



RESEARCH ARTICLE - MEDICAL TECHNIQUES

The Influencing Effect of Silver Nitrate Fillers on the hardness of Flexible Resin

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Article Info.	Abstract
<p><i>Article history:</i></p> <p>Received 29 March 2022</p> <p>Accepted 23 May 2022</p> <p>Publishing 30 June 2022</p>	<p>The development of polymer chemically produces alternative materials to polymethyl methacrylate, such as nylon, and epoxy resin, these resins are modified by thermoplastic process, and This Received The disadvantage of acrylic resin is the colonization of microorganism growth of fungi and candida adhesion. This study is designed to evaluate and compared the consequence of silver nitrate fillers reinforcement Accepted flexible acrylic hardness as one of the mechanical properties to find the effect of various concentrations. A (0.1 and 0. 2) ml of the filler (silver nitrate) additive to the flexible acrylic.</p> <p>Forty five (45) specimens were prepared for testing in this study. The hardness test was used in this study. The sample of this test was divided into (3) groups (control group) and experimental groups as follows:</p> <p>Group A= (15) specimens without silver nitrate (Control group 0% silver nitrate).</p> <p>Group B= (15) specimens with (0.1 ml) silver nitrate.</p> <p>Group C= (15) specimens with (0.2 ml) silver nitrate.</p> <p>All control and test groups were processed; cured then finished and polished the specimens ready for testing. Shore A test against the concentration of silver nitrate the result of this study showed a high significant increase in the mean value of hardness for control groups to the silver nitrate compared with experimental groups.</p>

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1. Introduction

The flexible denture base was introduced to improve both aesthetic and functional limitations of conventional removable partial dentures. Flexible denture base resin is ideal for partial dentures and unilateral restorations. The resin is biocompatible thermoplastic nylon with unique physical and aesthetic properties that provide unlimited designed versatility and eliminates the concern about acrylic allergic. The flexible partial (the flexible material used today is the thermoplastic nylon or polyamide resin commonly found in the market) allows the restoration to adapt to the constant movement and flexibility in the patient's mouth. Where it was stated that the flexibility, combined with strength and lightweight. Provides total comfort and great looks [1].

One of the disadvantages of the flexible denture base materials is their polymer characteristic feature as their ability to provide harbor for pathological microorganisms, which change by humidity and increasing temperature in the oral cavity beneath the denture bases [2, 3].

Silver is recognized for its germicidal [4] and anti-fungal effect like different positive and negative bacteria and fungal infections as well as some viral infections [5]. Researchers have increasingly been interested in the antibacterial capabilities of nanoparticles [6] because smaller particles like any other Nano material have a large surface area and their chemical and biological influencing effect. Silver ions can stop the action of the key enzymes and alter the DNA mechanism in bacteria [7]. The silver-based antibacterial agent was used in denture base materials [8] to evaluate the distribution and manner of release of silver ions from the base [9, 10].

Yeast of the type candida is commonly present in the plaque, their adhesion to the surface of the denture [11]. May cause candidosis infection to the patient and Surface roughness (irregularities on the surface) of the denture base material increases the likelihood of bacterial buildup and candida adherence compared to a smooth surface. To reduce the adhesion of candida albican that may be attached to the flexible denture base materials can additive filler [12] (silver nitrate) to it [13].

To reduce the frequency of secondary caries around the restoration, silver-containing materials, such as Novaron and Amenitop were incorporated into light activated resin composites, as well as the incorporation of the nanometer-sized silver-supported antimicrobial agent into denture base materials to investigate the distribution and study of the release mode of silver ions from the base [14, 15].

This study was designed to access the addition of silver nitrate fillers in forced flexible denture base resin.

Nomenclature & Symbols

°C	Degree Celsius	VH	Vickers hardness
ANOVA	Analysis of variance	T-test	Student test
SD	Standard deviation	LSD	Least significant difference

2. Materials and Methods

Select the volume used (0.1 ml), (0.2 ml) then add silver nitrate solution to the monomer flexible, the filler was well dispersed in the monomer by ultra-sonication, using a probe sonication apparatus, and the monomer with silver nitrate solution (0.1 ml) was immediately mixed with the flexible powder to reduce the possibility of particle aggregation and phase separation. All the materials were mixed and manipulated according to the manufacturer's instructions.

2.1. Sample grouping

Forty five (45) specimens prepared for testing in this study with different concentrations of silver nitrate (0.1, 0.2 ml) were prepared from silver nitrate (AgNO₃) solution. The samples of this test were divided into (3) groups (control group) and experimental groups.

