British Journal of Pharmaceutical and Medical Research Vol.07, Issue 05, Pg.4016 – 4030 Sept - October 2022

Available Online at http://www.bjpmr.org

BRITISH JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

Cross Ref DOI : https://doi.org/10.24942/bjpmr.2022.1017 Volume 07, Issue 05 Sept- October 2022

ISSN:2456-9836
IF 5.885 & ICV: 60.37

Research Article

Evaluate And Compare Flexural Strength Of Polyamide (Rigident) And Polymethamethacrylate (SR-Ivocap) Materials Using Injection Molding Technique In Different Thicknesses.

Dipali L Mungra[a], Vishal R. Chauhan[b], Vilas V. Patel[c], Sareen S. Duseja[d], Mustafa, F. Laxmidhar[e], Bhakti A. Patel[f].

[a]Private Practitioner, prakash, saru section road, Jamnagar, Gujarat, India.
[b]Professor, Department of Prosthodontics and Crown & Bridge, Govt. dental College and Hospital, Ahmedabad, Gujarat, India.
[c]Professor and Dean, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel, Dental College and Hospital, Visnagar, Gujarat, India.
[d]Professor, Department of Prosthodontics and Crown & Bridge, Narsinhbhai Patel Dental College and Hospital, Visnagar, Gujarat, India.
[e]Private Practitioner, Gariyadhar, Bhavnagar, Gujarat, India.
[f]Sr. lecturer, Department of Prosthodontics and Crown & Bridge, Govt. dental College and Hospital, Ahmedabad, Gujarat, India.

ARTICLE INFO

Article History:
Received on 09th Sept, 2022
Peer Reviewed on 25th Sept, 2022
Revised on 16th October, 2022
Published on 30th October, 2022

Keywords:
Denture bases, flexural strength, polyamide, PMMA, injection molding technique.

ABSTRACT

Purpose: To evaluate and compare the flexural strength of polyamide (Rigident) and polymethamethacrylate (SR-Ivocap) materials using Injection molding technique in different thicknesses.

Materials & Methods: Materials used in study are polyamide (Rigident) and polymethamethacrylate (SR-Ivocap). A total 60 specimens (65mm χ 10mm χ varying thickness of 1.5mm, 2.0mm, 2.5mm) were fabricated, 30 for each material being tested. Specimens were fabricated according to ADA specification no. 12. A three-point bending test was carried out to measure the flexural strength on an Instron testing machine at 5 mm/min crosshead speed.

Results: Polyamide groups show higher flexural strength than PMMA groups and there is a statistically significant difference between groups ($p<0.05$).

Conclusion: Flexural strength test is significantly useful in comparing denture base materials subjected to stress during mastication. The results from flexural test indicates that the difference observed can be attributed to difference in constitutes of materials. Polyamide (Rigident) may prove to be more advantageous than PMMA (SR-Ivocap).

Corresponding Author: *Dr. Dipali Mungra, Postal Address: The Motor Mechanics, near Ashapura Hotel, Saru section Road, Jamnagar, Gujarat, India.*

INTRODUCTION:

Since long, for denture construction variety of material have been used. The developments of these materials have lead it to the times, when the dentures were carved from stone, ivory, bone and wood to the latest polymers[1]. Denture base materials, in particular the resin based poly (methylmethacrylate) (PMMA) materials are the most widely used non-metallic denture base materials[2,3]. Previously, materials such as vulcanite, nitrocellulose, phenol formaldehyde, vinyl plastics, and porcelain were used for denture bases.

Polymethylmethacrylate (PMMA) resin was introduced as a denture base material in 1937[4]. Since then, PMMA acrylic resin has dominated the field of denture base construction. This has been ascribed to its favourable physical and aesthetic characteristics, material's availability, comparatively low cost, and the relative ease with which PMMA may be processed, adjusted, or repaired[5]. But later on it was found that PMMA have some disadvantages like polymerization shrinkage, weak flexural strength, lower impact strength and low fatigue resistance[6]. These often lead to denture failure during chewing or when fall out of the patient's hand. In order to enhance some properties of PMMA, various efforts have been taken including addition of metal wires or plates, fibers[7,8,9,10], metal inserts[11], and modification of chemical structure.

In recent years, improvised thermoplastic nylon can be a useful alternative to polymethylmethacrylate in special circumstances where higher flexibility, higher resistance to flexural fatigue, higher impact strength is required [6]. Polyamide resin was proposed as a denture base material in the 1950s[12]. Nylon is a generic name for certain types of thermoplastic polymers belonging to the class known as polyamides. These polyamides are produced by the condensation reactions between a diamine NH2-(CH2)6-NH2 and a dibasic acid, CO2H-(CH2)4-COOH[6].

