Winland and Young[26] described the six most common posterior palatal seal configurations used in dental schools of the United States as : bead; double bead; butterfly; butterfly with a bead on the posterior limit; butterfly with hamular notch area cut to half the depth of a No. 9 bur; and a shape with reference to House's classification of palatal forms as: Class I, flat – modified butterfly 3 to 4 mm wide, Class II, high – modified butterfly 2 to 3 mm wide and Class III, intermediate – a bead. No matter what type of posterior palatal seal is used, the important word is *seal* – to seal out air and food and to seal in partial pressure.[26]

Miller[15] stated that the width of the region of the posterior palatal seal varies in individuals from about 2mm to 10 to 12 mm. The shape is like a butterfly with the narrow part at the posterior nasal spine. Zarb et al[27] recommended that the posterior palatal seal should be limited to a bead that is 1 to 1,5 mm high and 1,5 mm broad at its base with a sharp apex to create a V-shape in cross-section. The vibrating line and width of the posterior palatal seal depends on the form of the soft palate. Basker et al[28] extends the posterior seal between the hamular notches and as far as the vibrating line. The depth varies depending on the compressibility of the mucosa with less resilience in the midline and more posterolaterally.

Most authors agree that the posterior palatal seal should extend through the hamular notches and anteriorly from the vibrating line. The dimensions of the area cannot be defined in terms of millimetres. It varies in depth and width according to the compressibility of the tissues which is dependent on the amount and distribution of glandular and fatty tissue, i.e. it should be "within physiologic limits".

Table 1. List of recommendations for post dam dimensions by various authors

Author	Year	Recommended dimensions		
		Shape and Position	**Width**	**Depth**
Pendleton	1944	NS	1-12mm anteroposteriorly	NS
Hardy and Kapur	1958	NS	Extend anterior 4mm in some areas, less in others, 2mm in hamular notch	Depends on displaceability, being thick lateral to midline and thin in midline or about one half the amount the tissue is displaceable
Hickey	1962	Through hamular notches and as far back as vibrating line. 2mm narrow bead in front of vibrating line	Distance between vibrating line and junction of hard and soft palate 2mm narrow bead	NS
Laney and Gonzalez	1967	Lip shaped area	Widest in posterolateral area, but not more than 5 or 6 mm	Between 1-4 mm depending on displaceability of tissues, and maximum not more than 2/3 of this displacement, deepest posteriorly and tapers forward
Swenson	1970	Groove 1.5mm tapering anteriorly to 0mm	NS	NS
Winland and Young	1973	Presence is important for “seal”	NS	NS
Boucher	1975	Bead	1.5mm wide	1.5mm deep
Ettinger	1980	End at / posterior to vibrating line	NS	NS
Calomeni et al	1983	NS	Widest in posterolateral area, but not more than 5 or 6 mm, 2mm wide in midline	Max depth 1-1.5 mm deep posteriorly & taper to 0mm anteriorly
Miller	1984	Butterfly	2-10 or 12 mm	
Zarb	2004	Bead that is V-shaped in cross section	1.5mm wide at base of V-shape	1.5mm deep
Basker et al	2007	Must extend over hamular notches and as far back as vibrating line	NS	Varies with compressibility, less in midline and more in posterolateral regions

NS= Not Specified

2.6. Study testing the efficacy of the post dam

Avant[23] carried out a study on 5 patients to test the retention of 5 maxillary denture bases that were identical in all aspects except for the PPS. One had no PPS, while each of the other 4 had differently designed PPS areas. The study concluded that the presence of a PPS was required for optimum denture retention, and that the types of PPS also had varying effects on retention. No single type of PPS was superior in all patients. However, the angle-shaped groove with the deepest part being 1.0 to 1.5 mm, located at the vibrating line and sloping out to zero anteriorly, and having a butterfly shape when viewed from the occlusal/transverse surface was the most effective for three out of five patients. The study is however of limited value due to the small sample size.

2.7. Consequences of incorrect post dam

A denture that extends posterior to this line may cause physiological violation of the mucosa and musculature of the soft palate resulting in irritation and mucosal ulceration, sharp pain if the pterygoid hamulus is covered, and/or painful swelling. The denture will also have a poor fit in this region with increased displaceability as it is extremely difficult to record accurately. Over post-damming also occurs as a result of aggressive scraping of the cast, leading to over compression and irritation of the mucosa.[14] On the other hand, a denture that is too short or of insufficient depth, cannot develop an adequate seal and compromises denture retention.[15]

2.8 Methods of recording and creating the PPS

2.8.1 Location of the PPS area

The anatomic location and physiologic interpretation of the PPS is the responsibility of the dentist as the tissue displacement can only be determined clinically.[6,11,29-32] The width, depth and location cannot be made on the edentulous cast because these dimensions must be physiologically compatible with the position of the tissue at rest, in function, as well as by their amount of compressibility. Laney and Gonzalez[18] went as far as to say, "to assign the laboratory technician this responsibility is a breach of the patient's faith in the diagnostic ability of the dentist". The delegation of this task to laboratory technicians is tantamount to dentists abusing basic principles to the detriment of the patients' oral health. There should be stricter control over delegated procedures, especially if the consequence is potential violation of the physiological limits of the tissue.[29]

Various authors have made reference to two vibrating lines: the anterior vibrating line and the posterior vibrating line.[11,12,20] The anterior vibrating line demarcates the zone of transition between no movement of the tissue overlying the hard palate and some movement of the tissue of the soft palate. This movement can be observed during the Valsalva manoeuvre by asking the patient to blow air gently through their nose with nostrils closed by fingers or asking the patient to say "ah" with short vigorous bursts. It is always located in the soft palate and forms the anterior border of the PPS. The posterior vibrating line is located at the junction of the aponeurosis and the muscular portion of the soft palate. This line demarcates the area between the soft palate that has limited or shallow movement during function (quivers) and the remainder of the soft palate that is markedly displaced during functional movements. This area can be observed by asking the patient to say "ah" in

short bursts in a normal, unexaggerated fashion. This line forms the most distal extension of the denture base.[12] The vibrating line is located at the junction of the movable and immovable portions of the soft palate and not at the junction of the hard and soft palate. The tissues surrounding the vibrating line are deeply yielding and are easily displaced. The path of the vibrating line across the soft palate is not a definite pattern but varies with the shape of the palate. "This variation is such a constant observation that palate and throat forms have been classified as class I, Class II and class III".[11] This area can also be palpated with a ball-ended instrument to assess the resilience and displaceability of the tissue in this region.