2.1.1. Group (A) (control group)

15 specimens of flexible resin free from silver nitrate solution (control group 0% silver nitrate).

2.1.2. Group (B) (experimental group)

15 specimens of flexible acrylic with (0.1ml) silver nitrate

2.1.3. Group (C) (experimental group)

15 specimens of flexible acrylic with (0.2ml) silver nitrate.

2.2. Specimens design

Plastic models were constructed by cutting plastic plates of different gauges (2 mm) into desired shape and dimension using highly accurate laser cutting machine [17].

Plastic pattern preparation Instead of wax pattern preparation, which needs more time and effort in its preparation of a wax elimination procedure, the plastic pattern in Fig. 1B, samples were constructed with a circle shape and dimensions according to the test.

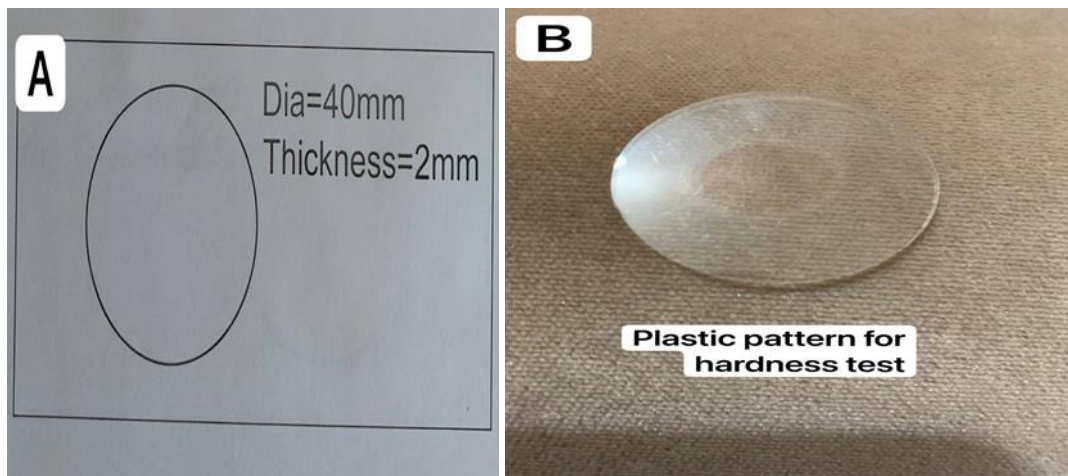


Fig 1. Disk sample; (A) Diagram of sample used for hardness test, and (B) Plastic pattern for hardness test

2.3. Flexible acrylic samples preparation for micro Vickers hardness tester

Plastic disk 40 mm diameter, 2mm thickness was prepared. Stone slurry was prepared (33ml water/100gm powder) [18]. And poured into the lower half of the flask, a plastic plate was placed over the stone in the lower half of the flask before it hardened, so that the plastic plate's level was equal to the stone's level. The plastic designs were then covered with separating material and allowed to cure (Mould preparation). The designs were then invested into the stone mixture and inserted to one-half of their depth in the lower section of the dental flask (mixed according to the manufacturer's specifications) with vibration to get rid of trapped air.

After setting, both the stone and the plastic surfaces were coated with a separating medium. The upper half of the flask was then positioned on the top of lower half and filled with silicone impression materials to make careful adaptation and sure all the plastic patterns will be covered late to set and make a pit in the impression silicon for retention and support then filled with dental stone, again with vibration to get rid of the trapped air to make silicon stone mould [17].

After the setting was completed the flask was opened, the plastic plate was removed as the Fig. 2 (A, C) and (B, D) according to conventional methods and the flask and the stone should be covered with a separating medium to be ready for packing with flexible acrylic (dough acrylic). After the packing stage then the curing, finishing, and polishing stage [17].



Fig 2. Mold preparation A, B, C, and D

2.3.1. Mixing ratio

Preparation of (2.5/1 by weight) (P/L) for the mixing of the acrylic resin. The mixing and manipulation were according to the manufactures instructions [16].

2.3.2. Addition of silver nitrate

Different concentrations of silver nitrate (0.1 and 0.2 ml) were prepared from silver nitrate (AgNO_3) solution when the weight of the (16.999 g) silver nitrate was an electronic balance. Water is poured into an opaque glass container because silver can absorb light. That container prevents light intransmission. The weighted filler to the distal water with the aid of a plastic spatula, the solution (silver nitrate filler and water) mixed for 6 to 10 minutes till dissolving all the fillers [16].

