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Comparative evaluation to check compressive strength of different restorative resins at different temperatures - An Invitro Study

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Abstract

Introduction: Chairside pre heating of composite prior to placement and curing has been advocated recently for its beneficial effect on physical and mechanical properties.

Aim- to compare the compressive strength of 3 different brands of composite resin material at three different temperatures i.e., room temperature, 40 deg, 50 deg under non- isothermal conditions using universal testing machine.

Materials and method: using matrix band, 45 cylindrical molds were prepared [4mm high, 6mm diameter]. Composite specimens were prepared with the help of mold and cured from both ends at room temperature and at 40 deg , 50 deg. Specimens were then loaded in UTM machine & readings were recorded.

Data were statistically analyzed.

Result: Increase in compressive strength was seen at 40 deg compared to 50 deg and room temperature. Slight reduction of compressive strength was seen at 50 deg compared to room temperature and 40 deg. Though on statistical analysis results were not found to be statistically significant.

Conclusion: Though the increase in compressive strength was not statistically significant. Loss of reduction in viscosity in composite helps in better manipulation and its adaptation.

Keywords: Composite pre- heating, Composite resins

Introduction

The use of composite resin as a substitute for amalgam restoration is gaining popularity due to an increase in esthetic demands of patients and environmental concerns of disposing mercury released from amalgam restoration.

There are other problems with the current methods for placing composite into the cavity preparation. The high viscosity and stickiness of highly filled composite makes insertion, as well as adaptation, of the material to preparation walls difficult and unpredictable[1] . Also, the extent of resin polymerization under room temperature [RT] condition yields polymers of relatively low monomer conversions[1].

Hence, the supreme aim of using composite resin as an ideal restorative material can be defined as being highly esthetic, long lasting, trouble free placement and easy for curing. Hence, this leads to rise in concerns about handling, packing and adaptation of the composite.

Many attempts were made to enhance the adaptation, decrease microleakage, improve its mechanical properties by incorporating flowable composite, fiber inserts or chemical and laser treatments of dentin[3] .

Chairside warming of composite resin before photopolymerization is one of the recent trends in their application[3] .

The concept came into existence with the early research dating back into 1980s though it is still debatable regarding composite heating methods and it's benefits for restoration. As Preheating reduces viscosity and increases flowability, which facilitates better adaptation to cavity walls. This reduces microleakage and thus the durability of the restoration and results in superior marginal adaptation[3,5] . The increase in temperature of composite enhances both radical and monomer mobility, resulting in high degree of monomer conversion as well as improvement of polymerization rate[3,9] . Therefore, this resulted in more highly cross linked polymer networking and improved mechanical and physical properties may be anticipated.

Flow of commercial hybrid composite is also a positive outcome of preheating. Nonetheless, the extent of flow varies among brands and various classifications. There is time lapse between dispensing composite from syringe and placing into the cavity preparation, contouring and finally curing it. Hence, it is of prime importance to evaluate the effect of pre- heating under non isothermal condition replicating clinical scenario.

Deb et al reported that some composite showed significantly higher flexural strength with pre- heating [3,5].

Two other studies found no significant difference in flexural strength between heated and non heated composite[2,3,8] . As yet, it seems that no clearly available data evaluates the effect of pre- heating on compressive strength of resin composites. Therefore, this study was done keeping two parameters i.e, non- isothermal condition and compressive strength of composite.

Hence, the aim of the study was to evaluate the effect of pre - warming of composites at different temperatures on its compressive strength. Thus, the effect of pre-warming of different types of composites at room temperature [37 ℃] , 40℃ and at 50 ℃ on its compressive strength.