Class I: A low, flat vault in the hard palate and soft palate has a minimal amount of drop and movement. This form of soft palate allows for a more distal extension of the maxillary denture and provides a broader posterior palatal seal area.

Class III: a high vaulted palate and an acute drop and maximal movement in the soft palate. The acuteness of the drop limits the distal extension of the maxillary denture and will accommodate only a narrow posterior palatal seal.

Class II: Palate forms intermediate between class I and class III (Fig. 2).

The abovementioned classifications are easily identified in dentate patient or in patients with well-preserved ridges. However, classification becomes more difficult in patients with extensively resorbed alveolar ridges.[11]

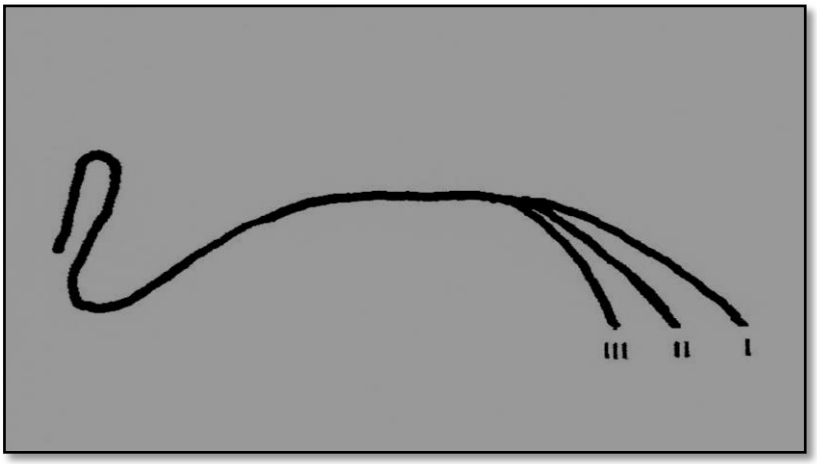


Figure 2. Diagrammatic representation of the lateral view of the soft palate indicating Class I, Class II, and Class III soft palates (from Millsap[11])

The fovea palatini may also be used to help locate the vibrating line. These are clinically visible pits representing ductal openings of the surrounding mucous glands and are located on each side of the midline in the region of the junction of the hard and soft palate. However, the pits may be extremely variable in their location relative to the junction of the hard and soft palates and the vibrating line, or may be not be visible entirely. A study by Lye[33] in 100 randomly selected subjects found the fovea palatine to be present in 92 percent of cases, with about 20 % of these having single pits while the rest showed the usual double fovea. They were posterior to the vibrating line in 13 % of the cases, coincided with it in 17%, and lay anterior to it in the remaining 70%. The mean measured positioned of the vibrating line was 1.31mm behind the fovea and the maximum distances from the vibrating line was 3 mm posterior to and 5 mm anterior to it. Due to the variability of their location the fovea palatine should only be used as landmarks or checkpoints and not as the distal limit of the maxillary denture.[11]

2.8.2 Recording of the PPS area and transfer to the master cast

The vibrating line can be located at the final impression, jaw registration or try-in stages of denture fabrication. The area is then marked with an indelible pencil and transferred to the casts by "picking-up" the mark on the intaglio surface of the impression or record block, transferring it to the cast, then marking and cutting (scribing) the post-dam into the master cast. It is the responsibility of the clinician to determine the position intra-orally, transfer its location to the cast and carve it on the master cast prior to denture processing. Chang and Wright[32] carried out the same technique but at the try-in stage thus the trial denture was used to transfer the marked post dam to the final cast, which is then scribed.

Another technique described for location of the PPS is to place mouth temperature wax onto the special tray before taking the secondary impression and then later scraping the cast. Miller[15] used this technique and advocated palpating the region with a ball burnisher at the final impression stage, to determine its width and displaceability. He then outlined the area with an indelible marker, and replaced the impression in the mouth to transfer the mark to its fitting surface. This marked area is then covered by a 2 to 2.5mm layer of Iowa wax and the final impression reinserted in the mouth, allowing the wax to exert mild compression of the PPS area.[15,18] Ansari[31] described a similar technique but used softened green stick modelling compound rather than the wax.

Addition of the PPS during final impression stage has the following advantages: it places the responsibility on the clinician; the retentive qualities of the finished denture can be assessed; the PPS can be incorporated in the trial base, increasing the diagnostic information, and aiding retention at this stage to allow greater accuracy for jaw registration procedure; and over compression of the tissue is avoided.[31] The disadvantages of this

method are that it takes more time at the final impression stage; a heating unit is needed to condition the wax; it is technique sensitive and difficult to handle some of the waxes advocated for use and it may require more time and care to box the impression before pouring the final cast.

Hardy and Kapur[6] determined the displaceability of the tissues clinically with the aid of a T burnisher, and then scraped the cast to a depth of about one-half the amount to which the tissue in that area was displaced. The scraping was deepest in the centre and tapered to zero towards its anterior and posterior borders. According to these authors, Irritation of the tissue has been observed in cases where the posterior palatal seal is sharp and wedge shape with its deepest part the distal border and only tapered anteriorly.

Arbitrary scribing of the master cast, or delegating this function to the laboratory technician is considered to be the least accurate method and leaves the most to chance at the insertion appointment. In a study by Potter[29] laboratory technicians were asked to mark the posterior extent of a maxillary denture on the final casts of 57 edentulous patients. Only 7 cases were acceptable in the midline (i.e. within 1 mm of the actual vibrating line), and 5 out of the seven marked the position incorrectly in the hamular notch areas.