2.3.3. Preparation of flexible acrylic specimens (prosthetic study)

To select the proper percentage of silver nitrate to use as antifungal when which adhesive in flexible acrylic denture base by addition of silver nitrate to the monomer to evaluate the effect of hardness of flexible denture base.

Select the volume used (0.1 ml), (0.2 ml) [16], Fig. 3 & 4. The filler was thoroughly disseminated in the monomer by ultra-sonication, utilizing a probe sonication instrument (120 W, 60 kHz) for 3 minutes to break them into individual microcrystals after adding silver nitrate solution to the monomer flexible. Put the glass Pyrex inside the container and have cold water to prevent fracture because of heat generation during the mixing process. The suspension of the monomer with silver nitrate solution (0.1 ml). Then as soon as added the flexible acrylic (powder) to prevent the possibility of particle aggregation and phase separation.

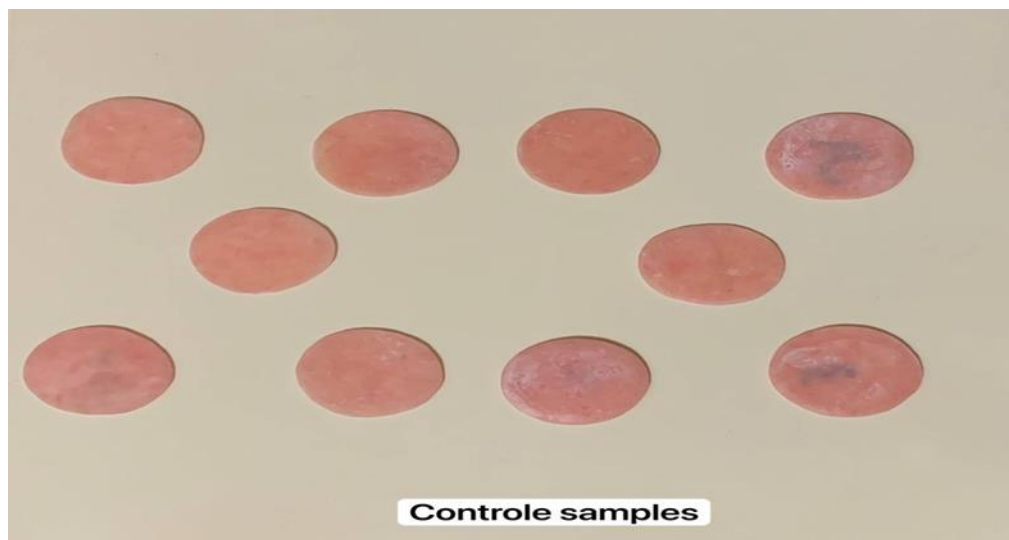


Fig 3. Control samples with Dia =40 mm

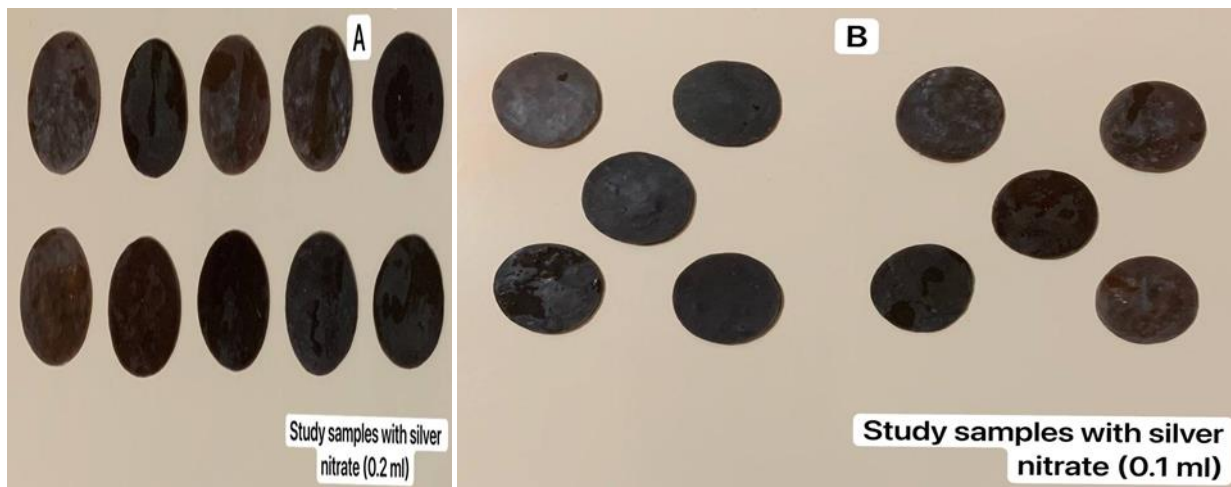


Fig 4. Study samples; (A) Study samples with silver nitrate (0.2 ml), and (B) Study samples with silver nitrate (0.1 ml)