Nylon is a crystalline polymer, whereas PMMA is amorphous. This crystalline effect accounts for the lack of solubility of nylon in solvents, as well as high heat resistance and high strength coupled with ductility[13,14].

For fabrication of denture base different techniques are there, that are: Heat-activated, chemically activated, Microwave cured or Light-activated. Heat-activated resin can be manipulated by either compression molding technique or injection molding technique. Compression molding technique is more commonly used for fabrication of dentures. Injection molding technique was introduced by Pryor in 1942. The injection molding processingmethod for the denture fabrication leads to less Polymerization shrinkage and produces a more accurate denture than the compression molding process[15].

Moreover, the thickness of denture base also affects the properties of material andalso the clinical outcome. The thicker the denture base, the greater will be the fracture resistance because of its greater flexural strength[15,16,17].

This increase in strength is probably not sufficient to warrant the greater bulk of material in the mouth[18], which will reduce the height available for the replacement teeth where interridge space is limited. Increased base thickness in the anterior region of the maxillary arch beyond what is considered clinically acceptable reduces tongue space[19], and sharp changes in palatal contour may also affect speech[19]. Pin holes, inclusions, deep scratches, and residual processing stresses may also cause stress intensification that can increase the risk of fracture[20,21].

Presently, the use of polyamide (nylon) denture base material is limited in clinical practice because of less information provided by the manufacturers. Also there are insufficient scientific evidence as less number of studies comparing conventional acrylic denture base material to polyamide (nylon) denture base materials are available. Also no studies are available in literature that compare polyamide and PMMA denture bases at various thicknesses.

So the purpose of this in vitro study was to evaluate and compare the flexural strength of polyamide and PMMA denture base materials using injection molding technique in different thickness.

MATERIAL AND METHOD

This present in - vitro study was conducted to compare flexure strength of polyamide and PMMA denture base materials using injection molding technique in different thicknesses (1.5mm, 2.0mm, 2.5mm). Information about the materials is reported in Table 1.

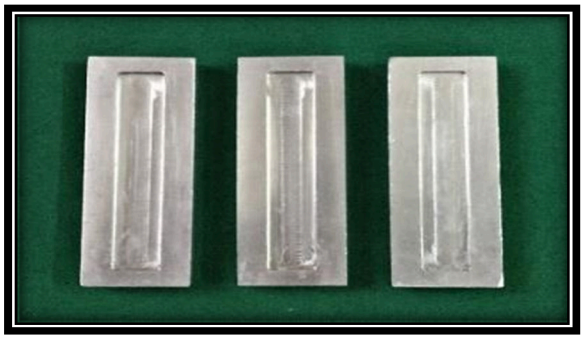
Preparation of the Die

In this study, stainless steel dies were prepared according to American Dental Association Specification no. 12. Die consist of ruled block which have a length of 65mm, width of10mm and thickness of 1.5mm, 2.0mm and 2.5mm (Figure 1)

Table 1 *Denture base materials used in study and their manufacturers*

TRADE NAME	MANUFACTURER	TYPE OF MATERIAL	Manufacturing method
Rigident	Posca dental supply, Placentia, US	Polyamide	Injection molded
SR-Ivocap	Ivoclar AG, Schaan, Liectenstein	Polymethamethacrylate	Injection molded

Figure 1 *Master dies*



a) Fabrication of Samples:

I) The stainless steel die of each thickness was invested in lower portion of injectionmolding unit denture flask using dental stone. **(Figure 1,2).**

II) After setting of dental stone, wax sprues were attached to side of the metal diesand separating media was applied. **(Figure 3).**

III) Then the upper portion of the metal flask was positioned on the top of lower portion and filled with dental stone. After setting, dewaxing was done. **(Figure 4).**

IV) Injection molding machine was used to inject the polyamide material into the mould at 150 psi pressure. **(Figure 5)** and for PMMA Premeasured capsules (20 g powder and 30 ml liquid) of SR-Ivocap High Impact were mixed in cap vibrator (Ivoclar vivadent) for 5 minutes prior to injecting into the flask & While injecting resin into the flask, a constant pressure of 6 atm was maintained. Curing was done inboiling water at 100 ˚C maintaining 6 atm pressure for 35 minutes as mentioned by manufacturer. **(Figure 5).**

V) After cooling, specimen was deflasked. Any irregularities and sprues was removed with tungsten carbide bur. Finishing and polishing of the specimen was carried out. Size verification of samples was carried out using digital Vernier caliper.

VI) Total of 30 samples; 10 for each group with thickness of 1.5mm, 2.0mm, and 2.5mm were prepared. **(Figure 6).** These specimens were stored at room temperaturein distilled water.

