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The effect of environment (Dry and Natural Saliva) on clasp retention: *In vitro* study - Part I

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ABSTRACT

Objective: The purpose of this study was to investigate the importance of environments (dry and wet) to dislodge the clasp. **Materials and Methods:** Mandibular test models with natural premolar and molar teeth were used to test four types of clasp (each 12) (Akers, rest plate Akers [RPA], half and half [H-H], and ring clasp) in dry and natural fresh saliva environments. Each clasp was pulled out 10 times with a crosshead speed of 10 mm/min and the force required to withdraw each was measured. **Statistical Analysis Used:** A paired sample *t*-test and Wilcoxon test were used. **Results:** There were significant differences between the dry and wet (natural fresh saliva) environment. However, while the mean of the environment for RPA and ring clasp type was significantly different, the H-H and Akers clasp type was not. **Conclusion:** The environment has an effect on dislodging the clasp but differs according to the type of clasp.

Key words: Akers, clasp, environment, removable partial denture, retention, saliva

INTRODUCTION

Although conservative dentistry[1] has been cited as a choice of patients, a removable partial denture (RPD) represents an acceptable and economical modality treatment for patients with partial edentulous. RPD must be esthetic with minimum periodontal tissue problem and sufficiently retentive to avoid begin displaced in function.[2]

It generally consists of four parts as a base plate, clasp, major, and minor connector of the framework. However, clasp is the most practical and popular part of retention in RPD, especially for distal extension bases.

It should be designed to provide maximal retention for RPD avoiding direct transmission and rotational forces with a minimum amount of retention necessary to resist reasonable dislodging force.[3] Many previous studies indicated that the retentive force provided by cobalt-chrome (Co-Cr) clasps ranging between 3 and

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7.5 N.[4-6] However, this load capacity of the clasp may depend on various factors such as type of clasp and the environments around it (dry such as a patient with xerostomia or wet [natural saliva]).

Most of the former studies measured the retentive force in dry condition.[4,5,7-13] However, the perception of dry mouth among a group of denture wearers with oral symptoms and function was significant.[14] Due to that, denture retention should be examined under wet condition, especially for human enamel and porcelain to be clinically relevant.[15]

Wet environment could be fresh natural saliva (FNS) or saliva substitute. FNS is a viscoelastic fluid with distinct surface activity. Mucins (glycoprotein) in saliva are responsible for the viscoelastic character forming a lubricative film, which enables free movement of oral tissues.[16-22]

These mucins have the properties of low solubility and high viscosity.[23] However, saliva is known to undergo changes in its viscosity (lubricant activity) over time due to the bacterial and enzymatic processes.[24]

The analysis of LaVere on the retention showed that there were no marked statistical differences between the wet and dry testing condition.[25]

Sato *et al*. indicated that nonmetal abutment materials indicated a higher friction coefficient in the present of saliva than in dry condition.[15]

Therefore, this study has been carried out to investigate the importance of environments to dislodge different types of clasp. The null hypothesis was that the environment would not affect the retention force of the clasp.

MATERIALS AND METHODS

Four clasps were selected for this study: Akers, rest plate Akers (RPA), half and half (H-H), and ring clasp. A total of 48 Cr-Co clasps (each type 12 clasps) in two different environments were tested.

Three natural (2nd) premolar and one second molar teeth were selected. They were cleaned, devoid of any caries lesion or abnormalities, and sterilized.

Using a maxillary plastic model (Frasaco AG-3 WOK 40), four master casts were prepared. Three for premolar teeth and one for molar following the method used by Mourshed *et al*.[2]

The casts were surveyed, undercut depths were measured (0.50 mm), the path of insertion was then recorded, and rests were prepared[26] and examined[3] [Figure 1]. To achieve standardized, parallel guiding plane was prepared approximately 2 mm on proximal surface in occlusogingival direction[3] using milling machine (AF 30, Milling Machine, Switzerland).

The master casts were then duplicated to obtain a cast made with dental stone. The casts were replaced on the surveying table and aligned using the previously marked tripod lines as on the master casts. The master stone casts were duplicated with agar (Castogel, 52052, Bego, Germany) using a conventional method and invested (Wirovest, 51048, Bego, Germany) using a mechanical vacuum mixing machine (Motova SLA, 255142, Bego, Germany), according to the manufacture's direction.

A standardize prefabricated wax was used to fabricated four types of clasps (each 12 waxed refractory cast from each clasp type: Akers, RPA, H-H, and ring). A small projection of wax that extended from the bottom of each proximal plate parallel to the edentulous ridge and away from it was made to act as a saddle to each clasp. All groups were designed and waxed for ring on the rest as a pull-out location. All the pull-out extensions were placed parallel to the path of insertion with the aid of surveyor.