2.3.4. Packing

It was packed in a mold that had been painted with separating material with the help of a nylon sheet, and the flask's two sides were sealed, then pressed by a hydraulic press (1200 psi).

Exerted the force was gradually to ensure that the dough stage acrylic flowed evenly across the mold region. After that forces are released, then the flask is ready for curing [19].

2.3.5. Curing

Following the manufacturer's instructions, the flask was cured in a thermostatically controlled water bath. After curing, the flask permits it to cool at room temperature. When de flasking process is completed, in this time flexible resin designs are removed [19].

2.3.6. Finishing and polishing

By Carbide and stone burs and sand, paper sheets were used to finish all of the flexible acrylic resin specimens, while bristle brush and pumice were used to polish them with a dental lathe-polishing machine at a low speed (1500rpm).

On the dental lathe, a final glossy finish was achieved using a wool brush and polishing soap [19].

On all samples, the abrasive paper was employed with light manual pressure. The fine particle pumice was combined with water in a 1:1 ratio. On the polishing lathe, a 12.5mm cloth wheel was used for 60 seconds at 3,000 rpm. With fine grit pumice, the process was repeated. All Study samples are made with the same steps and stages.

2.4. The devices used and testing procedures

Fig. 5 show the device used in this study, Vickers hardness devise is the device that can measure surface wear resistance (hardness) of flexible material specimens (shore A).

Device shore (A), (Shor A Hardness tester TH200), With standard specifications (ISO 761g).



Fig 5. Shor A Hardness tester TH200

3. Results of Statistical analysis

Table 1 Descriptive Statistics of hardness in different groups, the descriptive statistics of the hardness tests among the different groups of the experiment were applied to 15 specimens in each of the three groups. The Table shows that the minimum hardness was obtained in the third group of tests with a mean hardness of 90.572 and where the concentration of silver nitrate was 0.2, while the maximum hardness was in the control group with a mean hardness of 100.060, Fig. 6.

Table 1 Results of the hardness analysis according to the tested groups

Groups	N	Mean	SD.	Std. Error	Range	
					Min.	Maxi.
Control polyamide	15	100.060	1.405	0.363	96.98	101.68
Silver Nitrate Concentrate (0.1 ml) + polyamide	15	95.353	3.366	0.869	89.02	100.60
Silver Nitrate Concentrate (0.2 ml) + polyamide	15	90.572	2.974	0.768	87.00	95.54
Total	45					

