Assessment of Surface Roughness of Dental Amalgam Following Polishing at Different Time Points

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**Abstract: Background:** Unpolished amalgam restorations can lead to uneven and rough surfaces therefore conductive to plaque accumulation. Finishing and polishing of amalgam restoration is an essential component in various successful clinical restorations. Amalgam restorations may not be performed due to additional visits required by the patient. And also certain polishing methods generate heat onto the tooth structure which may or may not affect the dental pulp which plays a major role in tooth vitality. **Aim:** The aim of this study is to assess the surface roughness of amalgam restoration after finishing and polishing at different time points. **Method:** The Surftest SJ-310 is used which is compact, portable, easy-to-use surface roughness measurement instrument equipped with extensive measurement and analysis features. **Results:** The average value of roughness for 1 hour duration is 0.4752 and for 24 hour duration the average roughness value is obtained as 1.362 which was done under Surftest SJ-310 . **Conclusion:** Therefore by comparing the mean average values for both 1 hour and 24 hour durations, polishing after 1 hour shows better significance since it has better mean average value compared to the polishing done after 24 hours.

**Keywords:** Surface roughness, dental amalgam, finishing and polishing

# Introduction

Dental amalgam is considered to be one of the oldest ways of doing dental restorative treatments in dental practice for more than 150 years in dental history[(Soler et al., 2002)](https://paperpile.com/c/lir9YV/BzAJz)[(Aparna et al., 2021; Poornima et al., 2021a; Verma & Muthuswamy Pandian, 2021)](https://paperpile.com/c/lir9YV/b61QL+PVp7Q+O0c13). The practice by using dental amalgam accounts for 75-80% of all restorative materials which have been practiced in dentistry[(Bharti et al., 2010)](https://paperpile.com/c/lir9YV/9lTPJ)[(Ganapathy & Professor and Head of Department of Prosthodontics, 2021; Merchant et al., 2022; Pandiyan et al., 2022)](https://paperpile.com/c/lir9YV/P4G4Y+PKViH+OgE2J). Though dental amalgam is used as a common restorative material for various cavity lesions, it gradually diminishes and restorations like composites are expected to be replaced[(Miletic, 2017)](https://paperpile.com/c/lir9YV/xVJCk)[(Ganapathy & Professor and Head of Department of Prosthodontics, 2021; Merchant et al., 2022; Pandiyan et al., 2022)](https://paperpile.com/c/lir9YV/P4G4Y+PKViH+OgE2J)). In various studies and also in clinical trials it has been evident that amalgam has shown to be superior to composite resin restorative materials[(Jokstad et al., 1994)](https://paperpile.com/c/lir9YV/wM48F)[(Chokkattu et al., 2022a; Ramamurthy et al., 2022a)](https://paperpile.com/c/lir9YV/Du4Pn+GdlQT).

As much as performing amalgam restorations, it is equally important to finish and polish all the surface of the restoration, where the operators are failing to do so due to reasons like extra heat production and time consuming[(S. D. Heintze et al., 2010)](https://paperpile.com/c/lir9YV/Tm6m)[(S. D. Heintze et al., 2010; Merchant et al., 2025; Shenoy et al., 2024)](https://paperpile.com/c/lir9YV/Tm6m+fo02+FUIs)[(S. D. Heintze et al., 2010)](https://paperpile.com/c/lir9YV/Tm6m). The major advantage seen in post amalgam polishing is that it eliminates all surface irregularities of the restoration thereby preventing all sorts of tarnish and also removes the excess amalgam material present in all cavosurface margins on the desirable tooth structure [(Aparna et al., 2021; Poornima et al., 2021b; Verma & Muthuswamy Pandian, 2021)](https://paperpile.com/c/lir9YV/b61QL+PVp7Q+moMdK). This provides a cleansable area which is suitable for preventing the accumulation of plaque formation[(Chokkattu et al., 2022b; Ramamurthy et al., 2022b)](https://paperpile.com/c/lir9YV/O4qQn+8CayJ)).Polishing is usually best achieved after 24 hours [(Wadhwani et al., 2022)](https://paperpile.com/c/lir9YV/Yz5bD). Although other parameters, including as tint, form, and contour of the restoration also affect aesthetics, the surface texture of dental materials has a significant impact on plaque buildup, wear, and discoloration of restorations, which may eventually compromise their aesthetic appeal [(S. D. Heintze et al., 2010)](https://paperpile.com/c/lir9YV/Tm6m)[(Muthuswamy Pandian et al., 2022; Ramakrishnan et al., 2023)](https://paperpile.com/c/lir9YV/kLVAX+tCjW).Some studies suggested that surface roughness varied depending on the substance and was affected by the force and polishing duration [(Laghari et al., 2023; Ramakrishnan et al., 2023)](https://paperpile.com/c/lir9YV/tCjW+yCpY). Gloss evaluation might be an adequate way to screen materials for their polishability because gloss and roughness have been shown to be strongly related [(S. Heintze et al., 2006)](https://paperpile.com/c/lir9YV/zzLH7)[(Marya et al., 2022)](https://paperpile.com/c/lir9YV/aI1Ug). Therefore surface roughness plays a role in deciding the efficacy of the amalgam restoration [(Sreevarun et al., 2023)](https://paperpile.com/c/lir9YV/pM6iW).

