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ASSESSMENT OF LIGHT CURING UNIT'S INTENSITY AT KING KHALID UNIVERSITY DENTAL HOSPITAL

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Abstract

Background: The success of any adhesive restorative procedure relies upon multiple factors. Such factors are related to operator and their level of experience, type of restorative device and its properties, and the efficiency of devices used to initiate polymerization reaction of adhesives and restorative resins. Reduced light intensity can lead to improper polymerization of the restorative resin used as permanent restorations, adhesive resins, resin cements, and light activated GIC's. This will lead to inevitable biological hazards, waste of material, waste of patient's time, and possible failure of the restorative procedure. **Objective:** There is no information about the efficiency and quality of light curing units used at King Khalid University Dental Hospital nor is there a quality protocol to ensure their proper function. Therefore, the present work aims at assessing the structural integrity of the LCU's and utilizinga commercial radiometer to check the light output of LCU's used in the dental hospital to ensure proper light intensity, hence ensuring a proper execution of the restorative procedures. **Method:** A cross-section study was conducted with a total of 109 participants randomly chosen to fill the questionnaire. **Conclusion:** the findings of this study highlight the importance of LCU brand and model in determining light intensity. While tip cleanliness did not significantly impact light intensity in this study, further research is needed to confirm this finding. Clinicians should be aware of these factors and take appropriate measures to ensure optimal LCU performance and effective polymerization of dental materials.

Keywords:

Introduction

The success of any adhesive restorative procedure relies upon multiple factors. Such factors are related to operator and their level of experience, type of restorative device and its properties, and the efficiency of devices used to initiate polymerization reaction of adhesives and restorative resins. Reduced light intensity can lead to improper polymerization of the restorative resin used as permanent restorations, adhesive resins, resin cements, and light activated GIC's. This will lead to inevitable biological hazards, waste of material, waste of patient's time, and possible failure of the restorative procedure. Studies conducted on the success of restorative treatment clearly indicate that constant quality check of light curing units (LCU's) used in dental offices is paramount to ensure proper curing function and efficient treatment execution. It is suggested that most current restorative resins must be exposed to at least 400 mW/cm2for at least 20 seconds at a thickness of 2 mm or less (based on shade, type of the restorative resin, and type of initiator and

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co-initiator system used) to be sufficiently polymerized. There is no information about the efficiency and quality of light curing units used at King Khalid University Dental Hospital nor is there a quality protocol to ensure their proper function. Therefore, the present work aims at assessing the structural integrity of the LCU's and utilizinga commercial radiometer to check the light output of LCU's used in the dental hospital to ensure proper light intensity, hence ensuring a proper execution of the restorative procedures

Hypothesis:

The lack of quality protocol at King Khalid University Dental Hospital will affect the proper function of light curing units to effectively polymerize dental resins and lightactivated cements.

Ensuring proper light intensity (aligned with that stated in the literature) within the light curing units used in the restorative procedures will ensure sufficient polymerization initiation of the restorative resins and light-activated cements.

Objectives:

- Assess the structural integrity of current light curing units used at King KhalidUniversity Dental Hospital.
- Assess the light output of the light curing units used at King Khalid University DentalHospital.
- Suggest a quality protocol to be conducted periodically on light curing units within thedental hospital to ensure proper light intensity and function.
- Inspect any damage to the light curing units that might affect their function and suggest any maintenance needed.

Methods:

71 LED-curing devices from different King Khalid University Dental Clinics, Abha, Saudi Arabia, will be selected to measure their light output using aBluePhase Meter II radiometer (Ivoclar Vivadent, Lichtenstein). The LED curing units will be selected from the undergraduate, intern, and specialist dental clinics.

The following parameters will be recorded for each unit: brand, age of use, location (male, female), serial number, curing tip diameter, tip cleanliness, and light output for 10 consecutive cycles with 20 seconds for each cycle. The light curing units will be fully charged, and the tip will be cleaned with an alcohol swab and dried using an air syringe, then a Bluephase matter II commercial radiometer will be used to record the output for 10 cycles (20 seconds each). The light curing tip will be placed perpendicular to the radiometer's sensor, as close as possible without touching the surface. The LCU will be turned on for 20 seconds for 10 cycles with 2 seconds to rest in between the readings to avoid overheating.