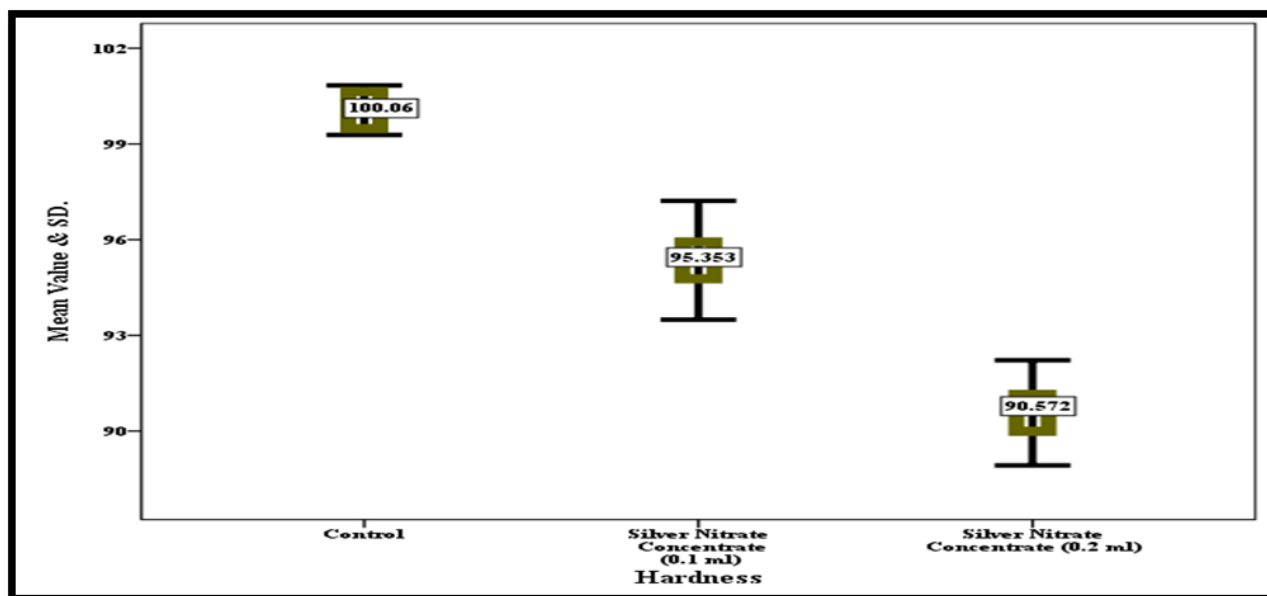


Fig 6. Mean Value and Stander deviation (SD.) of Hardness in different groups

The LSD (Least Significant Difference) test of Hardness between Silver Nitrate of both Concentrates (0.1 ml), (0.2 ml), and Control. Table 2 shows significant variances between the control group and the 0.1 concentrate group, and high significant variances between the 0.1 and 0.2 groups. The mean of differences between the two later groups was 4.781 with a p-value = 0 indicating high significance.

Table 2 Results of the hardness (LSD) test according to different concentrates of silver nitrate groups

	Sum of Squares	D f	Mean Square	F-test	(Sig.) P-Value	LSD
Concentrate (0.1 ml)/ and Control						
Between Groups	44.098	1	44.098	4.522	P<0.05	P=0.028
Within Groups	273.065	28	9.752		(S)	(S)
Total	317.163	29				
Concentrate (0.2 ml)/and Control						
Between Groups	85.455	1	85.455	14.748	P<0.01	P=0.001
Within Groups	162.244	28	5.794		(HS)	(HS)
Total	247.699	29				

Table 3 Mean Differences of Hardness group according to Silver Nitrate Concentrates.

Table 3 Results of hardness statistical difference analysis according to different Concentrates of Silver Nitrate

Hardness	Mean Differences	t-test	(Sig.) P-Value
Silver Nitrate Concentrate(0.1 ml) & Silver Nitrate Concentrate(0.2 ml)	4.781	13.132	P=0.000 (HS)

4. Discussion

4.1. Filler (silver nitrate) added to flexible acrylic

Filler (silver nitrate) added to the base material (flexible monomer) in liquid shape:

The effect of adding the liquid form of silver nitrate on the mechanical properties of the monomer and concentration of silver nitrate was investigated in this study, which positively affects the samples to improve their mechanical properties

4.2. Indentation hardness

Hardness [20] is a key quality, because of its resistance to occlusal stresses to allow acrylic materials to be used as denture base resins. This feature is linked to material development, chemistry, and polymerization method and gives scratch and abrasion resistance [21] the resistance to permanent surface indentation or penetration is a broad definition of hardness. This feature is critical in dentistry since it indicates the case of a structure's finishing and its resistance to in-service scratching [13].

Before adopting hardness testing method, sample factors such as size, shape, thickness, and composition should be addressed.

The most popular hardness tests for thermoplastic denture base polymer are Vickers and Knoop [22]. Because both diagonals are tested and the average value is applied, the Vickers test is favorable.

A diamond indenter with a specified geometry is used to conduct indentation hardness tests.

To acquire precise results, the micro Vickers hardness test method was chosen for this investigation. The result of this study showed the resulting hardness according to the mean value of the control samples was higher, while the hardness value decreased in the experimental samples as the concentration of silver nitrate increased. this result agrees with the study stated this discovery can be cleared by that soft liner material mixed with silver nitrate filler that promotes the penetration of polymeric chains. When bonded inside a soft liner, it becomes harder and more resistant [16].

There were some studies incorporating (silver benzoate) into resin and studied their effect, the result of this study showed that by adding (silver benzoate) there was a decrease in the degree of curing, resulting in a reduction in Rockwell hardness for light cure resin. This finding is in agreement with the work [8].

5. Conclusion

It can conclude that the hardness according to the studied groups when silver nitrate was incorporated into flexible acrylic had a highly significant between control and experimental in concentrations of 0.1 ml and 0.2ml.

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