This article deals with the surface [(Muthuswamy Pandian et al., 2022; Ramakrishnan et al., 2023)](https://paperpile.com/c/lir9YV/kLVAX+tCjW)) roughness of dental amalgam after finishing and polishing at different time points [(Jain & Verma, 2022; Marya et al., 2022)](https://paperpile.com/c/lir9YV/aI1Ug+j3Yf5).

# Materials and methods

The Surftest SJ-310 is a compact, portable, easy-to-use surface roughness measurement instrument equipped with extensive measurement and analysis features.

Complies with many industry standards the Surftest SJ-310 complies with the following standards: JIS (JIS-B0601-2001, JIS-B0601-1994, JIS B0601-1982), VDA, ISO-1997 and ANSI.



(a)



(b) (c)

Figure 1: (a) (b) (c)Amalgam pellets are placed in Mitutoyo SJ-310 Stylus Profilometer

# RESULTS

Table 1: 1 hour roughness

|  |  |  |  |
| --- | --- | --- | --- |
| **SAMPLES** | **Ra** | **Rq** | **Rz** |
| **1** | **0.626** | **0.850** | **6.632** |
| **2** | **0.605** | **0.713** | **3.679** |
| **3** | **0.268** | **0.332** | **1.703** |
| **4** | **0.442** | **0.652** | **5.642** |
| **5** | **0.435** | **0.610** | **4.330** |

**Table 1:** Surface profile was determined as average roughness (Ra), defined as the mean between peaks and valleys of the surface profile, Rq is the largest roughness considering all the cut-offs (highest peak and highest valley) and Rz is the mean of 10 peaks and 10 valley heights in each cut-off. Ra and Rz are average roughness parameters and they are not enough to distinguish surfaces that differ in spacing or shape (Chehelgerdi et al., 2023). Therefore it is first calculated at an interval of 1 hour time point interval.

**Table 2:** It is same as table 1, Surface profile was determined as average roughness (Ra), defined as the mean between peaks and valleys of the surface profile, Rq is the largest roughness considering all the cut-offs (highest peak and highest valley) and Rz is the mean of 10 peaks and 10 valley heights in each cut-off. Ra and Rz are average roughness parameters and they are not enough to distinguish surfaces that differ in spacing or shape (Saadh et al., 2024). Here it is calculated after a time point interval of 24 hours.

