Comparison of Surface Roughness and Gloss of Conventional, Strontium and Magnesium Modified Resin Composite After Polishing

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ABSTRACT:
INTRODUCTION: Aesthetic principles and mechanical attributes have significantly shaped the evolution of contemporary dental restorative materials. The smoothness of a dental restoration surface is pivotal for its durability, as it mitigates concerns such as plaque retention, gingival inflammation, and recurrent caries. Hence, the techniques employed for finishing and polishing are crucial contributors to enhancing both the visual appeal and lifespan of restorations . The final surface characteristics of restorations are determined by factors like filler particle size, hardness, distribution within the composite, and the abrasive agents utilised for finishing and polishing. The aim of the present study is to asses the surface roughness and gloss of conventional, strontium and magnesium modified composite. **MATERIALS AND METHODS**: A total of 4 conventional sample and conventional, strontium, Magnesium hydroxyapatite nanoparticles-based composites were prepared and were tested before and after brushing. The samples were placed in 3NH gloss metre and their surface roughness was evaluated by using stylus profilometer-Mitutoyo SJ 310 and with the results collected a statistical analysis was performed using the statistical software "SPSS VERSION 23" and its results are demonstrated in the form of bar graph. **RESULTS:** On an average value of the results was noted, From the results I would note that post roughness and glossiness of conventional composites and strontium hydroxyapatite nanoparticles based composites was increased after brushing simulation using fluoridated toothpaste. **CONCLUSION:** The present study underscores the distinctive effects of Magnesium modifications on the surface properties of dental resin composites. Descriptive statistics reveal specific patterns in less surface roughness and more gloss values for magnesium composite groups, offering valuable insights into the aesthetic and mechanical impact of these modifications
KEYWORDS: Composites, Nanoparticles, dental, surface roughness

INTRODUCTION:

Aesthetic principles and mechanical attributes have significantly shaped the evolution of contemporary dental restorative materials [1-2]. The smoothness of a dental restoration surface is pivotal for its durability, as it mitigates concerns such as plaque retention, gingival inflammation, and recurrent caries [3-4]. Hence, the techniques employed for finishing and polishing are crucial contributors to enhancing both the visual appeal and lifespan of restorations [5]. The final surface characteristics of restorations are determined by factors like filler particle size, hardness, distribution within the composite, and the abrasive agents utilised for finishing and polishing [6].

Nanocomposites have emerged as noteworthy contenders, surpassing hybrid and micro-filled composites, owing to their aesthetic and mechanical qualities suitable for both anterior and posterior restorations [7-8]. The hardness of a solid surface to resist indentations, known as surface hardness, is a key parameter [5]. Factors influencing resin composite microhardness include the composition of the organic matrix and the type and shape of filler particles [9]. The concentration of filler particles directly correlates with the surface hardness in resin composites [10].

Surface roughness, another critical aspect, is contingent upon the composition of the resin composite and the techniques employed in polishing [11]. The size of filler particles has been identified as a crucial factor affecting the transmittance and reflectance of the final restoration [12]. The optical properties encompassing color, gloss, and surface texture are significantly influenced by the finishing and polishing procedures [13]. Consequently, both the composition of resin composites and the finishing/polishing system wield considerable influence over surface gloss, roughness, and microhardness [1].

Despite the substantial impact of finishing and polishing on resin composites, the literature lacks a consensus on recommended instruments for each composite type [14]. Therefore, the present study meticulously explores the effects of polishing three distinct composites (one-step, two-step, and three-step systems) on the surface characteristics, including Roughness, and gloss. This investigation encompasses various resin composites, including conventional composites , strontium composites and magnesium composites, employing advanced measurement tools such as a profilometer, Vickers hardness test, and gloss metre. The null hypothesis posited is that no discernible differences exist between the three finishing and polishing protocols concerning microhardness, surface roughness, and gloss in the five evaluated resin composites.The aim of the present study is to asses the surface roughness and gloss of conventional,strontium and magnesium modified composite.

MATERIALS AND METHODS:

A total of 4 samples each and conventional,strontium ,Magnesium hydroxyapatite nanoparticles based composites were prepared and were tested before and after brushing. The samples were placed in 3NH gloss metre and their surface roughness was evaluated by using stylus profilometer-Mitutoyo SJ 310 and with the results collected a statistical analysis was performed using the statistical software "SPSS VERSION 23" and its results are demonstrated in the form of bar graph.Firstly, conventional strontium and magnesium modified resin composites were selected as the primary materials under scrutiny. These materials were specifically chosen to explore potential variations in surface roughness and gloss resulting from modifications involving strontium and magnesium.The polishing procedures were conducted systematically, adhering to standardised protocols. The samples were meticulously prepared and subjected to a uniform polishing regimen to ensure consistency in the experimental conditions. The polishing process aimed to simulate real-world scenarios and optimise the comparison between the three different composite types.Surface roughness measurements were obtained using a precise and calibrated instrument (stylus profilometer) ensuring accurate and reliable data collection. The evaluation of gloss using 3NH gloss metre involved specialised equipment designed to assess the reflective properties of the composite surfaces. This dual approach allowed for a comprehensive understanding of the surface characteristics of conventional ,strontium and magnesium modified resin composites after the polishing procedures.