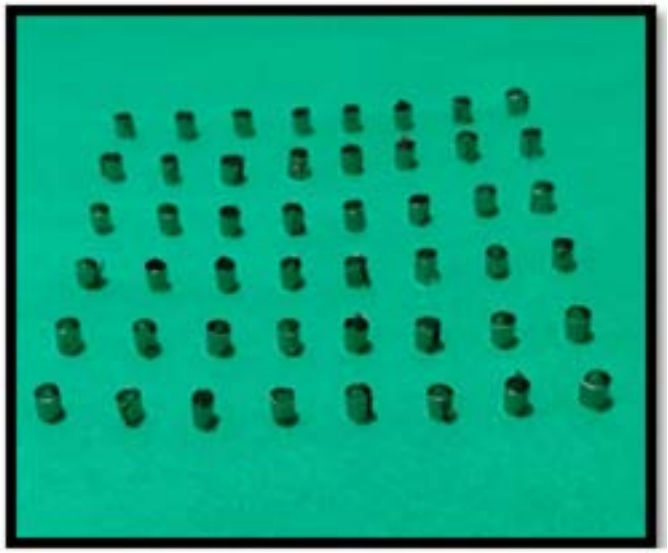


Figure 1

Figure 2

Figure 3

Figure 4

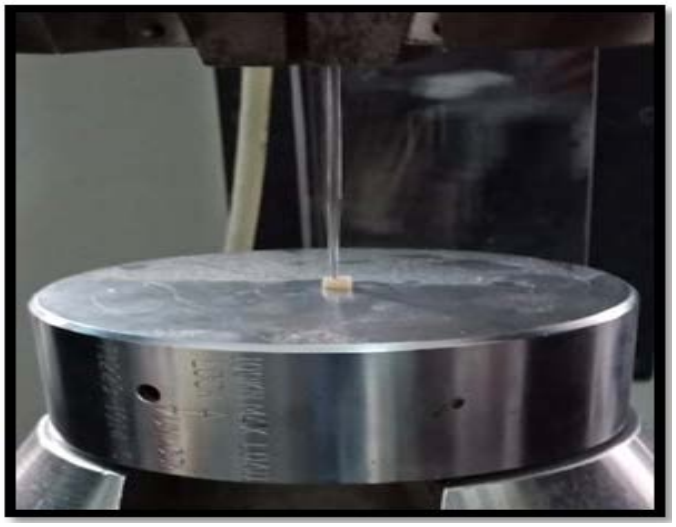


Figure 5

Figure 6

Materials and methods

Three restorative composites were evaluated in this investigation namely,

1 3M Z350XT.

2 GC Solare Sculpt.

3 Ivoclar Tetric N Ceram.

Each composite specimen was prepared at three different temperatures i.e., at room temperature [37 ℃],at 40 ℃

and 50 ℃. Using stainless steel matrix bands, cylindrical molds were prepared [4mm high 3mm diameter] [fig 1].

45 composite specimens were prepared from each composite at room temperature [37 ℃],at 40 ℃ and 50 ℃ [fig 3 and 4].

Composite warmer was used to preheat the composite prior to photo polymerization [fig 2]. Specimens were light polymerized from both ends for 30 s and then loaded in universal testing machine at 0.5mm/min until failure [fig 5].Compressive strength values was then calculated by applying the formula i.e.,

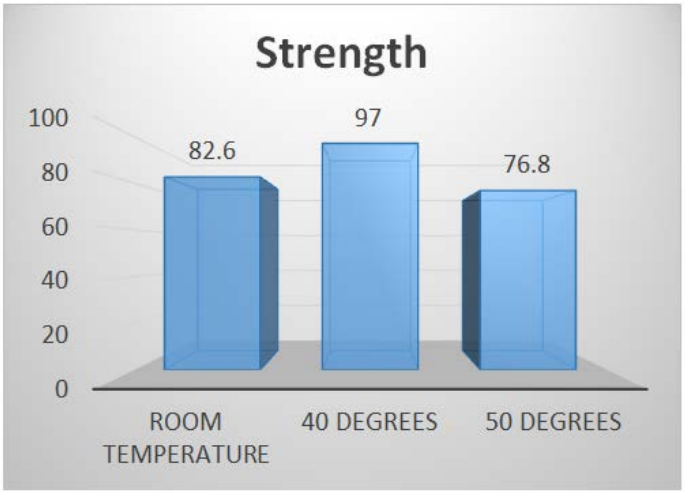
Compressive strength = 4 force [in newton] / 3.14 4D [in mm].