The inclusion criteria will only include LED devices at King Khalid University Dental Clinics, while the exclusion criteria will exclude any other type of light curing devices, any light curing devices outside King Khalid University Dental Clinics, and any light curing devices that do not reach full charge.

Data is analysed using statistical software R version 4.3.2. and Microsoft Excel. Categorical variables given in the form of frequency tables. Continuous variables given in Mean ± SD / Median (Min, Max) form. Normality of variable is checked by Shapiro Wilk test and QQ plot. Kruskal Wallis test is used to compare the distribution of light intensity over brand of LCU and LCU tip

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cleanliness. P-value less than or equal to 0.05 indicates statistical significance.

Results:

Data contains measurements on 109 subjects. The following table gives the distribution of subjects according to different variables.

Table 1Distribution of subjects according to different variables.

Variables	Sub Category	Number of subjects (%)
Gender	Female	50 (45.87%)
	Male	59 (54.13%)
Location	Undergrad	77 (70.64%)
	Intern	18 (16.51%)
	Specialist	14 (12.84%)
Brand of LCU	Woodpecker LED.H	2 (1.83%)
	VALO Cordless	1 (0.92%)
	Mectro - starlight uno	4 (3.67%)
	DEML - Kerr	4 (3.67%)
	Bluephase style	1 (0.92%)
	3M ESPE Elipar Deep Cure-L	25 (22.94%)
	3M ESPE Elipar	72 (66.06%)
LCU tip diameter	7	2 (1.83%)
	8	8 (7.34%)
	10	99 (90.83%)
LCU tip Cleanliness	1 (no visual contamination)	7 (6.42%)
	2 (<1/2 tip surface is contaminated)	17 (15.6%)
	3 (>1/2 tip surface is contaminated)	3 (2.75%)
	4 (tip surface is visually damaged)	82 (75.23%)
Light Intensity	0-500	15 (13.76%)
	500-1000	41 (37.61%)
	>1000	53 (48.62%)
	Mean ± SD Median (Min, Max)	876.88 ± 371.07 1000 (0, 1269)

Out of 109 subjects, 59 (54.13%) were male and 50 (45.87%) were females. 77 (70.64%) were undergrads, 18 (16.51%) were interns and 14 (12.84%) were specialists.

The Brand of the light curing unit of 72 (66.06%) were 3M ESPE Elipar, 25 (22.94%) were 3M ESPE Elipar Deep Cure-L, 4 (3.67%) were Mectro - starlight uno, 4 (3.67%) were DEML – Kerr, 2 (1.83%) were Woodpecker LED.H, 1 (0.92%) was VALO Cordless and 1 (0.92%) was Bluephase style. The LCU tip diameter was 10 in 99 (90.83%) cases.

Tip surface was visually damaged in 82 (75.23%) cases, >1/2 tip surface is contaminated in 3 (2.75%), <1/2 tip surface is contaminated in 17 (15.6%) and no visual contamination in 7 (6.42%) cases.

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The light intensity is 0-500 in 15 (13.76%) cases, 500-1000 in 41 (37.61%) cases and >1000 in 53 (48.62%) cases.

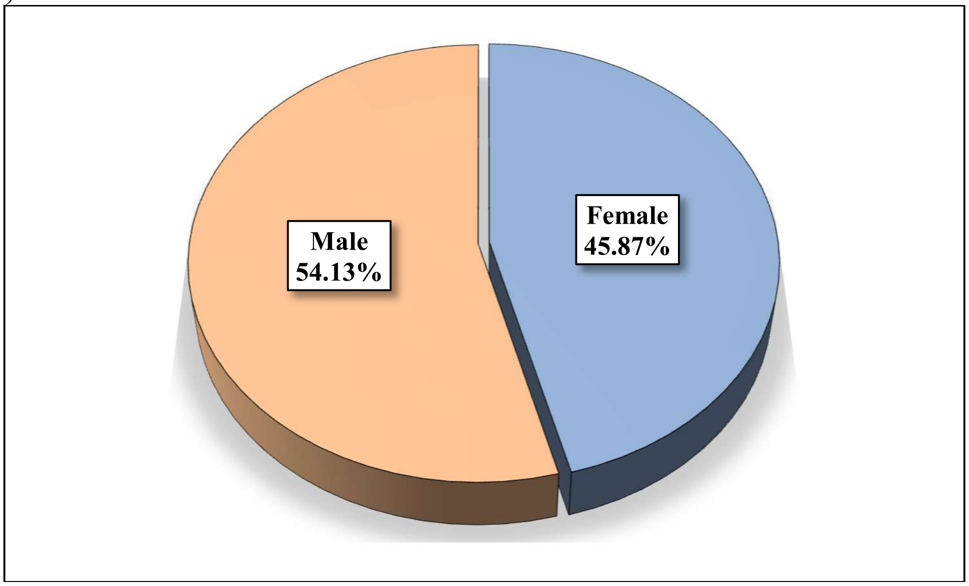

Figure 1Distribution of subjects according to gender.

