Original Article

Wettability of three denture base materials to human saliva, saliva substitute, and distilled water: A comparative *in vitro* study

Pavithra K. Ramanna

Department of Prosthodontics and Crown and Bridge, Vydehi Institute of Dental Sciences and Research Hospital, Bengaluru, Karnataka, India

Abstract

Aim: The purpose of this study was to compare the wettability of saliva, a saliva substitute, and distilled water to three denture base materials.

Materials and Methods: Thirty specimens of each denture base material: Heat cure polymethylmethacrylate (DPI heat cure), high‑impact polymethylmethacrylate (Trevalon HI), and nylon (Valplast) were fabricated. The specimens of each denture base material were divided into three groups of ten specimens. The advancing and receding contact angles of three media: a commercially available carboxymethylcellulose‑based saliva substitute (WET MOUTH), human whole saliva, and distilled water, with each denture base material were determined using a goniometer. The contact angle hysteresis was calculated as the difference between the advancing and receding contact angles. The data were statistically analyzed using univariate analysis of variance and Duncan *post hoc* test.

Results: Low‑advancing and receding contact angles were demonstrated on high‑impact heat‑polymerized polymethylmethacrylate denture base material. Highest hysteresis values were calculated for nylon denture base material.

Conclusion: Best wettability was demonstrated on high‑impact heat‑polymerized polymethylmethacrylate denture base material. Based on the high hysteresis values calculated with nylon denture base material, it would possibly provide better denture retention.

Keywords: Contact angle, denture base material, retention, saliva substitute, wettability

Address for correspondence: Dr. Pavithra K. Ramanna, MD – 8, Near HAL Hospital, Vimanapura, Bengaluru - 560 017, Karnataka, India.
E-mail: pavitrakr@yahoo.com

Received: 24th November, 2017, **Accepted:** 28th March, 2018

INTRODUCTION

The successful complete denture must provide a desired degree of retention and stability to the prosthesis.[1] Saliva is critical for retention of dentures and provides comfort while wearing removable prostheses.[2]

Access this article online	
Quick Response Code:	Website: www.j-ips.org
	DOI: 10.4103/jips.jips_301_17

Complete dentures are retained by a combination of muscular forces exerted by the cheeks, tongue, and lips, and by physical forces acting between the supporting tissues, the denture base, and the interposed film of saliva. Adhesion, defined as the attraction of unlike molecules, is one of the

How to cite this article: Ramanna PK. Wettability of three denture base materials to human saliva, saliva substitute, and distilled water: A comparative *in vitro* study. J Indian Prosthodont Soc 2018;18:248-56.

fundamental forces involved in denture retention.[3] The wettability of a liquid to a solid surface plays an important role in determining adhesion.

The wetting power of a liquid is represented by its tendency to spread on the surface of a solid. The wettability of a liquid to a solid surface can be studied by measuring the contact angles formed between them. The lower the contact angle, the better the tendency to wet the surface. Complete wetting occurs when the contact angle is zero.[4]

However, the fundamental requirement suggested for denture retention has been contact angle hysteresis, that is, the difference between the advancing liquid–solid contact angle and the receding contact angle. Advancing contact angle has been defined as the angle that a liquid drop forms on a dry solid surface. Receding contact angle is formed when the liquid recedes on the previously wet surface.[5] Higher the contact angle hysteresis, greater is the retention.

The wetting properties of denture base materials to saliva, therefore, play a vital role in the retention of dentures. Xerostomia, characterized by significantly decreased salivary flow, can make the wearing of dentures very uncomfortable for affected individuals and also affect denture retention. Causes for xerostomia include radiation therapy for oral cancer and systemic conditions such as Sjogren's syndrome, Parkinson's disease, salivary gland hypofunction, or side effects of drug therapies which use diuretics, antihistaminics, antihypertensives, etc.[6-9]

Water can be used as a saliva replacement, but it is known that water does not moisten and lubricate the oral mucosa adequately. Besides, salivary mucins present in the saliva possess rheological properties that include elasticity and adhesiveness which aid in retention of dentures.[4] Hence, saliva substitutes which are either mucin or carboxymethylcellulose (CMC based), with sorbitol or xylitol, and salts at concentrations equivalent to those in human saliva, are used. It is important that the wetting properties of these substitutes be comparable to that of human saliva when used with dentures.[10]

Polymethylmethacrylate has been the most commonly used denture base material in dentistry. Acrylic resin wets with water, and this effect is better with saliva, as it adsorbs mucopolysaccharides and proteins from saliva over time.[11] High-impact-resistant acrylic resins are also frequently used. These are polymethylmethacrylates reinforced with butadiene styrene rubber to improve fracture resistance.