At the University of Pretoria the protocol to fabricate the posterior palatal seal complies with guidelines outlined in various studies reported in the literature. The students are taught to locate the vibrating line and place the posterior limit of the maxillary denture just anterior to this line in compressible but non-mobile tissue extending between hamular notches. The depth and width is dependent on the compressibility of the tissue being wider and deeper in the posterolateral areas and narrower and less deep over the hamular notches and midpalatal suture. The University of Pretoria has quantified the dimensions for

depth and width of the post dam to fall within universally documented guidelines. The majority advocate a depth and width at the hamular notches and midpalatal suture areas of 0.5 to 1mm, and in the posterolateral areas, a depth between 1 and 2 mm, and a width of 1 to 4mm (see Table 1). The overall shape from an occlusal view is generally a butterfly shape. In cross-section the deepest portion is posteriorly with a bevel towards the anterior limit.

Chapter 3

EXPERIMENTAL DESIGN

Null Hypothesis:

The null hypothesis is that dentists and dental students do not mark and scribe the post dam on the master cast and leave this responsibility to the technician who has not had any clinical interaction with the patient.

The second hypothesis is that the shape and dimensions of the post dam are often not done according to guidelines set out by the University of Pretoria.

Aim:

The aim of this study was to investigate the methods used by private practitioners and students to fabricate a posterior palatal seal in dentures and determine how many clinicians carry out this procedure themselves.

Objectives

1. To evaluate the presence, location and shape of the posterior palatal seal on master casts and maxillary dentures at private laboratories as well as the University of Pretoria.
2. To investigate how many clinicians carried out this procedure themselves, how many requested their laboratories to do it, and how many did not specify any instruction for the creation of a post dam at all.

Materials and Methods:

Materials:

The materials used in this study were: examination forms (addendum A and B), an Iwansson gauge (Fig. 3), polyvinyl siloxane impression material (President putty soft by Coltene), scalpel handle and blades and a Carl Zeiss microscope (Fig. 4).

Figure 3. Iwansson gauge

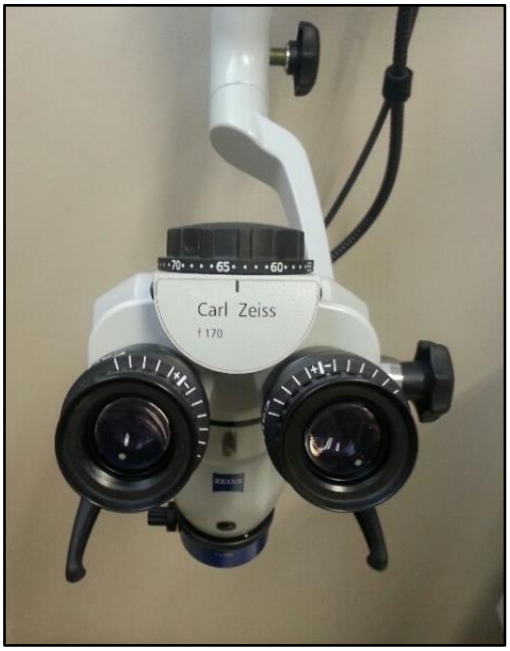


Figure 4. Carl Zeiss Microscope

Methods:

The study population was divided into two groups, private practitioners and dental students. However, data was collected from the respective laboratories to which their work was sent and not from the clinicians or students themselves. Thus, the purpose of the study was explained to the Head of the department of Prosthodontics of the Oral and Dental hospital and to all the laboratory owners. They were asked to grant permission to view and examine the laboratory slips, final impressions and study casts for the presence, position and dimensions of post dams (Addendum A and B). The primary investigator collected all the data, and ensured them that full anonymity and confidentiality would be maintained at all times. All of the laboratories agreed to participate in the study.

Group 1: Private practitioners

Five dental laboratories registered with the Dental Technicians Council in the Gauteng area were selected to participate in this study. The owners of the first five laboratories on the list were contacted telephonically and a meeting was arranged to explain the nature of the study and obtain permission to obtain the information required for the study. Only laboratories that were involved in the fabrication of complete removable dentures were included in the study. The first ten cases of laboratory work involving complete dentures that entered the laboratory on the day of data collection were selected in each laboratory. A record of the dentist's names was kept separately in order to verify that the same dentists' work was not evaluated twice.

Group 2: Dental Students

The same study was conducted on student cases sent to the in-house laboratory in the Department of Prosthodontics at University of Pretoria. The work of 4th and 5th year students was evaluated. Fifty student cases were selected by choosing the first fifty cases that entered the laboratory within the data collection period. The primary investigator assigned a number to laboratory work that was left in the waiting area for collection by the students. Laboratory cards were marked with a blue marker to avoid re-evaluation of the same work. A record of student names was recorded separately in order to verify that the same students work was not evaluated more than once. Data were collected on consecutive days over a period of several weeks until 50 cases had been examined.

No patient, dentist or student names or card numbers were recorded to ensure anonymity. The laboratory slips and master casts were examined.

An impression was taken of the master cast with a polyvinyl siloxane impression material to obtain the dimensions (depth and width) of the post dam. These were taken by the investigator to be examined further, however, no other laboratory work or laboratory cards were removed.

The impressions were sectioned with a scalpel as follows: an anteroposterior cut through the right and left hamular notches, in the midpalatal suture area, and in the right and left posterolateral regions (midway between hamular notch and midpalatal suture).

All cuts were perpendicular to the fitting surface of the impression. This was achieved by using a metal ruler and protractor to cut all sections parallel to a line drawn between the middle of the incisive papilla perpendicular to a line connecting the hamular notches. The

width and depth was measured with an Iwansson gauge under a microscope. The width of the post dam at selected areas were recorded between the most anterior and posterior areas of the raised portion (indicating post dam) in the impression. The depth was recorded on a line extending from the highest point of the raised portion perpendicular to a line connecting the anterior and posterior extent of the post dam. All findings were documented on a set form with a predetermined identification number (Addendums A and B).