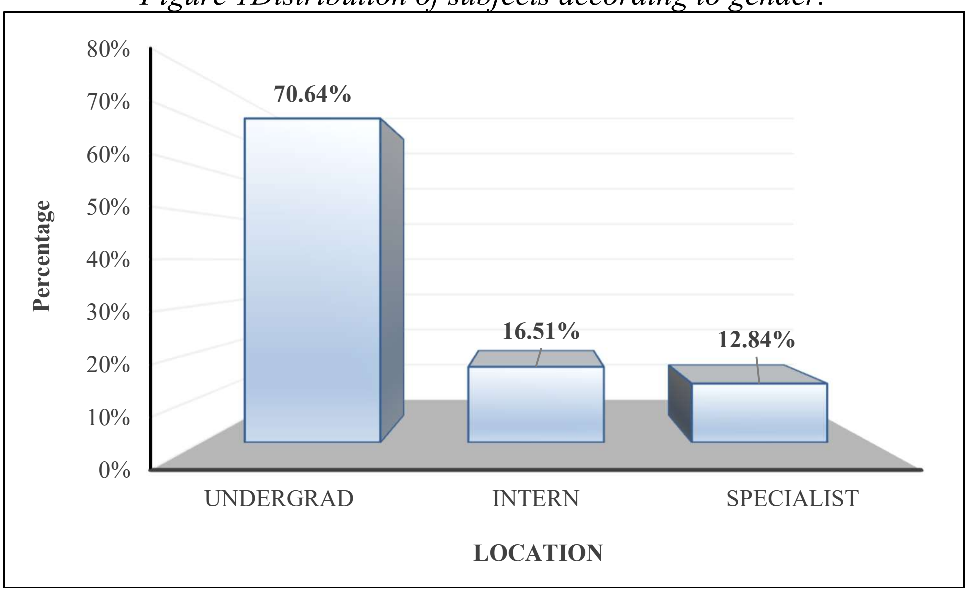

Figure 2Distribution of subjects according to location.

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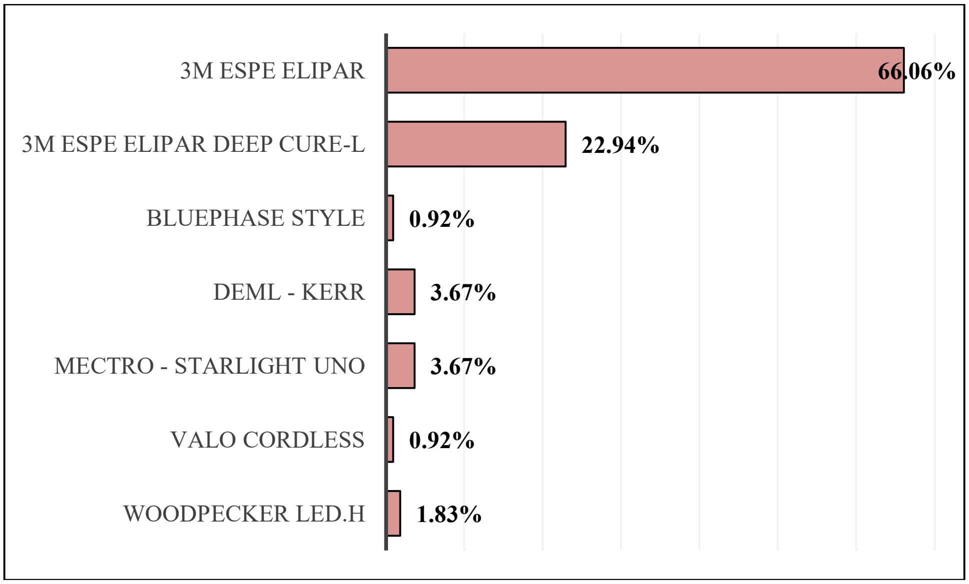

Figure 3Distribution of subjects according to brand of LCU.