Figure 2: Invested stainless steel die in lower portion of injection molding flask

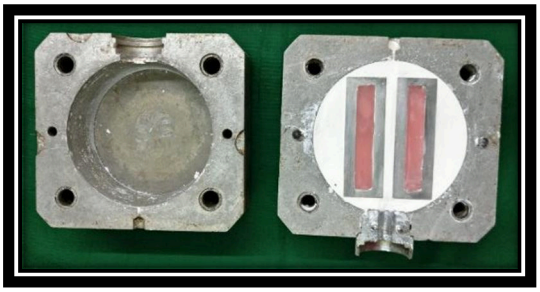


Figure 3: wax sprue was attached

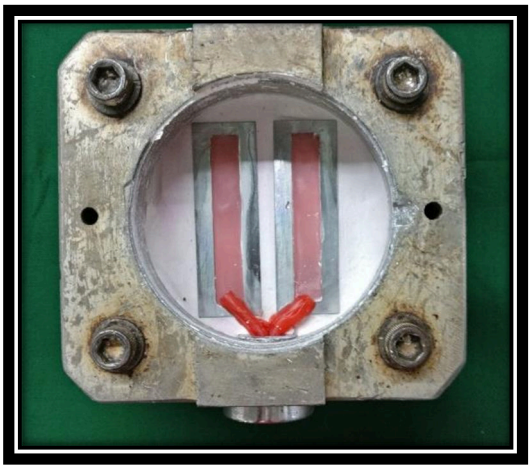


Figure 4: dewaxing was done

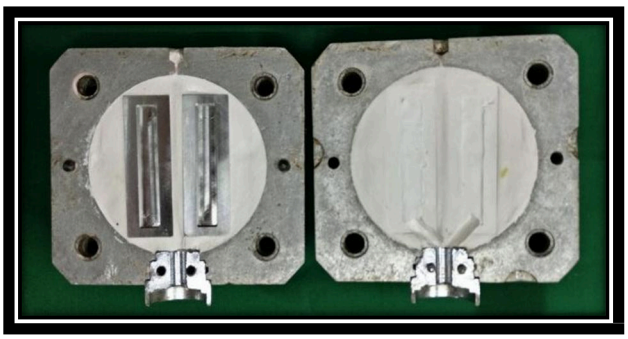
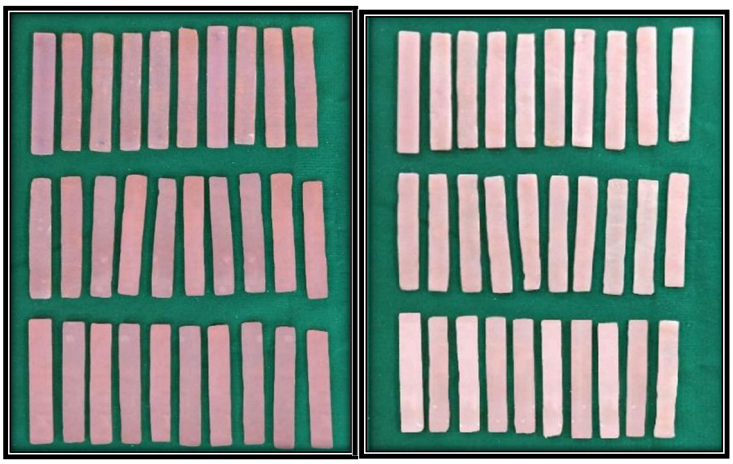


Figure 5: Injection molding unit for polyamide and PMMA

Figure 6: Polyamide and PMMA samples (60 samples)



Total 60 samples were fabricated with 10 samples in each group (Table 2). Samples were fabricated using stainless steel die as discussed previously. Measurement was carried out using universal testing machine.

Table 2 Grouping the samples:

Group P1	65×10×1.5mm thickness Polyamide denture base material blocks
Group P2	65×10×2.0mm thickness Polyamide denture base material blocks
Group P3	65×10×2.5mm thickness Polyamide denture base material blocks
Group A1	65×10×1.5mm thickness PMMA denture base material blocks
Group A2	65×10×2.0mm thickness PMMA denture base material blocks
Group A3	65×10×2.5mm thickness PMMA denture base material blocks

Testing for Flexural Strength (FS)

The samples were taken out from the distilled water 5 minutes before the test and transferredto room temperature. The tests for flexural strength was carried out in accordance with the conditions laid down in the ISO specification no. 1567 for denture base polymers.

The testing of the flexural strength was performed with the universal testing machine (Instron) using 3 point

bending testing device. Specimens were placed on two support separated by 50mm such that the polished surface faces the central loading plunger and then loaded at a cross head speed set at 5mm/ min **(Figure 7).** Each specimen was placed with its flat surface symmetrically on the supports. The force of loading plunger was increased from zero until the specimen breaks or fractures. **(Figure 8)**

Figure 7: sample placed in universal testing machine

Figure 8: sample under load

Flexural strength was calculated from the formula,

$$FS = 3PL/2bd^2$$

FS – Flexural strength, P – maximum load applied to the specimen, L – span length, b – width, d – thickness of the specimen.