The clasps then were cast, finished, and electropolishing. Before the fitting, clasps were checked from the external defect, inner surface, proximal surface, and the rest place for small interference then they were examined radiographically for internal porosity using (Siemens, 1448 237 D3195, Germany) X-ray machine. The clasps then were washed using a steam machine (Steam Generator SG5, Italy) [Figure 2].

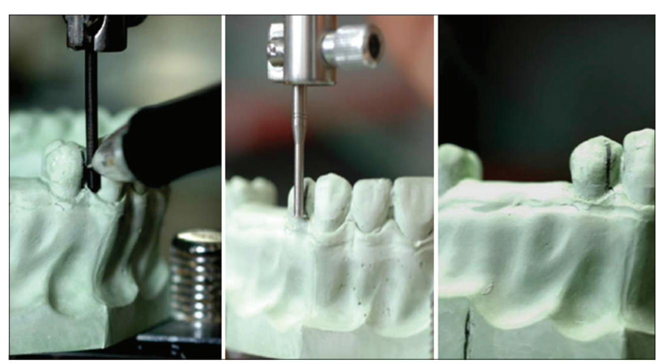


Figure 1: Preparation of auxiliary line and undercut spot on the master stone cast

Dry environment test

A movable special jig was constructed to hold the master cast in a container and to fix it perpendicular to the pulling out chain. The test model (master model) was rigidly fixed to the jig then to the lower part of the machine. The clasp was seated manually on the abutment, and the dislodging forces were always directed vertically [Figure 3].

A tensile load was applied to each clasp for dislodging until the machine automatically stopped. The pulling out test was repeated 10 times for each clasp with a crosshead speed of 10 mm/min. The force required to withdraw each was measured automatically by the testing machine.

Collection of fresh natural saliva

Fresh human saliva was collected at 10 am from clinically asymptomatic healthy volunteers using a 10 ml disposable plastic syringe. All volunteers (ten volunteers) were examined for any dental and mucosal abnormalities. The donor had to refrain from eating or drinking 1 h prior testing. They were asked to rinse their mouth thoroughly with distilled water and to keep the mouth opened for 3–5 min. The saliva was then collected from mouth floor by keeping the mouth in downward and forward position.[16]

Wet (Natural fresh saliva) environment test

Before testing, the master model was surrounded by a sheet of wax (wax container) to hold the saliva FNS was added to the wax container until it covered the master model to maintain a wet condition. The surfaces of the natural abutments were totally covered in saliva. The saliva used was changed every 30 min to maintain its lubricant property.

Figure 2: The clasps are ready for testing

RESULTS

The effect of environment on the retentive force for all types of clasps

A paired sample *t*-test was conducted to compare the effect of the environment on the retention regardless the type of clasp used. Results are summarized in Table 1.

The mean of the environment between dry and FNS was significantly different ($P = 0.002$). Subsequently, results showed that saliva effect on the retention by reducing the force required withdrawing the clasp.

The effect of environment on the retentive force of individual type of clasps

The effect of the environment on the retention for each clasp type (RPA, H-H, Akers, and ring) used is summarized in Table 2 and Graph 1.

Wilcoxon test was conducted to compare the effect of the environment on the retentive force of each clasp.

The mean of the environment for ring and RPA clasp type between dry and FNS was significantly different ($P = 0.005$ and $P = 0.010$). The results suggest that the saliva affects the retention of ring and RPA

Table 1: Comparison between dry and wet (natural fresh saliva) environment for all types of clasp (rest plate Akers, half and half, Akers, and ring)

Environment	*n*	Mean	SD	*t*	df	Significant (two-tailed)
Mean dry	48	11.47	5.91	3.23	47	0.002*
FNS	48	10.93	6.02			

*The difference is significant between dry and FNS. FNS: Fresh natural saliva, SD: Standard deviation