Few patients have been found allergic to methylmethacrylates. In such cases, the use of alternative denture base materials such as nylon and polycarbonates have been advocated.[12]

The study of wetting properties of denture base materials is essential to aid the clinician in his choice material.

MATERIALS AND METHODS

In this study, the wettability of three media to three denture base materials was tested.

The three media used were distilled water, a commercially available saliva substitute (WET MOUTH, ICPA Health Products Ltd.) and unstimulated human saliva [Figure 1].

Human saliva was collected from a healthy individual with normal salivary secretion, atleast 1 h after breakfast, by drooling from the lower lip into a container. The saliva sample was used without further treatment.

The three denture base materials tested were:
1. A conventional polymethylmethacrylate acrylic denture base resin (DPI heat cure material) [Figure 2]
2. A high-impact polymethylmethacrylate acrylic denture base resin (Trevlon – HI) [Figure 2]
3. A nylon-based denture base material (Valplast).

Specimen fabrication

a. Conventional acrylic denture base resin – thirty wax patterns of 21 mm × 16 mm × 2 mm (length × width × thickness) were fabricated. These

Figure 1: Media used – distilled water, WET MOUTH saliva substitute, and saliva

were invested in flasks and dewaxed. Conventional acrylic denture base resin (DPI heat cure material) was then packed into these moulds and acrylized according to the manufacturer's instructions. The specimens obtained were trimmed and sandpapered to obtain specimens of dimensions of 20 mm × 15 mm × 2 mm with a uniform surface. The specimens were not polished to simulate the tissue surface of dentures [Figures 3-5]

b. High-impact acrylic denture base resin – thirty wax patterns were prepared as with conventional acrylic denture base resin, invested, and dewaxed. The molds were packed with high-impact acrylic denture base resin (Trevalon HI) and acrylized according to the manufacturer's instructions. The specimens were trimmed and sandpapered to obtain specimens of 20 mm × 15 mm × 2 mm dimensions with a uniform surface. The specimens were not polished as with the conventional acrylic resin [Figure 6]

c. Nylon-based denture base material – thirty specimens of 20 mm × 15 mm × 2 mm with a uniform surface were fabricated using injection molding technique [Figure 7].

Contact angle measurements

Dynamic contact angle analysis was used to measure the advancing and receding contact angles using a goniometer (Dataphysics, SCA 20) [Figure 8].

The fluid/media to be tested is dispensed by a syringe onto the specimen [Figure 9]. The system allows for a standardized volume of fluid to be used on the specimen surface while measuring the advancing and receding contact angles. The system uses a high-speed camera to record changes of the drop contour which has been dispensed on to the specimen surface.

The system's program determines the advancing and receding contact angles. The contact angle is the angle formed by the baseline of the drop and a tangent at the three-phase line (solid/liquid/vapor). The advancing