The collected data were coded and entered in Statistical Package for Social Science (SPSS,IBM) version 22. The mean values among the groups were compared by using one way ANOVA test. The multiple comparison between the groups was made by using Post hoc Turkey's test, if the ANOVA shows significant result. For thickness wise comparison between groups independent sample t test was done.

RESULT:

Table 3 summarizes the result of the determined flexural strength for each group of polyamide and PMMA in each thicknesses. Polyamide group shows the higher flexural value in each thickness in comparison to PMMA group. The mean flexural strength values and standard deviation were calculated for each group. According to ISO 20795 –1, minimal required flexural strength value is 65Mpa. Table 4 shows the mean flexural strength values and standard deviation that were calculated for each group. In table 5 'One way ANOVA' test was done, the reason for this test was that for both groups, various thicknesses were to be compared. And it shows the statistically significant difference between groups, with p value

Table 6 Post hoc turkey's test was carried out for inter group comparison and it depictsthe statistically significant difference between groups with p value <0.05. Table 7 shows One way ANOVA test for PMMA group shows the statistically significant difference of mean values between groups with p value <0.05. table 8 shows the Post hoc turkey's test was carried out for inter group comparison and it depicts the statistically significant difference between groups with p value is <0.05. For intergroup

comparison of each thickness was carried out using independent sample t test (Table 9,10,11). There is statistically significant difference is there in different thickness with p value is <0.05. Graph 1 compare the mean value in different thicknesses for polyamide and PMMA groups.

Table 3: Raw data of flexural strength (Mpa) for each group

Injection molding technique/ materials	**Polyamide**			**PMMA**		
Thickness	1.5mm (P1)	2.0mm (P2)	2.5mm (P3)	1.5mm (A1)	2.0mm (A2)	2.5mm (A3)
Specimen 1 (Mpa)	78.5	103.24	114.22	60.8	92.4	103.38
Specimen 2 (Mpa)	67.33	105.46	119.04	54.4	93.94	105.32
Specimen 3 (Mpa)	80.67	108.95	115.37	67.43	89.96	97.54
Specimen 4 (Mpa)	79.13	104.19	108.3	62.46	92.1	107.1
Specimen 5 (Mpa)	88.46	103.35	112.94	68.46	86.44	102.89
Specimen 6 (Mpa)	78.5	110.81	115.48	61.06	92.44	103.32
Specimen 7 (Mpa)	67.26	105.26	114.17	55.8	90.22	105.31
Specimen 8 (Mpa)	80.93	108.97	114.29	62.13	88.39	103.43
Specimen 9 (Mpa)	78.53	105.19	115.32	60.8	92.4	105.32
Specimen 10 (Mpa)	76.66	93.97	114.19	67.23	93.97	98.69

Table 4: Mean and standard deviation for each group

MATERIAL	**THICKNESS**	**MEAN**	**SD**
Polyamide	1.5mm (P1)	77.60	6.29
	2.0mm(P2)	104.94	4.63
	2.5mm(P3)	114.32	2.66
PMMA	1.5mm(A1)	62.06	4.69
	2.0mm(A2)	91.23	2.43
	2.5mm(A3)	103.33	3.00

Table 5: Mean values comparison using one way ANOVA for polyamide group.

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7284.245	2	3642.123	160.157	.000
Within Groups	614.006	27	22.741		
Total	7898.252	29			

Table 6: multiple comparison between mean values by Post hoc Turkey's testcomparing mean flexural strength

Multiple Comparisons						
Dependent Variable: flexural strength						
(I) Thickness	(J) Thickness	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.5mm	2.0 mm	-27.34200*	2.13265	.000	-32.6297	-22.0543
	2.5 mm	-36.73500*	2.13265	.000	-42.0227	-31.4473
2.0mm	1.5 mm	27.34200*	2.13265	.000	22.0543	32.6297
	2.5 mm	-9.39300*	2.13265	.000	-14.6807	-4.1053
2.5mm	1.5 mm	36.73500*	2.13265	.000	31.4473	42.0227
	2.0 mm	9.39300*	2.13265	.000	4.1053	14.6807
*. The mean difference is significant at the 0.05 level.						

Post hoc turkey's test was carried out for inter group comparison and it depicts thestatistically significant difference between groups with p value <0.05.

Table 7 : Mean values are compared using one way ANOVA of PMMA group.