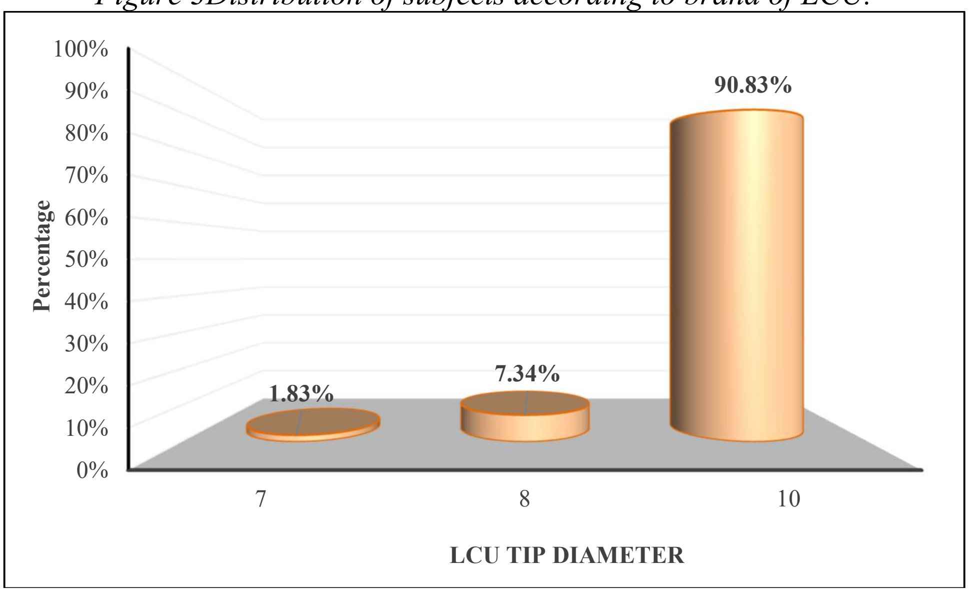

Figure 4Distribution of subjects according to LCU tip diameter.

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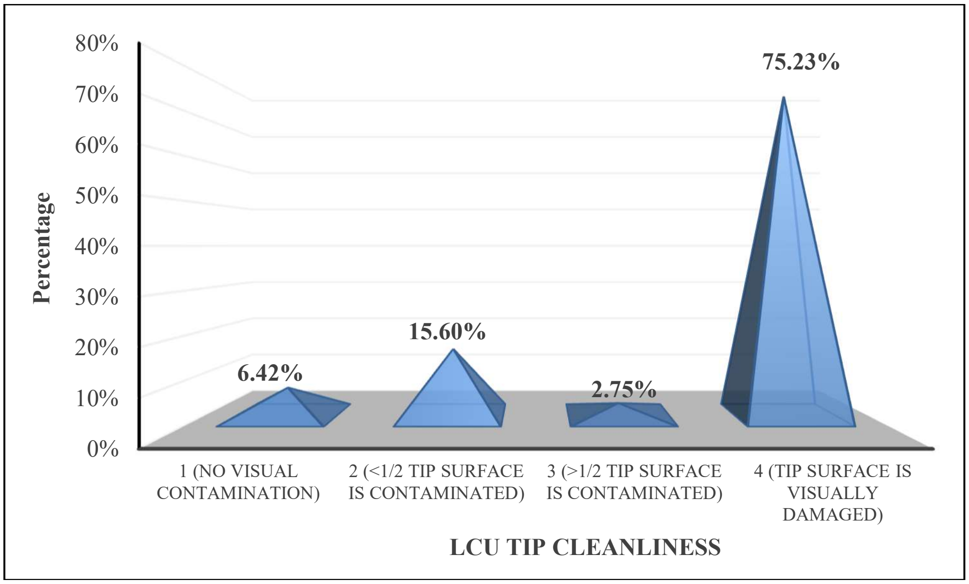

Figure 5Distribution of subjects according to LCU tip cleanliness.