Figure 2: Denture base materials tested – Trevalon HI and DPI heat cure

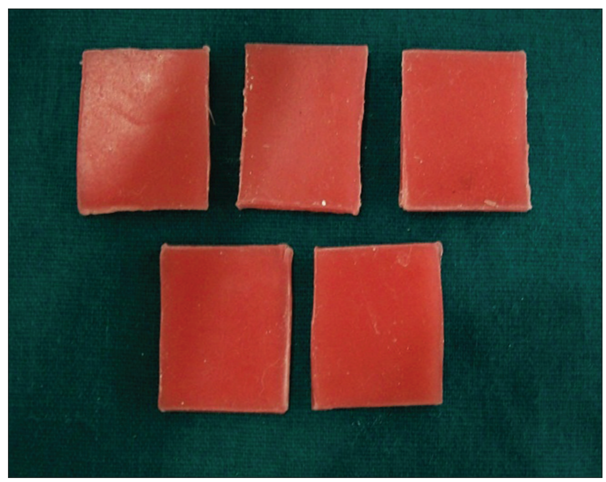

Figure 3: Wax patterns for specimens

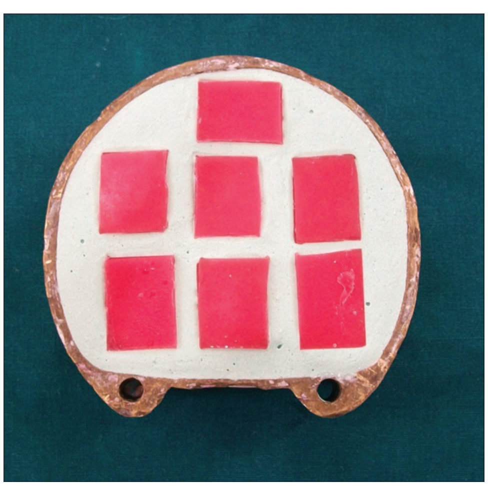

Figure 4: Invested wax patterns

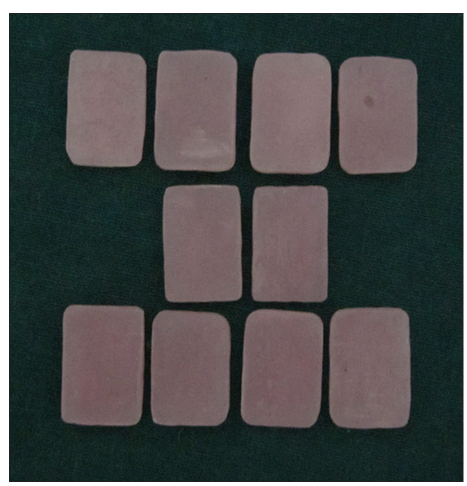

Figure 5: Conventional heat-polymerized polymethylmethacrylate denture base resin specimens

Figure 6: High-impact heat-polymerized polymethylmethacrylate denture base resin specimens

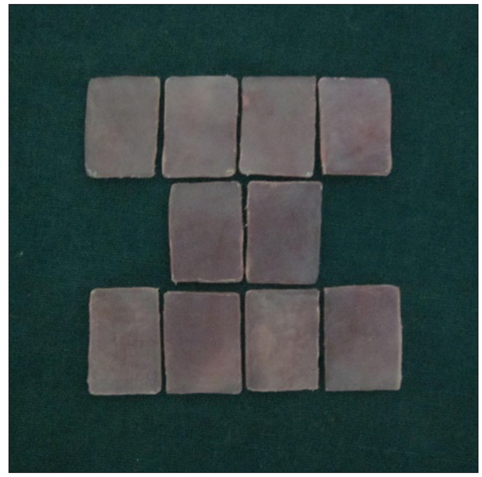

Figure 7: Nylon denture base resin specimens

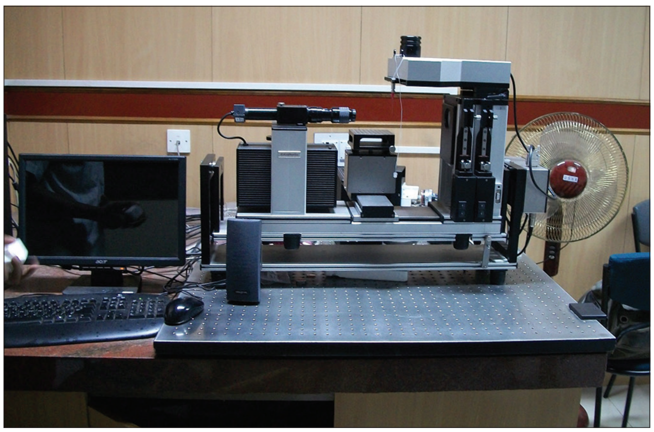

Figure 8: Contact angle goniometer

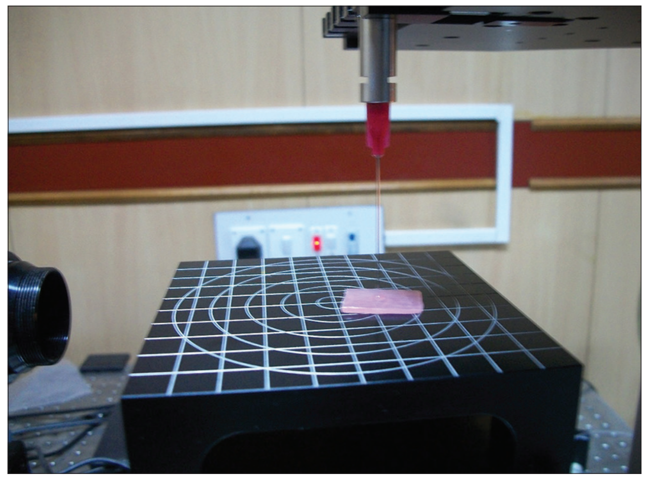

Figure 9: Specimen placed for testing

contact angle is measured as the contact angle that the liquid drop forms when dispensed on the dry specimen surface, while the receding contact angle as the contact angle formed after the liquid has receded from the surface [Figures 10 and 11].

