Evaluation of impact strength of heat cure and chemical cure acrylic resin denture base material

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Background and Objective: Thermal and self-curing acrylic resins are widely used in dentistry because they are biocompatible, have no flavour or odour, have good thermal properties and polishing capacity, and are simple and quick to apply. As a result of its widespread use, fracture-resistant behaviour is particularly significant. We investigated the fracture resistance capabilities of thermal and self-curing acrylic resins in vitro in this study. The aim was to compare the impact strength between hot cure acrylic and cold cure acrylic.

Method: 16 prosthetic specimens were made for each of the heat-cured and coldcured acrylic resins which were stroked and tested with a Charpy type digital impact tester (Electric Charpy impact tester) were used, and two joules of power were struck to get the fracture.

Result: Although the difference was not statistically significant, during evaluation on average thermosetting resins were more resistant to fracture than self-curable resins.

Conclusion: The outcome of this study concluded that the Heat-cured acrylic resins were, on average, more resistant to fracture than cold-cure acrylic resins, although the difference was not statistically significant.

Keywords: Acrylic resin, Impact strength, Self-curing, Thermosetting

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Introduction

Although dental implants are becoming more common in the treatment of edentulous people, for medical and budgetary reasons, a traditional complete denture is still the treatment of choice in many circumstances. In addition to biocompatibility and aesthetics, an ideal denture base material should have acceptable mechanical and physical qualities. Acrylic resin is commonly used to make denture bases because of its many benefits, including low cost, biocompatibility, ease of production, oral stability, and acceptable aesthetics.[1] Acrylic resins are widely utilized in dentistry, including complete dentures, repairs, relines, orthodontic appliances, maxillofacial prostheses, interim restorations, and even prosthodontic implant rehabilitation. This is conceivable since they are biocompatible, tasteless, and odourless, has adequate thermal properties, can be polished, and are simple and quick to repair.[2] Hot and cold cured acrylic resins are the most popular forms of acrylic resin materials used to create and repair denture bases around the world.[3] When subjected to specific temperatures, thermosetting acrylic resins harden permanently, becoming more resistant and dimensionally stable, and not reacting to future re-heating.[4]

One of the mechanical properties of acrylic resin denture base materials is impact strength; it is a measure of energy absorbed by a material when it is broken by a sudden blow. Ideally denture resins should have high impact strength to prevent breakage when accidentally dropped. Unmodified acrylic resins are generally brittle. Plasticizers increase the impact strength. However, 9 the significant improvement in impact strength is observed when the resin is modified with rubber .[5]

Method

The study consists of two groups. The total specimens were 32 specimens; each group was composed of 16 specimens distributed according to the materials that were fabricated (16 samples of hot cure acrylic and 16 samples of cold-cure acrylic). The materials used in this study are listed in the table below. For the preparation of heat-cured and cold-cured samples, a fabricated metal pattern was used to prepare the plaster moulds from which the acrylic samples were prepared. Bar-shaped metal patterns measured 80mm X 10mm X 4mm, length, width, and thickness respectively.[6] The specimens for heat-cured acrylic resin were fabricated using conventional compression moulding technique, the dental plaster was mixed according to manufacturer instruction and the lower half of the flask was filled with dental plaster on the vibrator to eliminate the air bubbles, the metal bar that coated with separating medium placed in the plaster. After the plaster was set, it was coated with a thin layer of separating medium and left to dry, and then the upper half of the flask was positioned on top of the lower half and filled with plaster, again on the vibrator to eliminate trapped air. Plaster was allowed to set before opening the flask.[7]

Once the dental plaster was set the two halves of the flask were separated from each other and the metal bar was removed carefully. The lower and upper half of the flask and plaster were coated with a separating medium and allowed to dry, the powder and liquid of heat-cure acrylic were mixed according to manufacturer instruction till it reached to dough stage, the heat acrylic resin dough was rolled, and placed in the mould space, the flask then closed and placed under mechanical bench hydraulic press with gradual application pressure till the press reached to (950 bars). Then the press was relieved and the flask was placed in hot water at the temperature of (100°C) for 40 minutes, after complete polymerization the flask was removed from the hot water and allowed to cool down by itself, then the heat acrylic specimens removed from the flask and the excess materials removed then one side of the specimens finished and polished to mimic the dentures fabricated to the patients (Figure 1) .[7] The Steps of specimen preparation for Cold-cured acrylic resin were the same as for Heat-cured acrylic resin, except that the specimens were not placed under pressure and hot water. Instead of these, after the mixing of powder and liquid according to manufacturer instructions the dough like acrylic resin is placed in the mould and then the upper half of the flask is placed on the lower half and allowed to set at room temperature, then after complete set, the cold cure acrylic resin removed carefully and one side of them polished.[6]