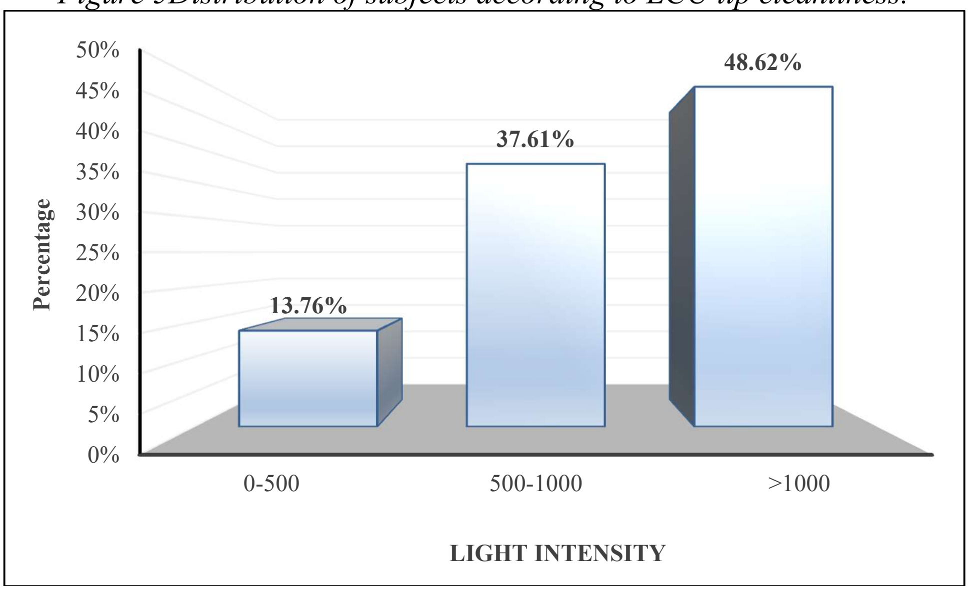

Figure 6Distribution of subjects according to light intensity.

The following table gives the comparison of light intensity over brand of light curing unit.

Table 2Comparison of light intensity over brand of light curing unit.

Brand of light curing unit	Light intensity		p-value
	Mean ± SD	Median (Min, Max)	
Woodpecker LED.H	1054.5 ± 36.06	1054.5 (1029, 1080)	< 0.001^K*
VALO Cordless	1048	1048 (1048,1048)	
Mectro - starlight uno	962.75 ± 47.42	947 (927, 1030)	

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DEML - Kerr	799.25 ± 159.11	823 (596, 955)	
Bluephase style	933	933 (933, 933)	
3M ESPE Elipar Deep Cure-L	1168.2 ± 70.08	1190 (1039, 1269)	
3M ESPE Elipar	767.18 ± 403.02	976 (0, 1112)	

*Abbreviation: K – Kruskal Wallis test, * indicates statistical significance.*

From Kruskal Wallis test, it is observed that, there is significant difference in the distribution of light intensity over brand of light curing unit.