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8967.142	2	4483.571	363.102	.000
Within Groups	333.395	27	12.348		
Total	9300.537	29			

Table 8 multiple comparison between mean values by Post hoc Turkey's test comparingmean flexural strength

Multiple Comparisons						
Dependent Variable: Flexural strength						
(I) Thickness	(J) Thickness	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.5 mm	2.0 mm	-29.16900*	1.57149	.000	-33.0654	-25.2726
	2.5 mm	-41.17300*	1.57149	.000	-45.0694	-37.2766
2.0 mm	1.5 mm	29.16900*	1.57149	.000	25.2726	33.0654
	2.5 mm	-12.00400*	1.57149	.000	-15.9004	-8.1076
2.5 mm	1.5 mm	41.17300*	1.57149	.000	37.2766	45.0694
	2.0 mm	12.00400*	1.57149	.000	8.1076	15.9004
*. The mean difference is significant at the 0.05 level.						

Table 9 Comparison of mean flexural strength values of polyamide and PMMA at 1.5mm thickness by using independent sample t test

Group Statistics									
	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	F	Sig.
Flexural strength	P1	10	77.5970	6.29419	1.99040	6.256	18	.246	.000
	A1	10	62.0570	4.69904	1.48597				

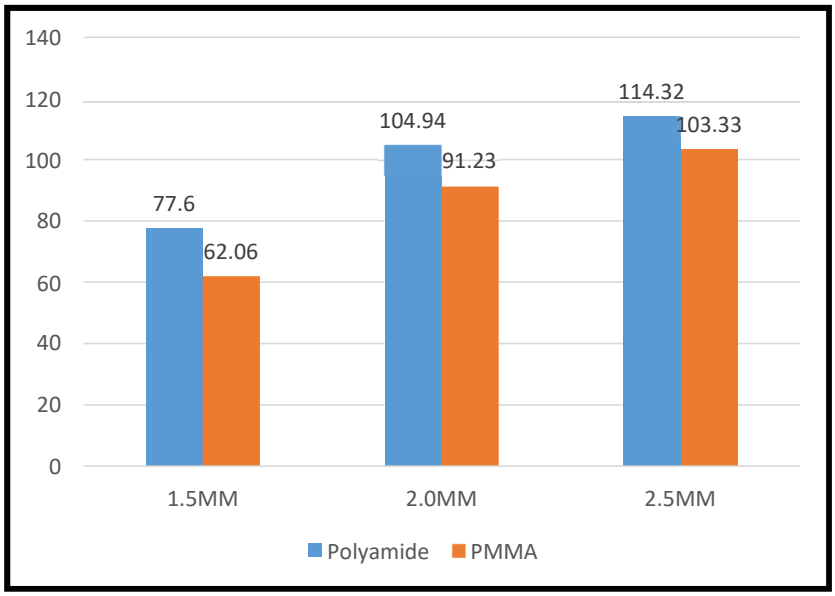
Table 10: Comparison of mean flexural strength values of polyamide and PMMA at 2.0 mm thickness by using independent sample t test

Group Statistics									
	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	F	Sig.
Flexural strength	P2	10	104.9390	4.63722	1.46642	8.278	18	.799	.000
	A2	10	91.2260	2.43705	.77066				

Table 11: Comparison of mean flexural strength values of polyamide and PMMA at 2.5 mm thickness by using independent sample t test

Group Statistics									
	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	F	Sig.
Flexural strength	P3	10	114.3320	2.66500	.84275	8.743	18	.344	.000
	A3	10	103.2300	3.00395	.94993				

Graph 1: Bar diagram showing mean value of polyamide and PMMA.



DISCUSSION:

The present study measured and compared the flexural strength of polyamide and polymethamethacrylate denture base material fabricated by injection molding technique in different thicknesses. The null hypothesis that there would not be any statistically significant difference in the flexural strength of two materials.

Even though different materials have been used for denture construction, polymethyl methacrylate (PMMA) resins are the most commonly used. However, PMMA resin fracture strength is not high[22]. There has been ongoing effort to enhance the strength and fatigue resistance of PMMA like reinforcement with the addition of filling materials[7,8], altering the chemistry, manufacturing alternative denture base materials[23].

One technique that improves the physical properties of dentures is injection molding[24]. Anderson et al and Strohaver reported that the dimensional stability was improved with the injection-molding technique compared to the compression-molding technique, in addition to the decreased polymerization shrinkage and diminished changes in vertical dimension[25,26].

Polyamides, known as 'nylon' are thermoplastic polymers produced by condensation between a diamine and a dibasic acid. In a number of studies polyamide was used as a denture base polymer in 1950s[22,27]. Because of their crystalline nature there is lack of solubility in solvent, high heat resistance, high strength and low fatigue resistance. Various studies were carried out that compare the various physical and mechanical properties of polyamide and PMMA group [16,23,27].