Before dispensing a different fluid onto the specimen, care was taken to thoroughly rinse the dispensing syringe with water, followed by the fluid to be tested.

Advancing and receding contact angles of each of the three media to ten specimens of each denture base material were measured, that is, a total of 9 groups were tested. The groups were (A, B, and C):

Group A:
1. Water and conventional heat-polymerized polymethylmethacrylate denture base resin (acrylic)
2. Water and high-impact heat-polymerized polymethylmethacrylate denture base resin (high impact)
3. Water and nylon-based denture base material (nylon).

Group B:
1. Saliva substitute and acrylic
2. Saliva substitute and high impact
3. Saliva substitute and nylon.

Group C:
1. Saliva and acrylic
2. Saliva and high impact
3. Saliva and nylon.

Calculation of hysteresis

The hysteresis was calculated as the difference between the advancing and receding contact angles for each of the specimens tested.

RESULTS

The data obtained were statistically analyzed using Univariate analysis of variance and Duncan *post hoc* tests. The results of the analysis are presented in Tables 1-9 and graphically depicted in Figures 12-14.

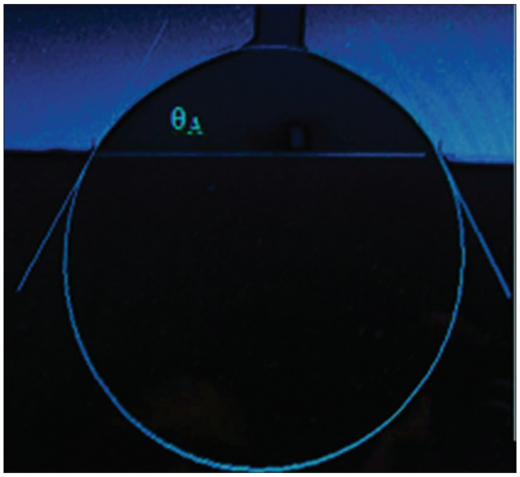

Figure 10: Advancing contact angle – θ_A

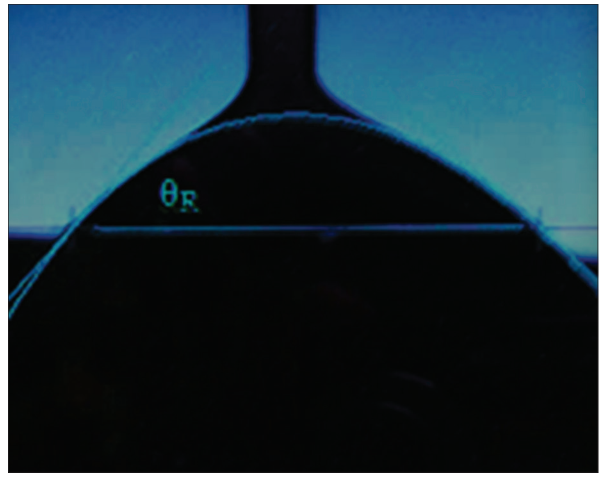

Figure 11: Receding contact angle – θ_R

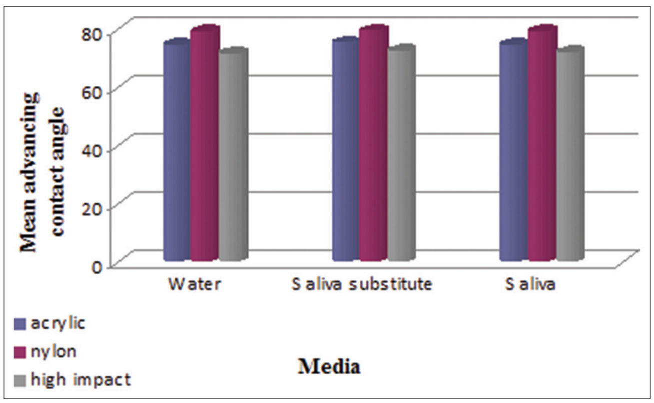

Figure 12: Mean advancing contact angle values of denture base materials in various media