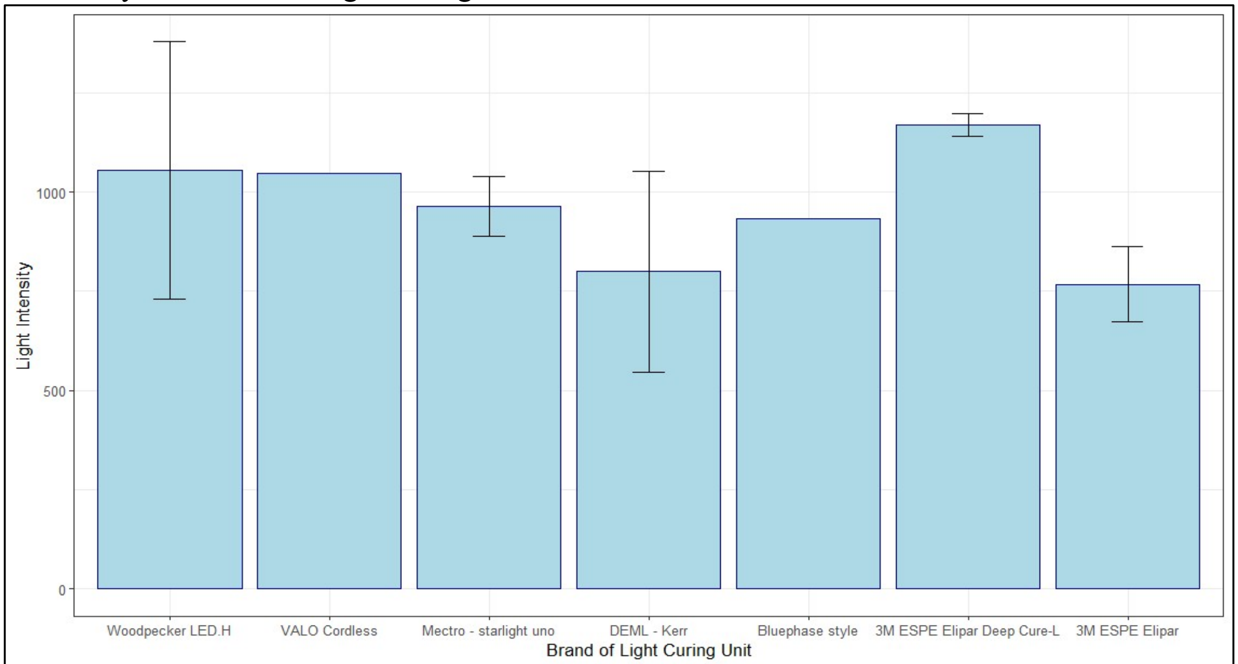

Figure 7 Distribution of light intensity over brand of light curing unit.

The following table gives the comparison of light intensity over LCU tip cleanliness.

Table 3 Comparison of light intensity over LCU tip cleanliness.

LCU tip cleanliness	Light intensity		p-value
	Mean ± SD	Median (Min, Max)	
1 (no visual contamination)	895.86 ± 401.14	1029 (0, 1189)	0.5705^K
2 (<1/2 tip surface is contaminated)	884.65 ± 433.02	1065 (0, 1257)	
3 (>1/2 tip surface is contaminated)	1020 ± 85.11	1039 (927, 1094)	
4 (tip surface is visually damaged)	868.41 ± 365.49	986.5 (0, 1269)	

Abbreviation: K – Kruskal Wallis test.

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From Kruskal Wallis test, it is observed that there is no significant difference in the distribution of light intensity over LCU tip cleanliness.

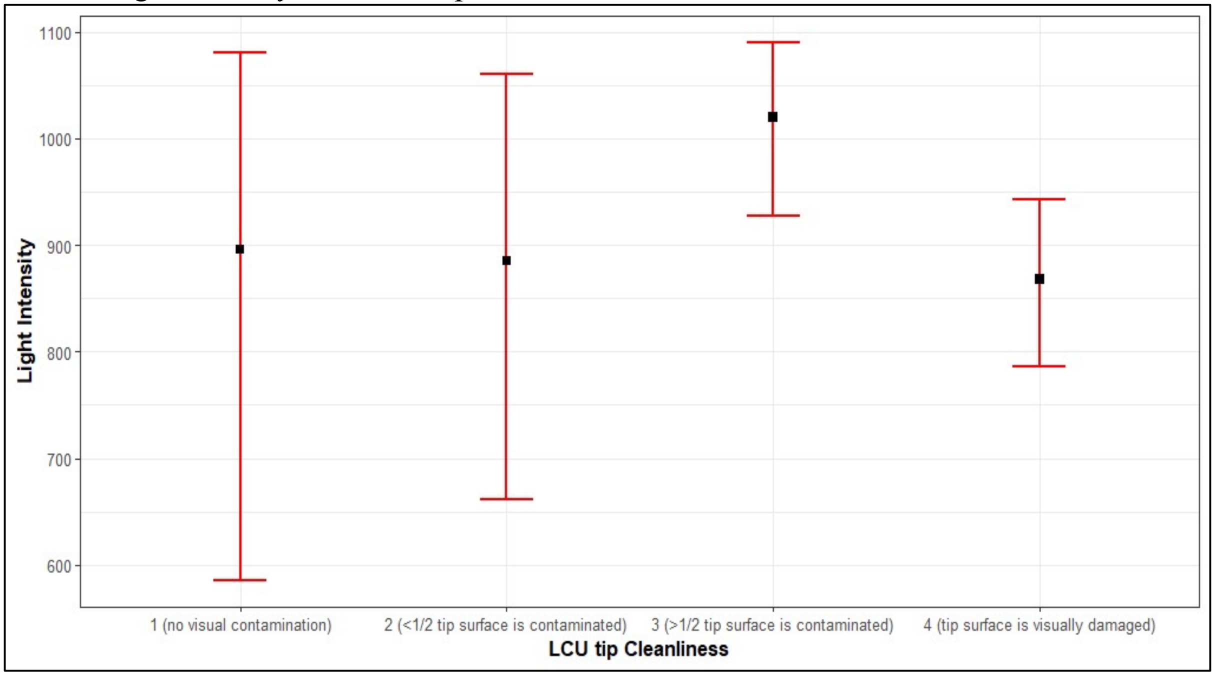

Figure 8 Mean plot of light intensity over LCU tip cleanliness.