In this study for SR Ivocap Injection System (PMMA) features controlled heat/pressure polymerization, during which the exact amount of material keeps flowing into the flask to compensate acrylic shrinkage[24] while for Rigident Posca Dental Supply & Mfg (Polyamide) material was plasticized for 17 minutes at 300^0c in electric furnace and rapid andfirm pressure was applied at 150 psi. So, material properly flows into all parts of the mold.

Flexural strength also known as transverse strength was selected as the unit of comparison because it is the value that has been reported most commonly in dental literature. The flexural strength is important because it reflects the rigidity of the material, which in turn is important for the integrity of the supporting ridge and tissues, along with the fitting accuracy of the denture. Denture base resin should not deform under loading to permit proper load distribution to the underlying structures. The prosthesis may fracture accidentally due to an impact while outside the mouth, or it may crack while in service in the mouth. Fracture of denture base in situ occurs via fatigue mechanism in which relatively small flexural stresses over a period of time eventually leads to formation of microscopic cracks in areas of stress concentration. With continued loading these cracks fuse to ever growing fissure that weakens the material. Catastrophic failure results from a final loading cycle that exceeds mechanical capacity of remaining sound portion of the material. Additionally, denture fracture is also related to faulty design, fabrication and material choice[28].

Fracture of the upper dentures invariably occurs through the midline of the denture, due to flexure. Therefore, the denture base should have sufficient flexural strength to resist fracture (McCabe and Walls, 1998). This study compared the flexural strength between polyamide and PMMA denture base materials by injection molding technique in different thicknesses.

In order to study the effect of thickness on the flexural strength of two different materials, in this study, rectangular stainless steel dies according to ADA specification no. 12 were used to fabricate the specimens of 3 different thicknesses (1.5, 2.0, 2.5 mm). As stated by Gharechahi these uniform rectangular dies enabled us to analyse the property of acrylic resin per se by controlling effect of factors such as shape and presence of teeth[24].

A large number of study compare the different mechanical and physical properties of polyamide and PMMA materials using either compression molding technique or injection molding technique [23,29,30] but effect of thickness was not compared. So this present study was carried out to inspect how flexural strength is affected by the different thicknesses of two different denture base materials. To inspect this mechanical property, here three different thickness rectangular specimen namely 1.5, 2.0, 2.5 mm were used. The flexural strength test was measured using 3 point

bending test.

The measurement conditions in this study were designed to simulate clinical conditions, where the thickness of the test specimens stays within the thickness range of actual denture base polymer, and the span of the flexural test approximates to chewing.

The results of flexural strength for all groups reported in Table 2. According to ISO 20795 –1, minimal required flexural strength value is 65Mpa. The mean flexural strength of all three materials tested in the current work was higher than required in ISO 20795–1 except group A1 (PMMA 1.5mm thickness). In this study mean flexural strength value of all polyamide groups were higher than that of PMMA groups (Table 3). However, **Yunus et al** found lower flexural strengthcompared to the current project[23]. The difference between the two studies might be attributed to different testing conditions. **Yunus et al** carried out the test at 37◦C[23]. Tests of the current study were performed at room temperature. **Soygun et al** reported higher flexural strength for the injection-molding technique[30]. However, a different brand was used in their study. **Ucer et al** also found higher flexural values and they did study at room temperature[23].

The results in this study indicate that flexural properties are not only examined under constant thickness but varying thicknesses of the test specimen are also important. When mean values of different thicknesses of polyamide group is compared (Table 4) using One- way ANOVA revealed statistically significant difference ($p < 0.05$). When comparing the mean values between groups using Post hoc Turkey's test, there was statistically significant difference also, $p<0.05$ (Table 5). Graph 1 shows that mean value increase as thickness increase and it was clear that the mean flexural strength value of 1.5mm is sufficient as a denture base thickness as it was higher than required in ISO 20795–1.

Table 6 shows that there was a statistically significant difference for PMMA group ($p<0.05$) also there was a statistically significant difference was observed while comparing mean values between groups using post hoc Turkey's test (Table 7). Mean value of different groups increases as thicknesses increases as shown in graph 2, but mean value of PMMA at 1.5mm thickness was less than required in ISO 20795-1. So for PMMA to achieve the good result in term of flexural strength minimum required denture base thickness should me at least 2mm.

So, adequate flexural strength as required in ISO 20795-1 was fulfilled with minimal thickness of 1.5mm for polyamide group and 2.0mm for PMMA group. This not onlyreduced the bulk of the material but also increase the height available replacement of teeth, provide adequate tongue space, improved speech, patient satisfaction[19].