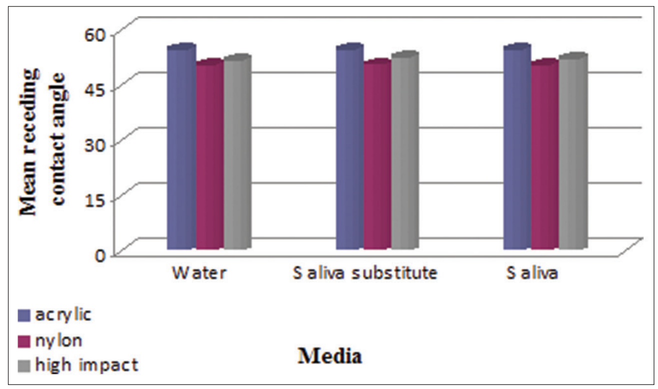

Figure 13: Mean receding contact angle values of denture base materials in various media

Table 1: Univariate analysis of variance for advancing contact angles – descriptive statistics

Media	Denture base material	Mean	SD	Sample size
Water	Acrylic	74.6100	1.70258	10
	Nylon	79.1900	3.74950	10
	High impact	71.5900	6.94381	10
	Total	75.1300	5.50681	30
Saliva substitute	Acrylic	75.4400	2.17317	10
	Nylon	79.5600	4.74065	10
	High impact	72.5000	2.92499	10
	Total	75.8333	4.44626	30
Saliva	Acrylic	74.7800	2.69848	10
	Nylon	79.3900	3.82345	10
	High impact	72.0300	4.37088	10
	Total	75.4000	4.71849	30
Total	Acrylic	74.9433	2.18122	30
	Nylon	79.3800	3.98726	30
	High impact	72.0400	4.86732	30
	Total	75.4544	4.86439	90

SD: Standard deviation

Univariate analysis of variance showed no statistically significant difference in the advancing contact angle, receding contact angle, and hysteresis values between the three media, that is, distilled water, saliva substitute, and saliva. However, there was a statistically significant difference in the advancing contact angle, receding contact angle, and hysteresis values between the three denture base materials.

The Duncan *post hoc* comparison of advancing contact angles with the different denture base materials found that the highest advancing contact angle values were observed with Nylon (79.38 ± 3.98 standard deviation [SD]), followed by acrylic (74.94 ± 2.18 SD) and high impact, which had the lowest advancing contact angle value (72.04 ± 4.86 SD).

The Duncan *post hoc* comparison of receding contact angles with the different denture base materials showed a significantly higher receding contact angle value with acrylic (54.38 ± 2.75 SD) than high impact or nylon. There was no statistically significant difference between the receding contact angle values with nylon and high impact.

The Duncan *post hoc* comparison of the hysteresis values with the different denture base materials showed nylon had the highest statistically significant hysteresis

Table 2: Advancing contact angle: Tests for between-denture base material and between-media effects

Source	df	Mean square	*F*	Significance
Media	2	3.777	0.239	0.788
Denture base material	2	409.945	25.995	<0.001

Table 3: Duncan *post hoc* comparison of advancing contact angles of denture base materials

Denture base material	Sample size	Subset			*P*
		1	2	3	
High impact	30	72.0400			<0.001
Acrylic	30		74.9433		
Nylon	30			79.3800	

Significant $P<0.05$

Table 4: Univariate analysis of variance for receding contact angles – descriptive statistics

Media	Denture base material	Mean	SD	Sample size
Water	Acrylic	54.3600	2.06408	10
	Nylon	50.2600	4.57729	10
	High impact	51.5000	4.80879	10
	Total	52.0400	4.24854	30
Saliva substitute	Acrylic	54.4100	2.94182	10
	Nylon	50.3600	4.98469	10
	High impact	52.2800	3.20236	10
	Total	52.3500	4.05095	30
Saliva	Acrylic	54.3800	3.39568	10
	Nylon	50.3200	4.08188	10
	High impact	51.8600	3.74142	10
	Total	52.1867	3.99886	30
Total	Acrylic	54.3833	2.75444	30
	Nylon	50.3133	4.40296	30
	High impact	51.8800	3.84819	30
	Total	52.1922	4.05652	90

SD: Standard deviation

Table 5: Receding contact angle: Tests for between-denture base material and between-media effects

Source	df	Mean square	*F*	Significance
Media	2	0.721	0.048	0.953
Denture base material	2	126.430	8.474	<0.001

Table 6: Duncan *post hoc* comparison of receding contact angles of denture base materials

Denture base material	Sample size	Subset		*P*
		1	2	
Nylon	30	50.3133		<0.001
High impact	30	51.8800		
Acrylic	30		54.3833	

Significant $P<0.05$

value (29.06 ± 0.72 S.D). There was no statistically significant difference between the hysteresis values of acrylic and high impact.