Two independent examiners were asked to verify the shape and dimensions of the post dams to ensure reliability, repeatability and validity of the results.

Chapter 4

RESULTS

In the private laboratories, only one of the 50 cases examined had a PD marked – this was done at the secondary impression stage – thus it could not have been scribed at this time.

In the student laboratory, 20% of the cases were marked at the secondary impression stage, 14% at the JRR stage, and 12% at the try-in stage. Only 4% were scribed, these both being at the try-in stage. Finished cases were not evaluated as the technicians indicated that they routinely marked and scribed PDs before flasking if these were not already present.

Measurements for post dam dimensions could only be done on the two cases, which had been scribed by the students (refer to Table 2 for dimensions). In student cases 19 cases were examined, 10 of these marked the post dam at this stage. Twenty-six student cases were examined at the jaw registration stage, 8 cases marked the post dam at this stage but none scribed at this stage. Six student cases were examined at try-in stage and all six cases demonstrated post dam markings and two of these cases even showed the scribed post dam.

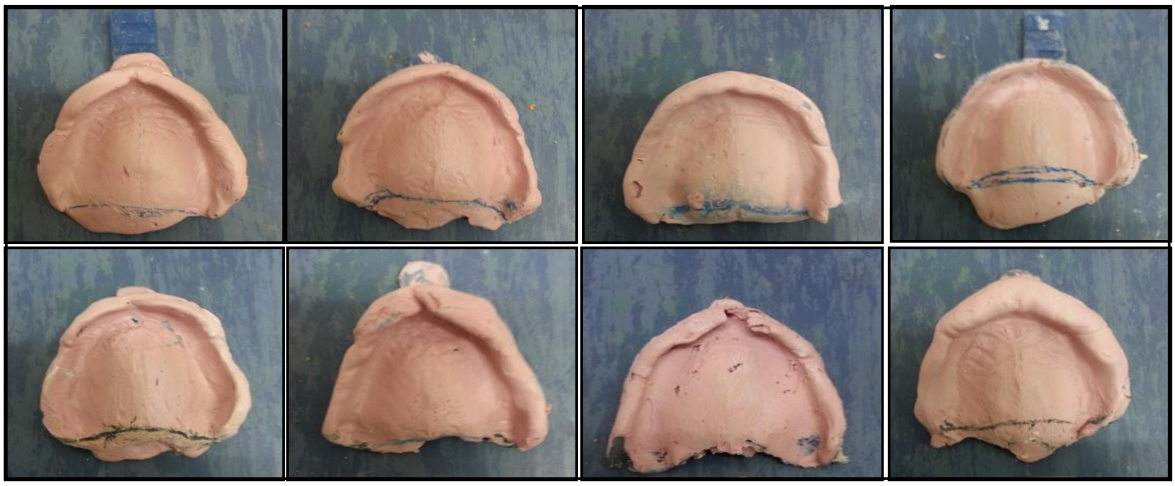


Figure 5. Post dam markings done at secondary stage taking from the student laboratory

Figure 6. Post dams marking and scribing at jaw relation and try in stages taken from the student laboratory

Table 2. Dimension recorded from the casts of the two students

Area along PD	Depth (in mm)		Width (in mm)	
	Student A	Student B	Student A	Student B
Left hamular notch	0	0.5	0	0.9
Right hamular notch	0	0.5	0	1.4
Midpalatal suture	1	1	2.4	1.9
Left posterolateral area	0.8	1.1	3.6	3.3
Right posterolateral area	1	1.3	3.4	3.6