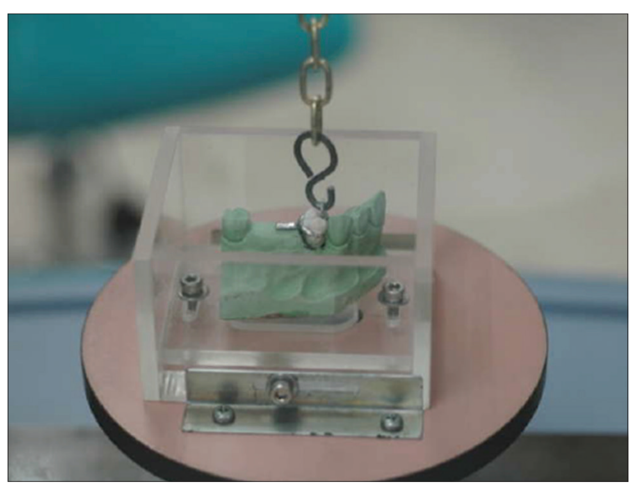
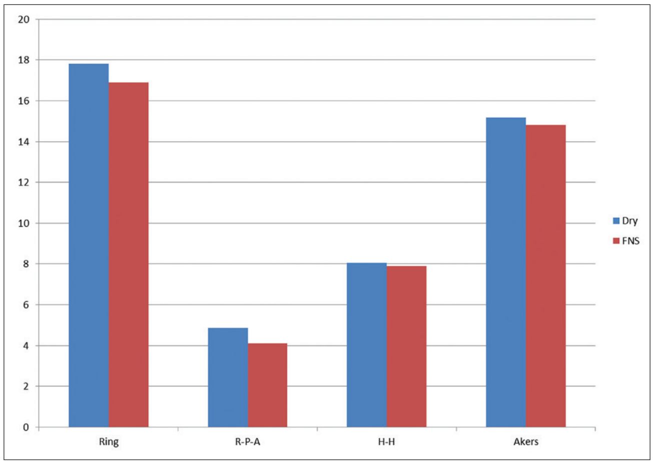


Figure 3: Testing of the clasp

Table 2: The mean and standard deviations for each clasp in dry and wet environment

Environment	Clasp type											
	Ring			RPA			H-H			Akers		
	n	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD
Mean dry	12	17.82	1.73	12	4.86	1.93	12	8.04	2.36	12	15.17	4.21
FNS	12	16.89	1.56	12	4.12	1.72	12	7.90	2.69	12	14.82	5.12

FNS: Fresh natural saliva, SD: Standard deviation, H-H: Half and half, RPA: Rest plate Akers



Graph 1: Average values in Newton of four types of clasps on the natural abutment in two environments

clasp type by reducing the force required to withdraw the clasp [Table 3].

The mean of the environment for H-H and Akers clasp type between dry and FNS was not significantly different ($P = 0.533$ and $P = 0.388$). The results showed that saliva does not affect the retention of H-H and Akers clasp type [Table 3].

Overall, these tests concluded that the effect of the environment differs according to the type of clasp [Table 3].

DISCUSSION

The null hypothesis was rejected. The result of the study showed that the environment affected the retention force of the clasp.

Although many studies measured the retentive force in dry condition,[4,5,7-13] in the present study, the test was performed in two environments; dry and wet. FNS was used as wet environment because it has been recommended that viscosity should be determined from fresh saliva samples.[27]

Unstimulated FNS was used because its lubricant qualities are significantly better than stimulated saliva.[28-30] In addition, saliva changes every 30 min to cope with change in viscosity and consequently the effect of lubricant that may change in about 30 min and this may affect the result of the test.

Table 3: Comparison between dry and wet (natural fresh saliva) environment for each clasp

Clasp type	Mean D and S			
	Ring	RPA	H-H	Akers
Z	−2.824	−2.589	−0.623	−0.863
Asymptotic significant (two-tailed)	0.005*	0.010*	0.533**	0.388**

*The difference is significant between dry and FNS for Ring and RPA clasps, **The difference is not significant between dry and FNS for H-H and Akers clasps. H-H: Half and half, RPA: Rest plate Akers, FNS: Fresh natural saliva

FNS reduced the retentive force of clasps (Akers, RPA, H-H, and Ring). Apparently, this may be due to the lubricant effect of the saliva. Lubrication is defined as the ability of a substance to reduce friction between two moving surfaces.[30] This lubricant property probably reduces the friction coefficient between the clasp and tooth, therefore reduces the retention of the clasp. However, changing FNS used in the test every 30 min is another explanation for this result. Saliva contains mucins which known as the best lubricating components of saliva.[16-18] The lubricant activity of the saliva is reduced over time due to the bacterial and enzymatic processes.[24] This lubricant property probably reduces the friction coefficient between the clasp and tooth, therefore reduces the retention of the clasp.

On the other hand, Sato *et al*. measured the friction coefficient between human enamel and hard metal in wet condition using natural saliva.[15] The results showed that the human enamel material indicated higher friction coefficient in the wet condition than in dry condition.[15] This difference might be due to the method used or the way of obtaining and storing natural saliva.

In addition, determining the effect of the environment for each clasp separately showed that there was significant decreasing in the retention force of ring clasp and RPA clasp under FNS environment than dry environment. This result might be due to the large surface area covered the abutment tooth by ring and RPA clasp compared to other clasps. Large surface covering may enhance the effect of lubricant propriety and reduce the friction between the clasp and abutment tooth. However, no previous study was available to be compared to our findings regarding the effect of FNS on the retentive force.

CONCLUSION

The environment (Natural fresh saliva) showed an effect on the retention by reducing the force required to withdraw the clasp. However, the effect of the environment differs according to the type of clasp.

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Conflicts of interest
There are no conflicts of interest.

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