DISCUSSION

Denture retention is related to forces necessary to completely remove the denture from its basal seat.[13] The wetting of the denture and the palate through the respective adhesive forces at the two interfaces is a necessary prelude to retention.

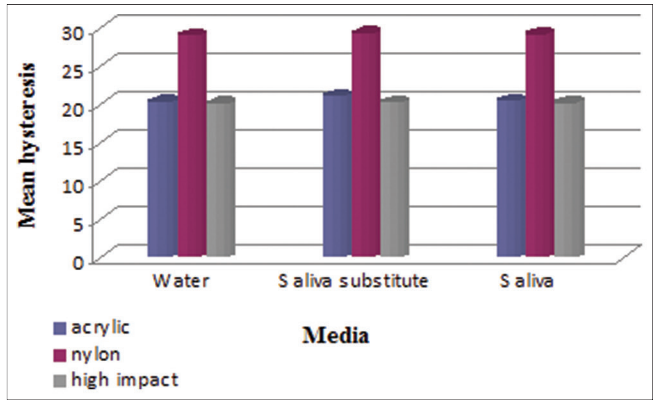

Figure 14: Mean hysteresis values of denture base materials in various media

According to Stanitz, the retention force is a function of saliva surface tension, liquid film thickness, surface of contact, and liquid-denture contact angle.[14]

Theoretical considerations and experimental results have demonstrated that, with the exception of some specific cases such as perfectly wettable solids, the contact angle of the advancing liquid front on a dry solid surface (advancing contact angle θ_A) is different than the receding contact angle (θ_R) which is formed when the liquid recedes on a previously wet surface.

The hysteresis of the contact angle ($\theta_A-\theta_R$) for pure liquids is mainly caused by surface flaws (geometric flaws and surface roughness) or the heterogeneous chemical composition of the surface. In case of polymers, the presence of liquid in contact with a solid may provoke the reorientation of surface groups, leading to contact angle hysteresis.

When instead of pure liquids, solutions containing different surface-active agents (such as surfactant or proteins) are used in contact angle measurements, adsorption of these molecules at the liquid–solid interface induces an important hysteresis.

Monsenego and Proust's analysis of denture retention showed that retention occurs only when hysteresis of denture-saliva contact angle exists.

According to their study,

$$F_{max} = mg\frac{\cos q_R}{\cos q_A}$$

Where

Table 7: Univariate analysis of variance for hysteresis – descriptive statistics

Media	Denture base material	Mean	SD	Sample size
Water	Acrylic	20.2500	0.48132	10
	Nylon	28.9300	1.03285	10
	High impact	20.0900	2.77266	10
	Total	23.0900	4.52040	30
Saliva substitute	Acrylic	21.0300	0.99672	10
	Nylon	29.2000	0.49889	10
	High impact	20.2200	0.55936	10
	Total	23.4833	4.18322	30
Saliva	Acrylic	20.4000	1.15950	10
	Nylon	29.0700	0.56184	10
	High impact	20.1700	1.05730	10
	Total	23.2133	4.31427	30
Total	Acrylic	20.5600	0.95686	30
	Nylon	29.0667	0.72031	30
	High impact	20.1600	1.68310	30
	Total	23.2622	4.29564	90

SD: Standard deviation

Table 8: Hysteresis: Tests for between-denture base material and between-media effects

Source	df	Mean square	*F*	Significance
Media	2	1.214	0.820	0.444
Denture base material	2	759.260	513.039	<0.001

Table 9: Duncan *post hoc* comparison of hysteresis values of denture base materials

Denture base material	Sample size	Subset		*P*
		1	2	
High impact	30	20.1600		<0.001
Acrylic	30	20.5600		
Nylon	30		29.0667	

Significant $P<0.05$

F_{max} is the maximum retentive force of the denture

θ_A is the advancing contact angle

θ_R is the receding contact angle

m is the mass of the denture and g is the gravitational force.

This shows that higher the contact angle hysteresis, greater is the force required to dislodge the denture.