Material	Room temperature [number of specimen] Control group [n=15]	At 40 ℃ [number of specimen]	At 50 ℃ [number of specimen]
3m filtek universal z350 xt	5	5	5
Gc solare sculpt	5	5	5
Ivoclar teric n- cream	5	5	5

Result

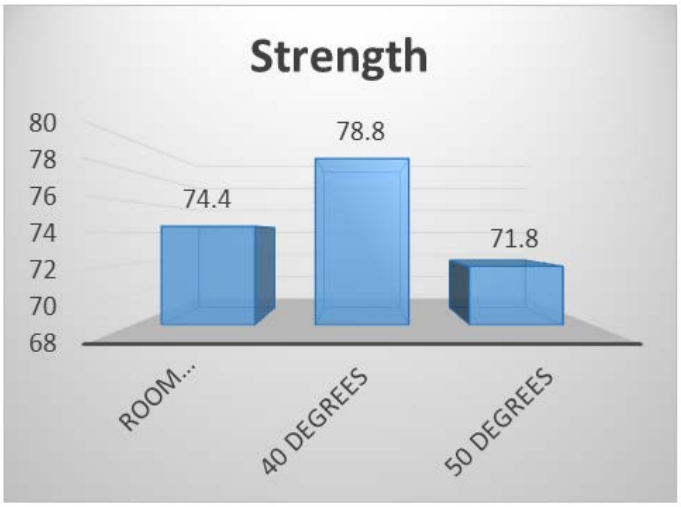
Comparison of Temperature

3m



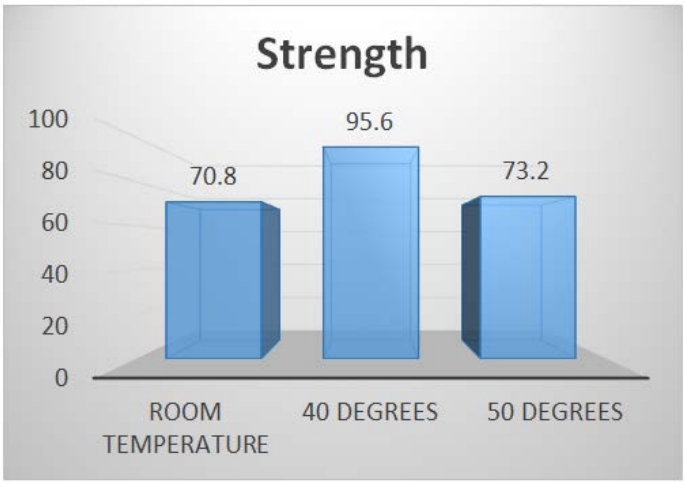
Comparison of Strength between the three groups shows that 40 degrees group has the highest value of 97 and 50 degrees has the least value of 76.8.

Gc solar sculpt



Comparison of Strength between the three groups shows that 40 degrees group has the highest value of 78.8 and 50 degrees has the least value of 71.8.