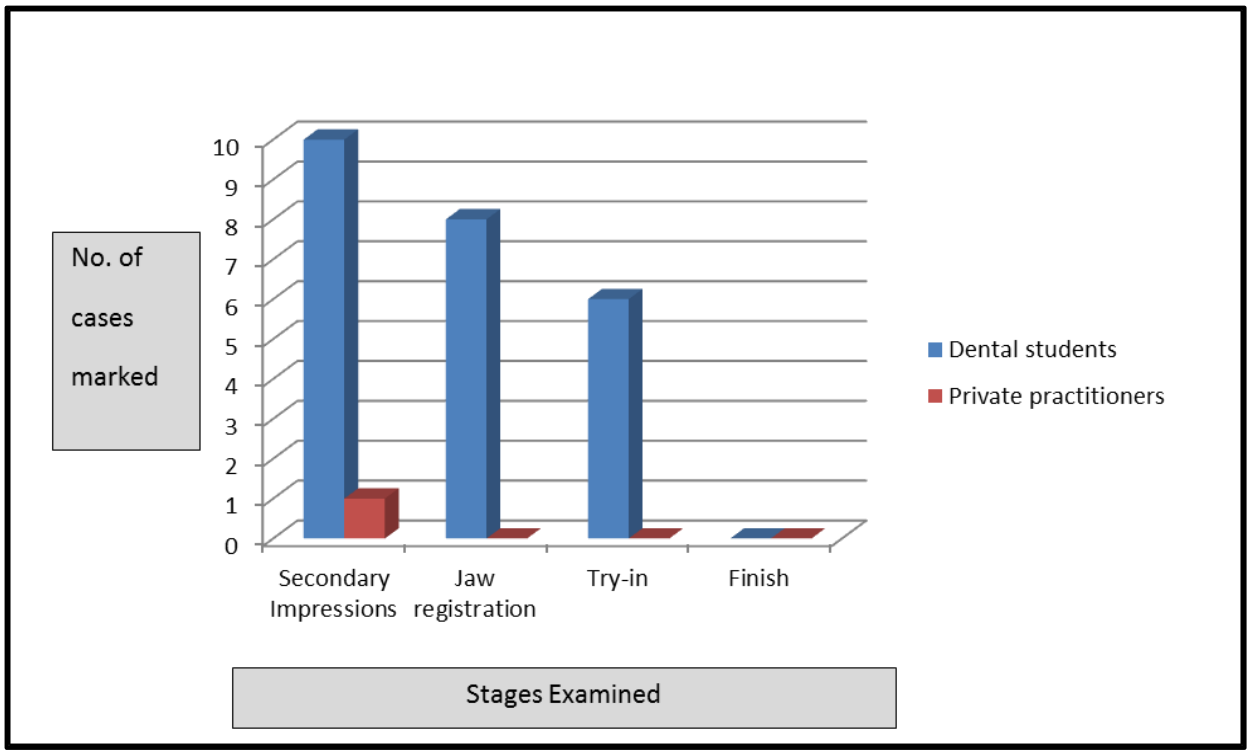


Figure 7. Number of cases by students and practitioners marked at each stage

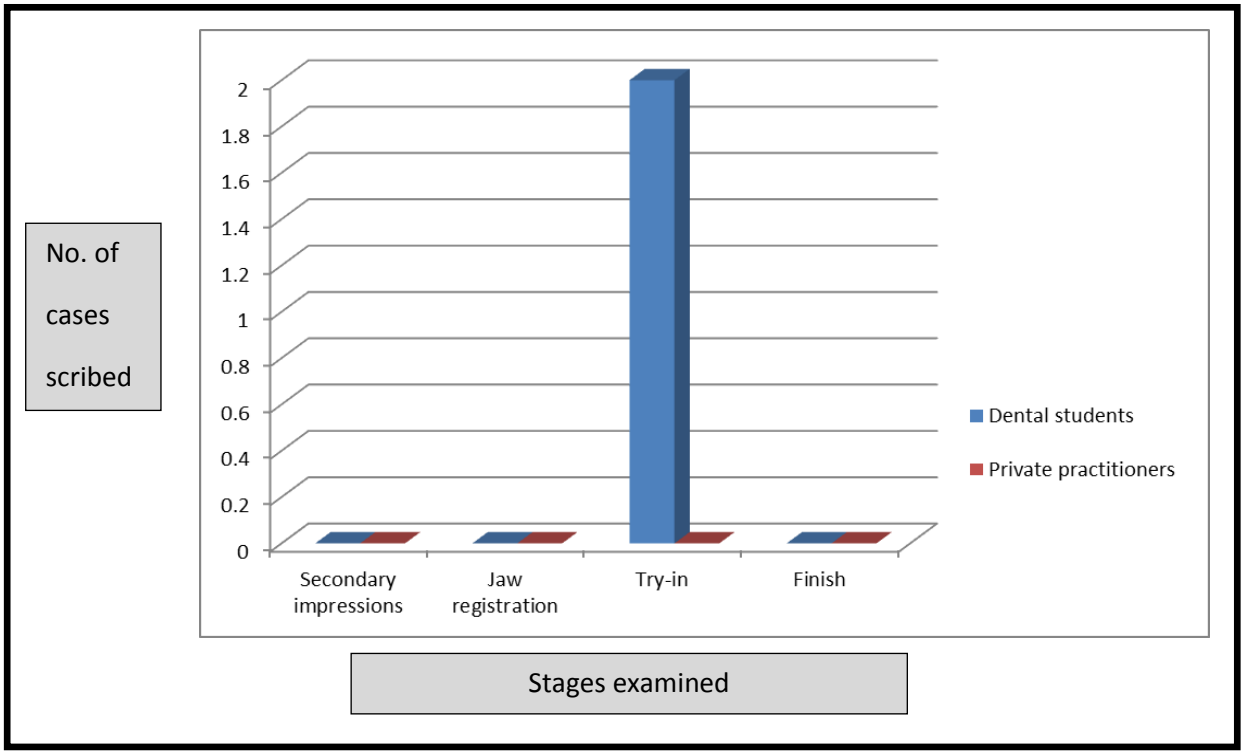


Figure 8. Number of cases by students and practitioners scribed at each stage

Chapter 5

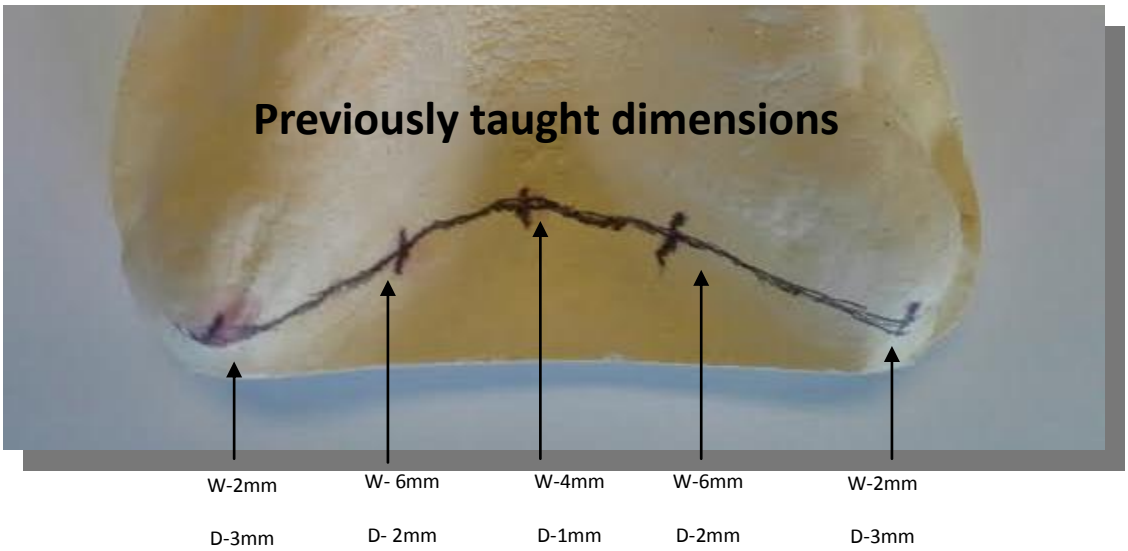
DISCUSSION

Despite the many conflicting theories in the literature as to the ideal shape and dimensions of the PD (refer to Table 1), there is unanimous agreement on its importance in maxillary dentures, and that it must be placed in an area of soft, displaceable tissue. As early as 1958, Hardy and Kapur[6] postulated that by creating a raised area at the distal edge of a maxillary denture and ensuring it terminated in soft, displaceable tissue, a seal could be created which would not be broken during function as these tissues tend to move with the denture. Laney and Gonzalez[18] further stressed the importance of determining the position and depth clinically based on individual patient anatomy and tissue compressibility, and stated that it must be "accurate and physiologically compatible with the tissue at rest and during function". Despite this, it was concerning to find that in this study population, none of the 50 private practitioner cases examined had any form of PD scribed and only one case had it marked (2%). This had been done at the secondary impression stage, so one cannot predict whether this clinician would have carved it later once the final cast had been poured. (The laboratory confirmed that this dentist was the only one who ever marked the PD, but never carved it themselves, or gave instructions to this effect).

In all of the remaining cases, not only were none of the casts marked or scribed, but there was not a single request to the laboratory technician to do this before completing and processing the dentures. In personal communication with the laboratory owners and technicians they confirmed that it was rare for dentists to ever mark or request the addition of a PD, and most merely took on this responsibility themselves. One could argue that if this is such a crucial, clinically-relevant step, then the arbitrary scribing done by the technicians