High values of denture mass and advancing contact angle θ_A, that is, θ_A close to 90° are factors favorable to denture retention. The most favorable values for θ_R is θ_R close to 0°. The results of this study is contrary to previous views that perfect wettability is necessary to obtain good retention and implies poor initial wettability (advancing contact angle) is favorable to good retention.[13]

Wettability of denture materials have been studied by Monsenego *et al.*, Waters *et al.*, and Zissis *et al.*, by measuring the advancing and receding contact angles and hysteresis. Monsenego *et al.* concluded from their *in vitro* study that the most convenient denture base material would be that exhibiting the highest contact angle hysteresis, such as high advancing contact angle (θ_A) and low receding contact angle (θ_R), and found that sand-abraded heat-polymerized resin would fulfill this condition better than the other materials studied.[5]

Waters *et al.* concluded that higher contact angle hysteresis values of soft-lining denture materials in comparison to polymethylmethacrylate denture base material gave an indication that the all soft lining materials would improve denture stability under dislodgement forces.[15]

Zissis *et al.* also applied contact angle hysteresis as an indicator of retention and found two of the soft liners tested showed greater contact angle hysteresis and concluded that, this indicted better retention properties.[16]

In this study, high-impact heat-polymerized polymethylmethacrylate denture base resin demonstrated the best wettability with the lowest advancing and receding contact angle values. Nylon denture base material, however, exhibited poor initial wettability with the highest advancing contact angle values. However, it also had the lowest receding contact angle values and the highest hysteresis value. This implies that nylon denture base would provide the best retention among the three denture base materials tested.

Nylon, which is the generic name of a thermoplastic polymer belonging to the class of polyamides, was first considered for dentures in the 1950s. High-impact acrylic denture base materials are methylmethacrylates reinforced with butadiene–styrene rubber to improve the impact strength of conventional polymethylmehacrylates. In general, polymethylmethacrylate is highly biocompatible and patients suffer few problems. Nevertheless, some patients will show an allergic reaction. This is most probably associated with various leachable components in the denture such as any residual monomer or benzoic acid. When a patient has a confirmed delayed hypersensitivity to methacrylate resins, then an alternative denture base material, such as polycarbonate or nylon may be considered.[12]

The chief advantage in nylon lies in its exceptional mechanical properties of resistance to shock and repeated stressing. However, coupled with a high flexibility, it is doubtful whether this is what is required in a denture base. For a given masticatory stress, the deformation of nylon will be higher than acrylic resin, and increased mechanical irritation of the tissues may well follow.[17]

Nylon also has the disadvantage of staining badly in the mouth and encouraging bacterial growth.[18]

A nylon denture base material, suitably stiffened, could be extremely useful in the treatment of patients for whom acrylic prostheses are not suitable. This would include patients who demonstrate repeated fracture of dentures and those that show tissue reactions of a proven allergic nature.[19]

In the current study, no statistically significant difference was found in the advancing and receding contact angle and hysteresis values of the three media: Distilled water, a saliva substitute, and saliva, which were tested.

In this aspect, it is similar to an *in vitro* study by Sharma and Chitre who studied the wettability of four commercially available saliva substitutes and distilled water on heat-polymerized acrylic resin. The study revealed no statistically significant difference in the advancing and receding contact angle, and hysteresis values between distilled water and WET MOUTH, a commercially available CMC-based saliva substitute.[6]

A study by Vissink *et al.* on the wetting properties of human saliva and saliva substitutes found that contact angles of CMC preparations and human whole saliva were comparable on the human mucosa. However, the contact angle of water on human mucosa was significantly higher than that of whole human saliva. Furthermore, on ground polished enamel, the contact angles of water, CMC, or mucin-containing saliva substitutes were significantly lower than whole human saliva.[10]

As mentioned earlier, when solutions contain surface-active substances, the surface and interfacial tensions, and the contact angles, depend on adsorption kinetics of these substances at the interfaces and are therefore time dependent.[13]

Craig *et al.* stated that the contact angle showed better wetting of the dentures if the dentures were previously soaked in saliva before use. The length of the soaking period was not given.[14]

It has been seen that the contact angle for saliva freshly applied to the acrylic plastic surface is 75°, which is the same as that of water. When saliva is allowed to stand overnight in contact with the plastic material, the contact angle of saliva was reduced to approximately 68°, which indicates that the surface wetting is somewhat improved after remaining in contact with saliva.[4]

The effect on the contact angle values due to prolonged contact of the media with the denture base materials was not considered in this study. Further studies incorporating this factor would be useful.

Saliva aids in the preservation and maintenance of oral health. It plays a significant role in prosthodontic rehabilitation with complete dentures by aiding in retention and providing comfort.

Niedermeier and Kramer in their study emphasized that the secretion of the palatal salivary glands is primarily responsible for the physical retention of maxillary complete dentures.[20]

Loss of salivary flow or xerostomia is both unpleasant and harmful to the patient. In addition to tissue irritation, it predisposes to candidal infections and periodontal disease. It affects denture retention and causes discomfort.