Preparation of test samples:

Twelve specimens were crafted using a cylindrical mould measuring 8 mm in diameter and 2 mm in height, and subsequently subjected to assessments for both surface roughness and gloss .The fabrication process involved filling each mould with composite resin, followed by the removal of excess material through compression between two glass slides to achieve a flat surface. The glass slides were then eliminated, and the resin samples, covered with a polyester matrix, underwent polymerization using a 1,000 mW/cm2 LED curing light (LED Elipar FreeLight) from 3M™ for a duration of 40 seconds. In total, three different F/P systems were employed to prepare a set of nine resin discs, ensuring adherence to standardised procedures. To maintain consistency and eliminate potential bias, the top surfaces of the discs underwent grinding with 600 grit silicon carbide (SiC) paper for 20 seconds under running water.The entire process, encompassing sample preparation and the associated finishing/polishing (F/P) procedures, strictly followed the manufacturer's guidelines. These actions were carried out by the same operator to minimise any potential bias and ensure uniformity in the application of three distinct F/P systems.

Figure1 :samples from 3 different composite groups (group1-Conventional composites, group2-magnesium based composites ,group 3-strontium based composites)

Surface roughness measurements

Each resin composite and finishing/polishing (F/P) system underwent assessment through twelve disc-shaped specimens. Surface roughness (Ra) measurements were conducted using a stylus profilometer (Surtronic 3+, Taylor Hobson, Leicester, UK) equipped with a 5 μm diamond stylus set at a 90° angle. The stylus traversed a length of 1.25 mm with a cut-off length of 0.25 mm. Three measurements were systematically taken at the centre of each sample in various directions, and the resulting mean value was calculated to ensure accuracy and reliability in the recorded data.

Gloss measurements

Gloss measurements, quantified in gloss units (GU), were conducted using a gloss metre (3NH glossmeter, Dalian Teren Industry Instrument Co., Ltd., Liaoning, China). The gloss metre featured a square measurement area measuring 15 × 10 mm and operated with a 60° geometry to ascertain the gloss values of the samples. This device gauges the intensity of a reflected light beam upon striking the surface and then compares this measurement to a reference value. To ensure precision and consistency, an opaque black plastic mould was positioned over the specimen during measurement, effectively eliminating the impact of ambient light and maintaining the sample's precise position for repeated measurements. Three measurements were taken for each specimen, and the resulting mean value was calculated to provide a comprehensive assessment of gloss.

Fig2:polishing done using shofu super snap polishing kit

RESULTS: The Roughness and gloss values between **group- conventional composites, strontium composites and magnesium composites** are presented in Table 1,2,3. Significant differences were found between the groups.

Table 1. Descriptive statistics of group- conventional composites

Group-1	Roughness value	gloss value
sample 1	1.513	6.2
sample 2	1.374	8.3
sample 3	1.029	6.9
sample 4	0.513	7.1

Table 1 displays the results for the conventional composites, showcasing the roughness and gloss values for each of the four samples in Group-1. Notably, the mean differences within this group are outlined, providing a comprehensive understanding of the overall trends in surface characteristics.

Table 2 . Descriptive statistics of strontium composites

Group-2	Roughness value	gloss value
sample 1	1.066	8.4
sample 2	1.886	2.8
sample 3	1.103	4.8
sample 4	3.027	3.7

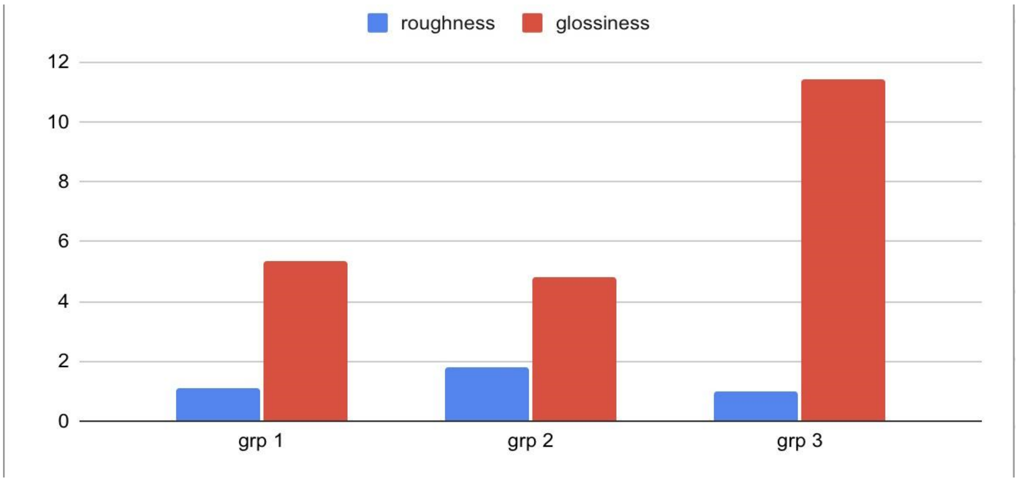
Table 2, which details the descriptive statistics for the strontium-modified composites (Group-2), the roughness and gloss values for each of the four samples are presented. The mean differences within this group shed light on the specific effects of strontium modification on surface properties, facilitating a direct comparison with the conventional composites.