Comparing mean flexural strength value of polyamide and PMMA for different thicknesses (1.5,2.0,2.5mm) using independent sample t test shows statistically significant difference, $p<0.05$ (Table 8,9,10). As seen in graph 3 mean flexural strength values for polyamide was higher than PMMA group. This may be due to polyamide molecules contain the amide group regularly spaced at the main chain. Polyamide is a crystalline polymer whereas PMMA is amorphous. Polyamide molecules contain hydrogen bonding, which increases the melting point of the polyamide. Thus, in the polyamide structure, there is more ordered packing of molecules, which is due to the strong attractive forces between the chains. Also the polyamide denture base material has relatively higher resilience, defined as the energy that the material could be imparted without any fracture of the material. It could be stated that the PMMA has a brittle behaviour whereas polyamide is more ductile[31].

The result of this study is in agreement with a previously study performed by **Ucer et al** in which flexural strength of polyamide and PMMA was performed and mean value for polyamide was higher than PMMA group [23]. The flexural strength is especially useful in comparing denture base materials in which stress of this type is applied to the denture during mastication (Wiskott 1995). The flexural strength is a combination of compressive, tensile, and shear strengths, all of which directly reflect the stiffness and resistance of material to fracture (Gorbuz 2010).

The most important advantage of polyamide denture base materials is esthetics. A variety of colors is provided by all manufacturers. Especially when a more transparent selection is made, the material reflects the color of the base tissue, either the teeth or

the mucosa. This result provides a more acceptable appearance of the clasps used for retention and the denture material, respectively. Nevertheless, the repair of a polyamide denture is more difficult than repairing PMMA dentures. It is difficult and expensive to fix the dropped teeth or clasps, repair fractures, and reline the denture when polyamide denture material is used. Most of the time, making a new denture is more convenient than repairing a polyamide denture[23].

Limitation of the present study include in-vitro tests may not always reflect intraoral conditions and be predictive of clinical performance. However they are valuable and can be applicable to clinical situations. There was the lack of cyclic loading and thermocycling prior to the three-point flexural test. The effect of thermocycling on the flexural strength of denturebase resins was examined in a prior study. Thermocyled (5000 cycles) samples of Lucitone 199 displayed significantly lower flexural strength compared to samples that were not thermocycled[28]. This is due to the effect water has on the physical properties of processed polymers. Also, the samples tested do not reflect the shape of an actual denture. Clinically, heavy masticatory forces, or a complete denture opposing natural dentition can be potential situation where polyamide may be more suitable than PMMA.

A clinical long-term prospective study should be planned to evaluate if there is a clinical significance between the strength and long-term use of the materials. Further research should be done before clinical use of this material is common. Also further studies are required to determine the minimal required flexural strength for single complete denture opposing to natural dentition.

CONCLUSION:

Within the limitations of this in-vitro study, the following conclusions can be made:-

1. Statistically significant difference found between flexural strength of injection molded polyamide and PMMA group ($p<0.05$) with superior polyamide group.
2. Polyamide group shows the flexural strength value of 77.60Mpa, 104.94 Mpa & 114.32 Mpa at thickness of 1.5mm, 2.0mm & 2.5mm respectively.
3. PMMA group shows the flexural strength value of 62.06 Mpa, 91.23 Mpa, & 103.23 Mpa at thickness of 1.5mm, 2.0mm & 2.5mm respectively.
4. Above groups shows the flexural strength value higher than required in 20795–1 except PMMA at 1.5mm thickness. So, polyamide groups provide high flexural strength value than PMMA groups in same thickness. It is clinically helpful to use polyamide with lower thickness while having adequate flexural strength for better patient acceptance.

Due to limitations of this study, further study is still required to get more accurate long term data.

REFRENCES:

1) Khindria S K, Mittal S, Sukhija U. Evolution of denture base materials – review article. J Prosthet Dent. 2009;9(2):64-9.
2) Jagger DC, Jagger RG, Allen SM, Harrison A: An investigation into the transverse and impact strength of "high strength" denture base acrylic resins. J Oral Rehabil 2002;29:263-7.
3) Price CA: A history of dental polymers. Aust Prosthodont J 1994;8:47-54.
4) Vojdani M, Giti R. Polyamide as a Denture Base Material: A Literature Review. J Dent Shiraz Univ Med Sci. 2015;16(1):1-9.
5) Meng Thomas R. Physical properties of four acrylic denture base resins. J Contemp Dent Pract. 2014;6(4):1–5.
6) Vivek R. Polyamide as a denture base material- a review. IOSR Journal of dental science and medical science 2016; 15(12): 119-21.
7) Marei MK. Reinforcement of denture base resin with glass fillers. J Prosthodont 1999; 8: 18-26.
8) Doğan OM, Bolayir G, Keskin S, Doğan A, Bek B, Boztuğ A. The effect of esthetic fibers on impact resistance of a conventional heat-cured denture base resin. Dent Mater J 2007; 26: 232-239.
9) John J, Gangadhar SA, Shah I. Flexural strength of heat-polymerized polymethyl methacrylate

denture resin reinforced with glass, aramid, or nylon fibers. J Prosthet Dent 2001; 86: 424-427.