Studies by Nakamoto and Duxbury *et al.* have found commercially available saliva substitutes such as VA-Oralube (CMC based) and Saliva Orthana (mucin-based) as effective substitutes.[7,8]

Mucin-based saliva substitutes have been proved to show better wettability than carboxymethyl cellulose-based saliva substitute,[6] but they are of bovine or porcine origin and may not be accepted by the Indian population.

The commercially available saliva substitute (WET MOUTH) tested in this study was carboxymethyl cellulose-based and was found to have wetting properties not significantly different from human saliva.

CONCLUSION

Within the limitations of this study, it could be concluded that:

1. The wettability of the commercially available saliva substitute tested (WET MOUTH) was comparable to that of human saliva as there was no statistically significant difference between the wettability of the three media tested
2. High-impact heat-polymerized polymethylmethacrylate denture base material (Trevalon HI) was the most easily wetted as it demonstrated low advancing and receding contact angles
3. Nylon denture base material (Valplast) could possibly provide the best retention of the three denture base materials tested as it had the highest hysteresis value.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kumar MS, Thombare RU. A comparative analysis of the effect of various denture adhesives available in market on the retentive ability of the maxillary denture: An *in vivo* study. J Indian Prosthodont Soc 2011;11:82-8.
2. Shekhar A, Das S, Bhattacharyya J, Goel P, Majumdar S, Ghosh S, *et al*. A comparative analysis of salivary factors and maxillary denture retention in different arch forms: An *in vivo* study. J Indian Prosthodont Soc 2018;18:53-60.
3. Barbenel JC. Physical retention of complete dentures. J Prosthet Dent 1971;26:592-600.
4. Powers JM, Sakaguchi RL. Craig's Restorative Dental Materials. 12th ed. Missouri: Elsevier; 2009. p. 19-25.
5. Monsénégo P, Baszkin A, Costa ML, Lejoyeux J. Complete denture retention. Part II: Wettability studies on various acrylic resin denture base materials. J Prosthet Dent 1989;62:308-12.
6. Sharma N, Chitre V. An *in vitro* comparative study of wettability of four commercially available saliva substitutes and distilled water on heat-polymerized acrylic resin. J Indian Prosthodont Soc 2008;8:30-5.
7. Duxbury AJ, Thakker NS, Wastell DG. A double-blind cross-over trial of a mucin-containing artificial saliva. Br Dent J 1989;166:115-20.
8. Nakamoto RY. Use of a saliva substitute in postradiation xerostomia. J Prosthet Dent 1979;42:539-42.
9. Mendoza AR, Tomlinson MJ. The split denture: A new technique for artificial saliva reservoirs in mandibular dentures. Aust Dent J 2003;48:190-4.
10. Vissink A, De Jong HP, Busscher HJ, Arends J, Gravenmade EJ. Wetting properties of human saliva and saliva substitutes. J Dent Res 1986;65:1121-4.
11. Darvell BW, Clark RK. The physical mechanisms of complete denture retention. Br Dent J 2000;189:248-52.
12. van Noort R. Introduction to Dental Materials. 3rd ed. London: Elsevier; 2007. p. 222.
13. Monsenego P, Proust J. Complete denture retention, Part I: Physical analysis of the mechanism: Hysteresis of the solid-liquid contact angle. J Prosthet Dent 1999;81:439-43.
14. Lindstrom RE, Pawelchak J, Heyd A, Tarbet WJ. Physical-chemical aspects of denture retention and stability: A review of the literature. J Prosthet Dent 1979;42:371-5.
15. Waters MG, Jagger RG, Jerolimov V, Williams KR. Wettability of denture soft-lining materials. J Prosthet Dent 1995;74:644-6.
16. Zissis A, Yannikakis S, Jagger RG, Waters MG. Wettability of denture materials. Quintessence Int 2001;32:457-62.
17. Mathews E, Smith DC. Nylon as a denture base material. Br Dent J 1955;98:231-7.
18. Watt DM. Clinical assessment of nylon as a partial denture base material. Br Dent J 1955;98:238-44.
19. Stafford GD, Huggett R, MacGregor AR, Graham J. The use of nylon as a denture-base material. J Dent 1986;14:18-22.
20. Niedermeier WH, Krämer R. Salivary secretion and denture retention. J Prosthet Dent 1992;67:211-6.