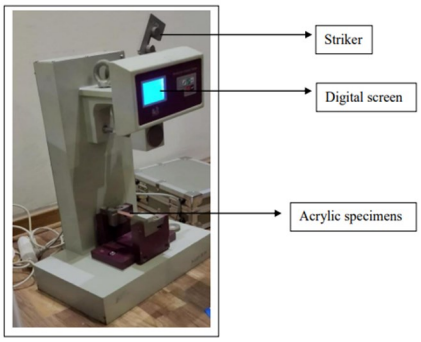
Table 1: Materials used in this study

No.	Material	Trade name	Manufacturer	Specification
1.	Heat-cured acrylic resin	Veracril	New Stetic S.A, Guame, Antiquia-Colombia	Expire date of Polymer: 2023-11 Monomer: 2022-11
2.	Cold-cured acrylic resin	Veracril	New Stetic S.A, Guame, Antiquia-Colombia	Expire date of Polymer: 2023-2 Monomer: 2022-11

Figure 1: Steps of heat-cured acrylic sample preparation, A. flasking. B. removing of the metal frame. C. deflaxing.

After preparation, the samples were conditioned in distilled water at 37°C for two days before the test by using an incubator and then subjected to testing to evaluate the impact strength of them.[8] To evaluate the impact strength of the samples Charpy type digital impact tester (Electric Charpy impact tester) was used, the striker had an energy range of 0.5.1, 2, 4, and 5 joules, and a striker of two joules testing capacity was used (figure 2). The samples were placed in the center and in an edgewise direction in which the direction of the striker was parallel to the width of the sample (figure 3), and then the striker released to break the sample, the absorbed energy to break the sample exposed at the screen and recorded.[6] The energy absorbed by the specimens during the impact was expressed in Joules and the Charpy impact strength of unnotched specimens was calculated in KJ/m² using the following formula: Impact strength = (E /b. d) X 103 Where E: is the energy absorbed to break the specimen. b: is the width of the specimen in millimetres. d: is the thickness of the specimens in millimetre.[6]

In



this study, we evaluated 32 samples, 16 specimens from cold-cured and 16 from hot-cured acrylic resin. The impact strength of the specimens was determined by the Digital Charpy Pendulum Type Impact tester. All the specimens of hot and cold cured resin fractured due to the sudden impact force delivered by the pendulum during the study. During the evaluation, among the hot cured acrylic resin samples the minimum impact strength that was observed was (5.9 KJ/m2) and the maximum impact strength was (28.3 KJ/m2), while among the auto polymerizing acrylic resin samples the minimum impact strength was (4.47 KJ/m2) and maximum strength that observed was (19.8 KJ/m2). The mean values of the impact strength test for each group are summarized in Figure 4. The T-test was used to determine the P-value between the two tested groups, and the P-value (0.1) showed that there is no significant difference between thermo-polymerized and autopolymerized acrylic resin.

Figure 2: Parts of Digital type Charpy impact tester

Result

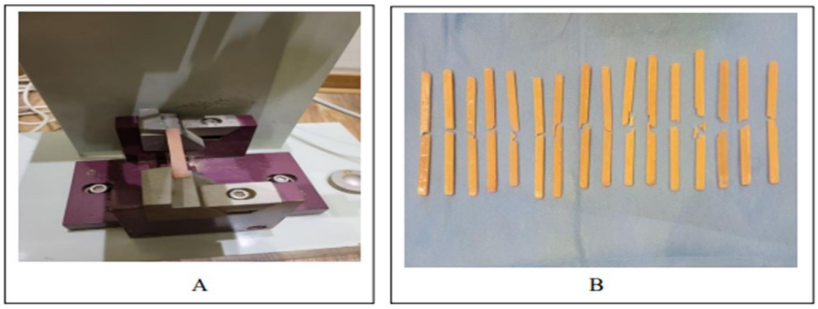


Figure 3: Sample placement and broken pieces A, sample placed in the center and edgewise direction. B, broken specimens