is nothing more than a “hit-and-miss” guesstimation and we should question its efficacy. However, one technician even stated that they had learned through experience that dentures without a PD were often returned with dentists blaming them for the inadequate retention. They then became liable for costs and time in remaking, relining or adding a PD at a later stage. It is perhaps thanks to patient adaptability and the fact that there seems to be “no ideal” preferred PD dimensions[23], that these dentures still succeed. As Winland and Young[26] put it, “no matter what type of posterior palatal seal is used, the important word is *seal* –to seal out air and food and to seal in partial pressure”.

At the University of Pretoria, the department needed to establish a common philosophy of understanding and teaching of the PD. Students seem to battle when presented with vague and controversial concepts and usually demand to be given a more concrete picture of the “ideal” shape and dimensions of the PD. For this reason, the lecturers studied all of the available literature and drew up a recommended protocol. This ensured that there was consistency amongst the clinicians and served as a guide when helping the students identify and scribe the post dams clinically. Thus, the current PD philosophy taught does not conform to any single concept, but is a combination based on the best available evidence to date. It has been substantially altered in the past 5 years to be in keeping with current literature. Previously (and still today) students carve a butterfly shape extending from one hamular notch to the other, with the deepest part posteriorly and tapering to zero anteriorly. However, both the depth and width dimensions have been reduced as follows:



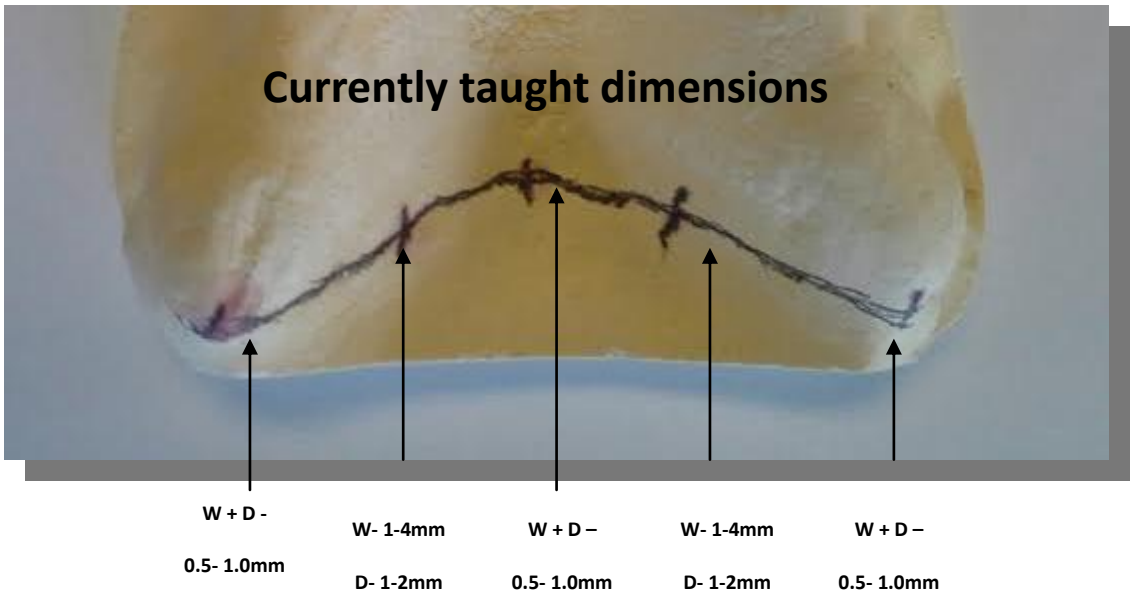


Figure 9. Previous and currently taught post dam dimensions

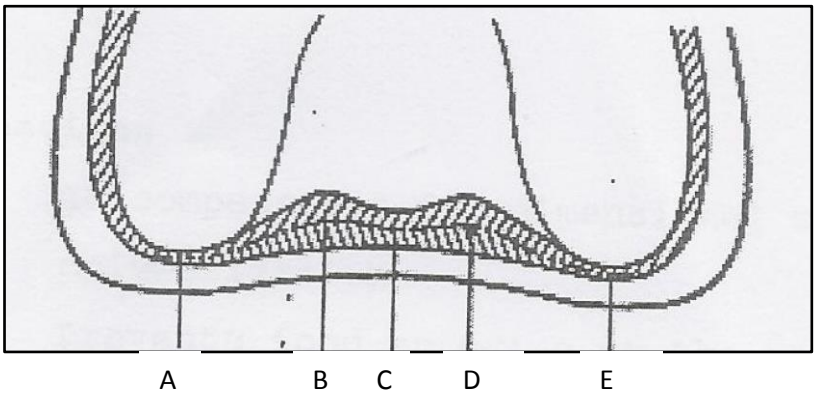


Figure 10. Butterfly shape currently taught (dimensions will vary depending on tissue compressibility). A = right hamular notch, B = right posterolateral area, C = midpalatal suture, C = left posterolateral area, E = hamular notch