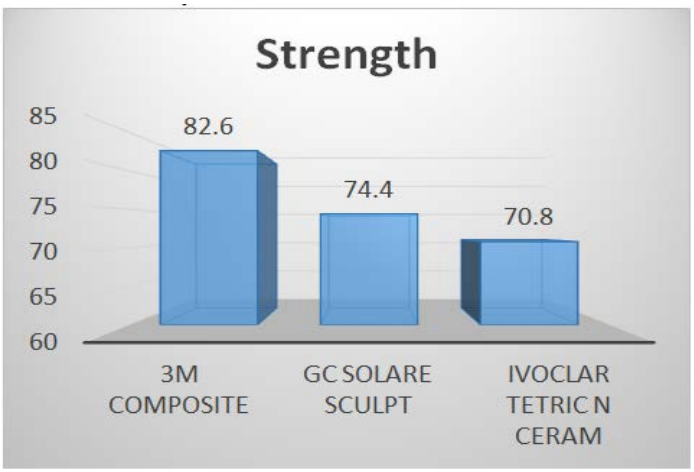
Ivoclar



Comparison of Strength between the three groups shows that 40 degrees group has the highest value of 95.6 and Room temperature has the least value of 70.8.

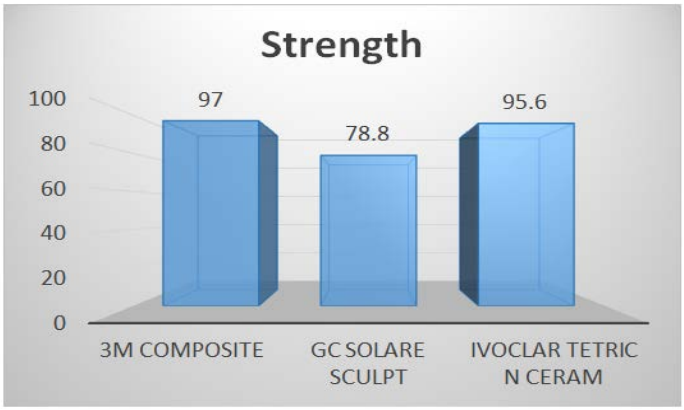
Comparison of composite in each temperature

At room temperature



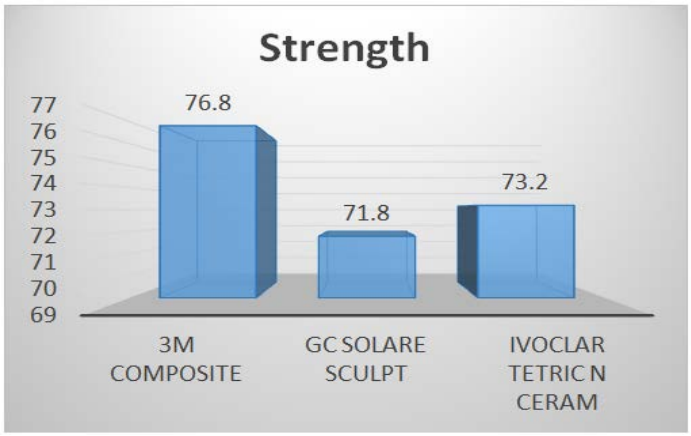
Comparison Of Strength Between The Three Groups Shows That 3M Composite Group Has The Highest Value Of 82.6 And GC Solare Sculpt Has The Least Value Of 74.4