10) Vojdani M, Khaledi AAR. Transverse Strength of Reinforced Denture Base Resin with Metal Wire and EGlass Fibers. J Dent Tehran Univ Med Scien 2006; 3: 167-172.
11) Vojdani M, Bagheri R, Khaledi AAR. Effects of aluminium oxide addition on the flexuralstrength, surface hardness, and roughness of heat-polymerized acrylic resin. Journal of Dental Sciences. 2012; 7: 238-244.
12) Munns D. Nylon as a denture base material. D Pract 1962; 18: 142-146.
13) Matthews E, Smith DC. Nylon as a denture base material. Br Dent J 1955; 98: 231–237.
14) MacGregor AR, Graham J, Stafford GD, Huggett R. Recent experiences with denture polymers. J Dent 1984; 12: 146-157.
15) Abhay P. N, Karishma, S. Comparative evaluation of impact and flexural strength of four commercially available flexible denture base materials: an in vitro study. J Indian Prosthodont Soc 2012; 13(4): 499-508.
16) Kubota H. The relation between the position of artificial teeth and the alveolar crest in dentures. Shiwa Gakuho 1959;59:377.
17) Morris JC, Khan Z, von Fraunhofer JA. Palatal shape and the flexural strength of maxillary denture bases. J Prosthet Dent 1985;53:670-3.
18) Beyli MS, von Fraunhofer JA. An analysis of causes of fracture of acrylic resin dentures. J Prosthet Dent 1981;46:238-41.
19) Johnston EP, Nicholls JI, Smith DE. Flexure fatigue of 10 commonly used denture base resins. J Prosthet Dent 1981;46:478-83
20) Proyr WJ. Injection molding of plastics for dentures. 1942.
21) Menon MS, Yunus N, Abdul Razak AA. Some Mechanical Properties of a Highly Cross- Linked, Microwave-Polymerized, Injection-Molded Denture Base Polymer. Int J Prosthodont 2001;14:214-8.
22) Ali IL, Yunus N, Abu-Hassan MI: Hardness, flexural strength, and flexural modulus comparisons of three differently cured denture base systems. J Prosthodont 2008; 17:545- 9.
23) Ucar Y, Akova T, Aysan I. Mechanical Properties of Polyamide Versus Different PMMA Denture Base Materials. J Prosthet Dent 2012;21(3):173–6.
24) Ganzarolli SM, Mello JAN, Shinkai RS, et al: Internal adaptation and some physical properties of methacrylate-based denture base resins polymerized by different techniques. J Biomed Mater Res Part B: App Biomater 2007; 82:169-73.
25) Anderson GC, Schulte JK, Arnold TG: Dimensional stability of injection and conventional processing of denture base acrylic resin. J Prosthet Dent 1988; 60:394-8.
26) Strohaver RA: Comparison of changes in vertical dimension between compression and injection molded complete dentures. J Prosthet Dent 1989;62:716-8.
27) Phoenix RD, Mansueto MA, Ackerman NA, Jones RE. Evaluation of mechanical and thermal properties of commonly used denture base resins. J Prosthodont 2004; 13:17- 27.
28) Raut A, Rao PL, Vikas BVJ, Ravindranath T, Paradkar A, Malakondaiah G. An in vitro study to compare the transverse strength of thermopressed and conventional compression-molded polymethylmethacrylate polymers. Indian J Dent Res2013;24(3);356-62.
29) Kurkcuoglu I, Koroglu A, Emre S, Ozdemir T. A comparative study of polyamide and PMMA denture base biomaterials: thermal, mechanical, and dynamic mechanical properties. Int J Polym Mater 2011;61:768-77.
30) Soygun K, Bolayir G, Boztug A. Mechanical and thermal properties of polyamide versus reinforced PMMA denture base materials. J Adv Prosthodont 2013;5(2):153-60.
31) Takahashi Y, Hamanaka I, Shimizu H. Effect of thermal shock on mechanical properties of injection-molded thermoplastic denture base resins. Acta Odontol Scand2011;70(4):297–302.

How To Cite This Article:

Dipali L Mungra, Vishal R. Chauhan, Vilas V. Patel, Sareen S. Duseja, Mustafa, F. Laxmidhar, Bhakti A. Patel *Evaluate And Compare Flexural Strength Of Polyamide (Rigident) And Polymethamethacrylate (SR-Ivocap) Materials Using Injection Molding Technique In Different Thicknesses.* Br J Pharm Med Res, Vol.07, Issue 05, Pg. 4016 - 4030, September - October 2022. ISSN:2456-9836 Cross Ref DOI : https://doi.org/10.24942/bjpmr.2022.1017

Source of Support: Nil **Conflict of Interest:** None declared