In the student laboratory, the technicians again reported that while some of the students marked the position of the PD, most of them did not scribe it. This is a concern as the importance of the PD, determination of its location and dimensions, and the carving are stressed repeatedly during undergraduate clinical training sessions. It leads one to question whether students have actually grasped the concept, and why the supervisors themselves are not checking and ensuring that this is being carried out correctly. The present study cannot comment on the finished dentures, as all of them did have various shapes and forms of PDs present, but there is no way we can determine which had been done by the students and which had been carried out in the laboratory by the technicians. Equally concerning was a comment made by one technician who stated that "we generally scribe it ourselves because the students seldom do it, and when they do, the scribing are incorrect". How is it that a clinically determined procedure can be evaluated and altered by someone in a laboratory who has never laid eyes on the patient, let alone examined or palpated the palate?

Of the two student cases where a PD had been scribed, both had carved a butterfly shape as taught. However, they were either too deep or too shallow in each of the three locations measured in comparison to recommendations made by the University of Pretoria.

The findings of this study suggest that dental students are aware of the need for a PD, but few have understood the concept and rationale behind its position and dimensions, as the fact that it has to be a clinically determined feature.

These findings should be used for some departmental introspection. The rationale behind the PD concept and the associated anatomy is taught in the pre-clinical third year course. It is repeated in fourth year with more emphasis placed functional movements and

compressibility underlying structures, as well as the methods used to clinically determine the correct position. However, it seems that this philosophy is not being carried through to the clinical setting. It would appear that many students (and clinicians) still have not grasped the notion and relevance of the PD, as they generally neglect to mark and carve it clinically according to "standard guidelines". They scribe it in some arbitrary position and not based on the patient's individual anatomy. This lack of understanding of the posterior palatal seal obviously then spills over into private practice, where the entire philosophy is almost completely forgotten. It would be interesting to evaluate how each individual technician "determines" where they will carve the PD and how they decide on the shape and dimensions based on a hard cast model. Considering how nebulous the entire practice has become, it is amazing that clinicians do not experience more denture retention problems. Or, perhaps is more "accurate" to surmise that in their ignorance, they do not even notice these – it is the poor patients who have to "experience and endure" the consequences.

The results of this study emphasize the need to address prosthodontic teaching and education. Unless students understand the philosophy behind the PD, and are shown how to relate this to their core anatomical knowledge, they will never grasp the importance of the posterior palatal seal, and as such will continue to neglect this step, or delegate it to the technician. They need to appreciate that the shape and dimensions of the PD cannot be arbitrarily made on the edentulous cast because this needs to be physiologically compatible with the tissues at rest and during function, as well as with the amount of compressibility in each site. Laney and Gonzalez[18]went as far as to say "to assign the laboratory technician this responsibility is a breach of the patient's faith in the diagnostic ability of the dentist". The

delegation of this task to laboratory technicians is tantamount to dentists abusing basic principles to the detriment of the patients' oral health and comfort.

The aim of this research was to assess teaching, education, and the practice of clinical dentistry, then these results should be a major concern to educators. Thus, in order for this project to make any sort of meaningful contribution, we need to analyse why such an important topic is being ignored, neglected and seemingly forgotten by students and clinicians alike. A dental graduate is expected to have sufficient knowledge, skills and understanding of biomedical, behavioural and clinical sciences, to be able to promote the health and oral health of individual patients as well as the community. To this end core competencies have been identified that should govern their teaching. These include: learning skills that promote life-long learning; knowledge of environmental and social determinants of health and disease, communication, diagnostic, therapeutic and technical skills, research outputs, ethical standards and management abilities.[34-37]

Undergraduate training has traditionally been techniques orientated, emphasizing the mechanical above the biological, and often overlooking areas such as scientific thinking, understanding of tissue biology, critical thinking, and appreciating how these interact in the final therapeutic decision making and clinical practice.[37] This deeper type of learning requires a change in the mind-set, in that the importance should not be on arriving at the correct answer, but rather on the way the student comes to that answer.[34]

It is assumed that assessment has an overwhelming influence on what, how and how much students study.[38] To this end, the recent approach in higher education has been to focus on learning outcomes and their assessment. However, the focus needs to shift away from "measurement" end of the scale, and concentrate more on the "learning" aspect. This poses

a problem for teachers as it has been found that what influences students most is NOT the quality of the teaching, but how they perceive the demands of the assessment system.[39] They become so called "cue seekers", who spend an enormous amount of time trying to get out of lecturers what is going to come up in exams, and then study according to their question spotting. This method of studying results in superficial learning that is forgotten as soon as the examination is over. The following quotation bears testimony to this "When I studied, I didn't try understand the subject, I just focused on passing the exam. I got 96%. I still don't understand the subject so it defeated the object in a way, however I passed the course".[40]

In an investigation where students were evaluated on coursework as well as by examinations, they were found to consistently perform better in the coursework, with less overall failures in subjects where this played a larger role in the final evaluation. There was a significant positive correlation between the proportion of coursework and the average marks.[41] Students also preferred coursework as it allowed them to organize their own work patterns, and they considered it fairer than exams as it measured a greater range of their abilities.[42]

Others are in agreement with these findings. It has been shown that coursework marks are better predictors of long term learning than are exams, resulting in a higher quality of learning. It appears that the kind of learning involved in carrying out assignments has better long-term consequences than the rote-type of learning involved in revision for exams, with students developing more sophisticated conceptions. They later answered exam questions using more comparisons, more evaluations and more sophisticated structures to their answers despite having had less formal teaching.[43]