Table 2: 24 hours roughness

|  |  |  |  |
| --- | --- | --- | --- |
| **SAMPLES** | **Ra** | **Rq** | **Rz** |
| **1** | **1.162** | **1.445** | **5.992** |
| **2** | **1.863** | **2.231** | **8.124** |
| **3** | **1.064** | **1.268** | **4.862** |
| **4** | **1.434** | **2.004** | **7.948** |
| **5** | **1.287** | **1.597** | **7.547** |

Therefore the average value of roughness for 1 hour duration is 0.4375 and for 24 hour duration the average roughness value is obtained as 1.412

# Discussion

Finishing and polishing of a restoration is an integral part to ensure appropriate contour and also attain a surface good enough to prevent debris accumulation [(Adel et al., 2023)](https://paperpile.com/c/lir9YV/qgfUL). In routine dental practice amalgam restorations are polished after 24 hours. It is after 24 hrs the amalgam achieves maximum compressive strength [(Chokkattu et al., 2023)](https://paperpile.com/c/lir9YV/kW3QI). In the clinical scenario, the patients do not report back for polishing. The research question of this study, whether polishing the amalgam restoration after one hour will have an influence on the surface roughness. The results indicate that polishing after one hour shows lesser surface roughness than when polished after 24 hours [(Subramanian & Harikrishnan, 2023)](https://paperpile.com/c/lir9YV/vSowZ). This could be attributed to the phase of amalgam and presence of eta phase of amalgam.

In the previous study by Heintze et al, No statistically significant difference in surface roughness was found before and after finishing and polishing[(Ganapathy & Professor and Head of Department of Prosthodontics, 2021)](https://paperpile.com/c/lir9YV/LXo73). There was no significant difference between the two brands [(S. D. Heintze & Forjanic, 2005)](https://paperpile.com/c/lir9YV/JBJjD). In the previous study by Ramadhani et al, polished amalgam showed the most significant changes. Surface roughness of dental materials depended on their physical and chemical properties. No correlation was found between surface roughness [(Ramadhani et al., 2017)](https://paperpile.com/c/lir9YV/OtvNf). In the previous study conducted by Lepri, mechanically polished produced smoother surfaces than chemically polished , and surface roughness as a result of polishing technique was not influenced by amalgam. Even though mechanically polished results in smoother surfaces initially[(Lepri & Palma-Dibb, 2012)](https://paperpile.com/c/lir9YV/yS4wd). The roughness was different (p < 0.05) for Z350 when finished with RDA\* 68. Dentifrice abrasiveness did not interfere in the ability to remove stains and roughness from aged samples [(Ganapathy & Professor and Head of Department of Prosthodontics,2021)](https://paperpile.com/c/lir9YV/LXo73). However, staining is material-dependent.

In the previous study by Oliveira et al, initial surface roughness of materials indicated that polished amalgam was the smoothest (0.13 μm), and finished amalgam the roughest (0.68 μm). All materials were significantly different. Although there was no statistical difference between finished amalgam and polished amalgam. The results indicated surface roughness may be more dependent on particle size, shape, and distribution of the individual high-copper amalgams than the polishing time or the surface treatment performed. In the previous study conducted, both amalgam alloys, when condensed against a new matrix band, lacked smoothness when compared to the surfaces obtained by finishing after 24 hours. There was a high correlation between arithmetic average roughness and average maximum peak height as quantitative measurements of surface texture.

In the previous study conducted, the samples polished 1 h after placement were always smoother, although their greatest increase in roughness occurred within 60 min of polishing. Although no statistically significant differences were noted between the 1 and 24 h polished specimens. In the previous study conducted by Leitao, significant correlation between roughness and porosity was found. In all amalgams the small voids were the most frequent. It was also found that the amalgam products which exhibited the highest frequency of big voids presented significantly higher surface roughness values. No significant correlation was found between roughness and alloy particle size. In the study conducted by creavan, compared with standard polishing after 24 hours, no advantage is gained by using an abrasive paste after 10 minutes. Polishing after 24 hours produced a significantly smoother surface for both amalgam alloys on both the simulated proximal and occlusal surfaces. 2. The standard polishing procedures after 24 hours produced a smoother surface than any of the immediate finishing procedures tested. Based on the present study surface roughness was lesser when polished after 1 hour. Further analysis on hardness, creep, surface luster and marginal integrity must be assessed when polished at different time periods.

# Conclusion

By comparing the mean average roughness, it is evident that polishing after 24 hour duration has an average of 1.362 which is higher compared to the mean average roughness value of the polishing done after 1 hour duration.

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