Discussion:

The data presented in Table 2 and Figure 7 demonstrate a significant variation in light intensity across different brands of light-curing units (LCUs). This finding aligns with previous research highlighting the importance of LCU brand and model in determining light output (1, 2). The 3M ESPE Elipar Deep Cure-L exhibited the highest mean light intensity, while the 3M ESPE Elipar demonstrated a wider range and lower mean intensity. These variations emphasize the need for clinicians to be aware of the specific characteristics of their LCU models and to ensure proper calibration and maintenance to achieve optimal polymerization outcomes.

Interestingly, Table 3 and Figure 8 reveal no statistically significant difference in light intensity based on LCU tip cleanliness. This finding contrasts with some studies that have reported a decrease in light intensity with increasing tip contamination (3). However, the absence of a significant association in this study could be attributed to various factors, such as the limited sample size or the specific types and levels of contamination encountered. Further investigation with larger sample sizes and controlled contamination levels is warranted to elucidate the potential impact of tip cleanliness on light intensity.

The data presented in this study have several implications for clinical practice. Firstly, the significant variation in light intensity across different LCU brands underscores the importance of selecting and using LCUs that meet or exceed the manufacturer's recommended intensity levels for effective polymerization. Secondly, regular calibration and maintenance of LCUs are crucial to ensure consistent and reliable light output. This includes checking for tip damage, cleaning the tip regularly, and replacing aging components as necessary. Finally, clinicians should be mindful of the potential impact of factors such as tip cleanliness and distance from the restoration on light intensity and, consequently, polymerization outcomes.

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Comparison with Existing Literature

Several studies have investigated the impact of LCU light intensity on the properties of dental materials. For example, a study by Rueggeberg et al. (2003) found that inadequate light intensity can result in incomplete polymerization, leading to decreased microhardness, increased water sorption, and reduced flexural strength of composite resins. Similarly, Peumans et al. (2005) reported that insufficient light intensity can compromise the bond strength between the restorative material and the tooth structure.

The finding that 3M ESPE Elipar Deep Cure-L exhibited higher mean light intensity compared to other brands aligns with previous research. For instance, a study by Ferrari et al. (2007) compared the performance of various LCUs and found that high-intensity units, such as the Elipar Deep Cure-L, can achieve adequate polymerization depths in shorter curing times.

The lack of a significant association between LCU tip cleanliness and light intensity in the current data is somewhat surprising. Previous studies have suggested that contaminated tips can reduce light transmission and, consequently, decrease light intensity (Fleischmann et al., 2008). [1] However, the current findings may be attributed to the relatively small sample size or other factors not considered in this study.

Implications for Dental Practice

The findings of this analysis have several implications for dental practice:

- **Regular LCU Calibration:** Dentists should ensure that their LCUs are regularly calibrated to maintain optimal light intensity and ensure consistent polymerization.
- **LCU Selection:** The choice of LCU should be based on its light intensity, spectral output, and clinical performance. High-intensity units may be particularly beneficial for deep restorations or when using materials with high opacity.
- **Tip Maintenance:** Although not statistically significant in this study, proper LCU tip maintenance, including regular cleaning and replacement, is essential to prevent light transmission issues.
- **Curing Protocols:** Dentists should adhere to the manufacturer's recommended curing protocols, including appropriate curing times and distances, to ensure adequate polymerization.

Future Research Directions

Further research is needed to investigate the following:

- The long-term clinical performance of restorations polymerized with LCUs of varying light intensities.
- The impact of different LCU tip designs and materials on light transmission and polymerization.
- The development of standardized protocols for LCU calibration and maintenance.

Conclusion

In conclusion, the findings of this study highlight the importance of LCU brand and model in determining light intensity. While tip cleanliness did not significantly impact light intensity in this study, further research is needed to confirm this finding. Clinicians should be aware of these factors and take appropriate measures to ensure optimal LCU performance and effective polymerization of dental materials.

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