At 40 degrees

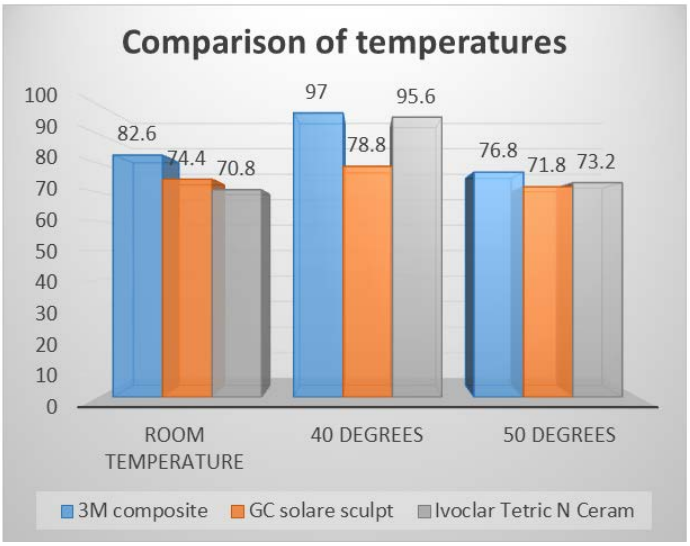


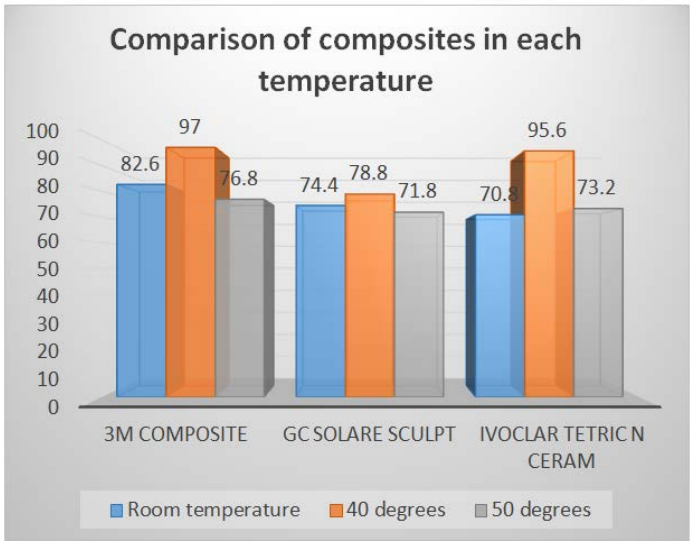
Comparison Of Strength Between The Three Groups Shows That 3M Composite Group Has The Highest Value Of 97 And GC Solare Sculpt Has The Least Value Of 78.8

At 50 degrees



Comparison Of Strength Between The Three Groups Shows That 3M Composite Group Has The Highest Value Of 76.8 And GC Solare Sculpt Has The Least Value Of 71.8





- The Compressive Strength Was Improved At 40 ℃ Though It Is Not Statistically Significant.
- 3M composites showed better results in all groups comparatively.

Discussion

Three different brands of composite materials were evaluated at three different temperatures. The choice of material was based on the4 fact that it is widely used as a core material. Additionally, it will support the concept of pre- heating and provide useful information to clinicians.

In this study different brands of composite showed slight different responses, the compressive strength was improved at 40 ℃ though it is not statistically significant. Among all the brands 3M Z350 XT composites showed better results in all groups comparatively. As per the literature suggests, the improvement in the compressive strength may be due to different filler content that caused the material to behave differently when pre- heated. The positive outcomes of composites when pre – heated also depends on the rate of cooling after removing it from the warming device and on handling time before curing. A previous study reported a 50% temperature drop within 2 minutes of removing composite compules from all the three heating devices being tested[1,3] .

Under non- isothermal conditions, the composite can be pre- warmed, to gain benefits such as increased flow and easier adaptation to the cavity.

It also depends on composite brand and type as the current study showed.

In clinical use a standard composite can be pre – warmed to achieve better flow and composite can be placed into a cavity and packed and contoured well. This could be attributed to the reduction in the composite viscosity and better adaptation to the cavity, especially in line angles and point angles. This is important clinical finding, as perfect sealing is essential to improve restoration longevity and to prevent post - operative sensitivity.

Nicholis et al reported the increase in temperature of composite resin with a warmer increased the flow of composites upto 68%. When composites become more flowable , the composite may have better adaptation to the tooth structure which may decrease microleakage. Because composite resin is a viscoelastic material. It may exhibit decrased viscosity and flowability with an increase in temperature[4,10] .

Conclusion

Within limits of this study, it can be concluded that,

1. Pre polymerization warming of composites showed enhanced compressive strength at 40 ℃ though it is not statistically significant.
2. Different composite brands behave differently with heat treatment resulting in enhanced properties.
3. Pre- warming increase flowability and reduces viscosity which facilitates color stability, better handling and adaptation of material to the cavity walls.

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