In order for assignments to be effective, they need to be structured around the specific learning objective. For example, simple essays will not help a student devise a laboratory experiment. It has been said, “The only way to learn how to solve problems is to solve lots of problems”. At the same time, appropriate feedback is equally important. It must be done often and in enough detail; should focus on student’s performance and learning, and on the actions under their control, rather than on them personally and their characteristics; it must be received timeously while it still matters to them and to allow them to pay attention to further learning opportunities or to get extra assistance if needed; it must be appropriate to the purpose of the assignment and to their understanding of what they are supposed to be doing; and it must be received and acted upon by the student.[40,43]

How then can these findings be used to change the way in which the PD concept (and probably many other aspects of dentistry) is taught and understood? A possible approach could be to first give the students specific tasks that require them to investigate and assemble some background knowledge on the topic before it is taught. Examples of tasks include: a practical exercise where they build models of the anatomical structures involved in the posterior palatal areas; giving them a case scenario of an actual patient presenting with a relevant problem such as a loose maxillary denture; a practical demonstration of the final flasking and processing of a denture to illustrate where and why warpage occurs, and how the PD compensates for this; allowing then to make simple acrylic plates for a patient, one with and one without a PD and testing the retention as well as eliciting patient feedback.

This study highlights the need for us as educators to devise novel ways of teaching important concepts, and offers new and exciting challenges for us to explore in both the formal lecturing situation as well as during clinical supervision.

Chapter 6

CONCLUSION

This study revealed that the task of determining the position and dimensions of the PD are being ignored, neglected and seemingly forgotten by students and clinicians alike and left in the hands of dental technicians. This shows a dismal lack of compliance and appreciation of the importance of the PD by both students and experienced dental clinicians. Further research should be directed at analysing why such an important topic is being ignored by clinicians. The findings should then be used to implement modifications and improvements in the structure and teaching methods used in prosthodontics, ensuring that students gain an appreciation of the rationale behind the PD concept as well as the importance of identifying its position and dimensions clinically. Hopefully with a deeper understanding of these biological principles, they will be more aware of its importance and functions when making dentures in the future, and will not ignore or delegate this task to the laboratory technicians.

Chapter 7

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Addendum A

Laboratory number_____

Study number: _____

Examination of laboratory slips, final impressions, final casts and complete maxillary dentures

1. Which one of the following is being examined:

   Laboratory slip ☐

   Final impression ☐

   Final cast after jaw relation ☐

   Final cast after try-in stage ☐

   Maxillary denture ☐

2. Was the post dam marked by the clinician? | Yes | No |
3. Was the post dam scribed by the clinician? | Yes | No |
4. Did the clinician mark the post dam on the cast and ask the technician to scribe it? | Yes | No |
5. If the post dam was not marked and/or scribed on the casts, did the dentist ask the technician to add the post dam? | Yes | No |
6. If the answer to question 6 is “no”, did the technician take his/her own initiative to add the post dam? | Yes | No |

7. At what stage was post dam added (if indicated on lab slip)?

Final impressions	Jaw relations	Try-in

8. Which of the following shapes was carved?

Bead □

Double bead □

Butterfly □

Butterfly with bead on posterior limit □

9. Indicate in the following tables if the dimensions at the hamular notches, midpalatal suture and lateral areas were too deep/ correct/ too shallow? Provide recorded measurements in millimetres.

	Too deep >2mm	Correct 1-2mm	Too shallow <1mm
Lateral areas			

	Too deep >1mm	Correct 0,5-1mm	Too shallow 0,5mm
Hamular notches			
Midpalatal sutures			

10. Indicate in the following tables if the width at the hamular notches, midpalatal suture and lateral areas were too much/ enough/ too little? Provide recorded measurements in millimetres.

	Too much >4mm	Enough 1-4mm	Too little <1mm
Lateral areas			

	Too much >2mm	Enough 1-2mm	Too little <1mm
Hamular notches			
Midpalatal sutures			

Addendum B

Student laboratory

Study number: _____

Examination of laboratory slips, final impressions, final casts and complete maxillary dentures

1. Which one of the following is being examined:

   Laboratory slip ☐

   Final impression ☐

   Final cast after jaw relation ☐

   Final cast after try-in stage ☐

   Maxillary denture ☐

2. Was the post dam marked by the clinician? | Yes | No |
3. Was the post dam scribed by the clinician? | Yes | No |
4. Did the clinician mark the post dam on the cast and ask the technician to scribe it? | Yes | No |
5. If the post dam was not marked and/or scribed on the casts, did the dentist ask the technician to add the post dam? | Yes | No |
6. If the answer to question 5 is “no”, did the technician take his/her own initiative to add the post dam? | Yes | No |

7. At what stage was post dam added (if indicated on lab slip)?

Final	Jaw relations	Try-in

8. Which of the following shapes was carved?

Bead □

Double bead □

Butterfly □

Butterfly with bead on posterior limit □

Other (describe) □

……

9. Indicate in the following tables if the dimensions at the hamular notches, midpalatal suture and lateral areas were deeper, correct or too shallow compared to guidelines provided at the University of Pretoria. Provide recorded measurements in millimetres.

	Too deep >2mm	Correct 1-2mm	Too shallow <1mm
Left posterolateral area			
Right posterolateral area			

	Too deep >1mm	Correct 0,5-1mm	Too shallow 0,5mm
Left hamular notch			
Right hamular notch			
Midpalatal suture			

10. Indicate in the following tables if the width at the hamular notches, midpalatal suture and lateral areas were wider, within the range or narrower than recommendations made at the University of Pretoria. Provide recorded measurements in millimetres.

	Too much >4mm	Enough 1-4mm	Too little <1mm
Left posterolateral area			
Right posterolateral area			

	Too much >2mm	Enough 1-2mm	Too little <1mm
Left hamular notch			
Right hamular notch			
Midpalatal suture			