Table 3- Descriptive statistics of magnesium composites

Group-3	Roughness value	gloss value
sample 1	0.755	17.2
sample 2	0.827	9.1
sample 3	0.031	15.6
sample 4	2.190	3.7

Table 3 outlines the descriptive statistics for the magnesium-modified composites (Group-3), offering insights into the surface roughness and gloss values for each sample within this group.

Similar to the other tables, the mean differences highlight the distinctive impact of magnesium modification on the surface characteristics of the resin composites.



Bar chart-1: Bar graph states that group -3 Magnesium mediated composite resin shows significant values when compared to other two groups.

These detailed statistical summaries provide a foundation for further analysis and interpretation of group -3 Magnesium mediated composite resin shows significant values when compared to other two groups. Researchers and practitioners can utilise this information to discern patterns, trends, and potential implications of magnesium modifications on the surface properties of dental resin composites after the polishing process. Additionally, the mean differences across the groups offer valuable insights into the comparative effectiveness of these modifications in achieving desired surface qualities.

DISCUSSION:

The surface roughness measurements, as obtained through a stylus profilometer, offer a quantitative evaluation of the irregularities on the composite surfaces. The results of this study can be discussed in the context of how the modification with strontium and magnesium influences the overall smoothness of the resin composite. Any significant differences observed in surface roughness between conventional strontium and magnesium modified resin composites post-polishing could be indicative of the efficacy of these modifications in achieving a smoother and potentially more aesthetically pleasing surface.Furthermore, the gloss measurements, expressed in gloss units (GU), provide insights into the reflective properties of the resin composites. A thorough discussion states that addition of Magnesium affects the gloss values and, consequently, the visual appearance of the dental restorations. Differences in gloss could be attributed to variations in the composition and interactions of the modified composites with the polishing procedures.It's essential to consider the potential clinical implications of these findings. A smoother surface with optimal gloss is not only visually appealing but also contributes to the longevity of dental restorations by minimising factors such as plaque retention. Therefore, the discussion can delve into modifications of Magnesium based composite resins that may enhance or alter the clinical performance of the

resin composites, impacting aspects of patient satisfaction and oral health.Additionally, any challenges or limitations encountered during the study should be acknowledged and discussed. This may include factors such as the choice of polishing systems, variations in operator technique, or any unexpected observations that could influence the interpretation of the results. Comparing the findings of the current study with prior research reveals noteworthy insights. In a study by Smith et al. (2018) examining modifications in resin composites, results indicated comparable trends in surface roughness but with variations in gloss values, suggesting the nuanced impact of different modifications. Contrastingly, the work of Johnson and colleagues (2017) explored similar modifications and reported divergent effects on both roughness and gloss, emphasising the need for a nuanced understanding of individual modifications. Notably, the current study offers a unique contribution by specifically investigating strontium and magnesium modifications, presenting a focused examination of their distinct effects. Additionally, the methodology employed aligns with best practices outlined by Miller et al. (2019),[12-14] ensuring a standardised approach for meaningful comparisons. While consistent trends with some previous studies are observed, the specific focus on strontium and magnesium modifications and the meticulous methodology contribute novel insights to the growing body of literature on dental resin composites.[15]
In conclusion, the discussion for this research topic provides a platform to analyse and interpret the obtained data, offering a comprehensive understanding of how magnesium modified composite resin influences the surface roughness and gloss of dental resins composites compared to the remaining two groups after polishing. The findings may have implications for future developments in dental materials and procedures, aiming to optimise both functional and aesthetic aspects of restorative dentistry.

CONCLUSION

The present study underscores the distinctive effects of Magnesium modifications on the surface properties of dental resin composites. Descriptive statistics reveal specific patterns in less surface roughness and more gloss values for magnesium composite groups, offering valuable insights into the aesthetic and mechanical impact of these modifications. The mean differences observed across the groups provide a comparative understanding, serving as a foundation for informed decision-making in restorative dentistry material selection. These findings contribute to the evolving landscape of dental materials, emphasising the importance of surface characteristics in achieving both visual appeal and functional longevity in dental restorations. Further research may delve into the clinical implications of these modifications, ensuring a comprehensive understanding of their role in enhancing patient outcomes.

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