Discussion

In dentistry, the great of products provided to sufferers have a necessary effect on the affected person exceptional of life. For acrylic resins, fracture resistance is an important theme because of the extended expenses worried in the repair of acrylic prostheses (Bahrani et al, 2012). The prostheses may also fracture due to fatigue caused with the aid of prolonged wear and degradation of the cloth or by the excessive masticatory load, passing the plastic segment of the material. Therefore, understanding the medical overall performance of the two most commonly used acrylic resins (Hot-cure and Cold-cure acrylic resin) with regard to fracture conduct can indicate how to keep away from fractures, avoiding probably needless expenses and improve the quality of life of patients (Bahrani et al, 2012). In this study, we aimed to comparatively analyse the fracture resistance capacity of thermal and self-curing acrylic resins. From the main results of the study, we did no longer discover statistically big variations between them. The outcomes refute our hypothesis that there are significant variations in fracture resistance between the thermo and self-curing acrylic resins. The literature shows that self-curing resins tend to be much less resistant to fracture due to the fact of the larger quantity of residual monomer they tend to generate (Tuna et al, 2013). Even though the results of this study did not show substantial variations in the fracture resistance values of self-and thermosetting acrylic resins, some tendency towards a lower propensity for fracture in thermosetting acrylic used to be found, which consents with the literature. Noting that certain factors are not replicated in this study, such as the effect of saliva PH (lower PH decreases fracture resistance) and various types of masticatory forces and directions. It is moreover essential to think that the manufacturers have a tendency to enhance their products, which can also moreover affect the result obtained The occlusion strength in the centric position of patients with complete dentures is variable-in accordance with a latest study, between 6 kgf and 8 kgf on average (Uzun and Hersek, 2002) and (Gurbuz et al, 2012). These two types of acrylic resin evaluated are nicely above the restrictions for human occlusion strength. This is a finding to think about when choosing an acrylic resin for the advent of prostheses, a consideration which may additionally be in addition developed in future investigations in a real-world context. The results are in line with the study of (Silva et al, 2021) on the subject, but with a few substantial variations to report. The fracture resistance behaviours of the acrylic resins discussed 24 here are essential to look at extra deeply in the future. Furthermore, it is important to think about the introduction of strengthening modifications in the shape of acrylic resins via the use of, for example, co-polymers and binding marketers (Gupta and Tewari, 2016) and (Jacob et al, 2001), as well as to reflect on consideration on the development of new processing and activation techniques for the identical reason (Altintas et al, 2008).

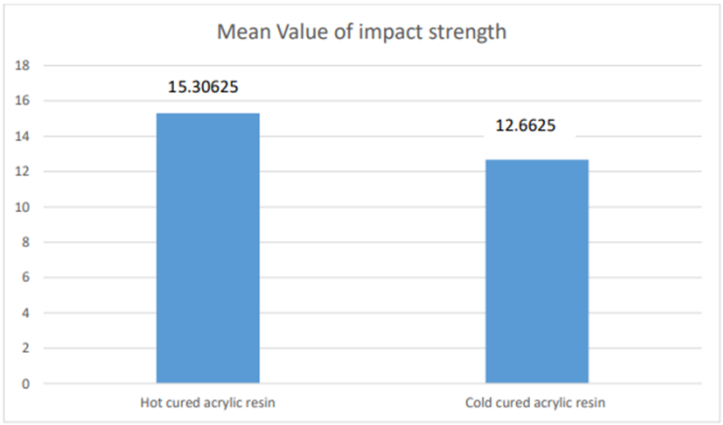


Figure 4: Mean values of impact strength test of hot and cold cured acrylic resin.

Conclusion

The outcome of this study concluded that the Heat-cured acrylic resins were, on average, more resistant to fracture than cold-cure acrylic resins, although the difference was not statistically significant. The conduct and resistance of the resins evidenced inside the look at had been properly above the reference restriction for the common human mastication force

Conflict of interest

The author reported no conflict of interests.

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