FACTORS ASSOCIATED WITH LIGHT CURING UNITS: A QUESTIONNAIRE SURVEY

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ABSTRACT

INTRODUCTION: The introduction of light-cured resin-based materials is a revolutionary step in restorative dentistry. Despite their wide distribution and daily use, the interaction between visible curing light and composite resins is not understood well enough by most dentists.

AIM: The aim of this study is to check dentists’ level of knowledge about different factors affecting the polymerization process of resin-based composites and the use of light curing units (LCUs).

MATERIALS AND METHODS: The task was performed by an anonymous questionnaire survey, consisting of 15 questions, which was filled out by 112 dentists from the whole country.

RESULTS AND DISCUSSION: The analysis of the results shows that most of the dentists are poorly acquainted with the factors affecting the polymerization of resin-based composites. Dentists often make mistakes when placing their adhesive restorations, which leads to the incomplete polymerization of the material and all the consequences from that – risk of fractures, lower wear resistance, elution of unreacted monomers, higher microleakage, and lower adhesive bonding strength.

Light intensity is one of the main factors that determine the necessary curing time. However, more than the half of the participants in the survey (52%) do not know their LCU’s output and 21% do not use any protection, which leads to a serious risk of eye damage.

CONCLUSION: It is necessary for dentists to improve their knowledge about LCUs and the polymerization process of resin-based composites, which will significantly increase the longevity of their composite fillings.

Keywords: light curing units, polymerization process, resin-based composites

INTRODUCTION

In many countries the use of dental amalgams is being phased out and replaced by adhesive materials in the restorative treatment of dental caries (1,2,3,4). Most resin-based composites (RBCs) found on the market today contain photoinitiator systems that require absorption of optical radiation in the wavelength range ~350–500 nm to set. Nowadays light-emitting diode (LED) light curing units (LCUs)
are the most widely used light sources. Despite their wide distribution and daily use, the interaction between visible curing light and resin-based composites (RBCs) is not understood well enough by most of the dentists.

Although the composite surface close to the light source hardens easily and it seems that the material is completely polymerized, that does not always happen in the deeper layers of the filling. According to different authors the degree of conversion of RBC varies between 35 and 77% (5,6,7). The unfavorable consequences from the incomplete polymerization of the material are: a risk of fractures, lower wear resistance, elution of unreacted monomers, higher microleakage, lower adhesive bonding strength and faster change of color (8,9). The monomer-polymer conversion depends on many factors. The most important ones are: light intensity, curing time, thickness of the layers, distance and angulation of the LCU tip, composite color, temperature of the material, and others (10).

Blue visible light, such as that emitted from LCUs, can cause eye damage (11,12). The risk is dependent on LCU’s emission and radiative geometry, exposure time, the degree to which light is reflected as well as the use of adequate eye protection (13). In modern dental practice, safety concerns are crucial to avoid work injury.

The presence of blood and saliva in the operative field creates a great risk of cross infections in dental offices. The instruments and the equipment used in dentistry are a subject to different protocols for infection control, depending on their contact with body fluids. According to CDC (Centers for Disease Control and Prevention), there are three categories for dental instruments, depending on the risk of contamination and cross infections. LCUs are in the middle one, because there is a risk for their contamination with blood and saliva, but they are not designed to penetrate into vital tissues (14). Adequate disinfection of LCUs, such as cold sterilization and autoclaving, is crucial for the prevention of cross infection in dental offices (15).

Understanding the main factors associated with LCUs and polymerization of RBC will give dentists valuable information on how to increase the longevity of their adhesive restorations and at the same time will help them to protect themselves from eye damage and reduce the risk of cross infections in their offices.

**AIM**

The aim of this study is to check dentists’ level of knowledge about different factors affecting the polymerization process of RBCs and LCUs.

**MATERIALS AND METHODS:**

The task was performed by an anonymous questionnaire survey, consisting of 15 questions, which was filled out by 112 dentists from the whole country. The interviewed people were between 26 and 61 years of age. Sixty of them were women and 52 were men (54% and 46%, respectively). All of them answered to 15 questions from a specially designed questionnaire.

**RESULTS:**

Most of the interviewed dentists were between 30 and 40 years of age – 52 people, 39 were under 30 years of age, 13 were between 40 and 50, and 8 were over 50 years of age.

On the question concerning the type of LCU they used depending on the light source, most of the interviewed people said that they work with LED LCUs – 110 (98.2%). Only two participants (1.8%) pointed out that they possessed plasma arc curing lamps. None of the dentists used halogen LCUs in their practice.

**Fig. 1. Type of LCUs depending on the power supply**

| Type of LCU          | Percentage |
|----------------------|------------|
| Cordless LCU         | 75%        |
| Mounted LCU          | 2%         |
| Both types           | 23%        |
On the question about the type of the LCU depending on the power supply, most of the interviewed dentists declared that they used cordless LCUs – 75%, 20.5% worked with devices that were mounted on the dental unit and 4.5% had both types of LCUs (Fig. 1).

Question number 3 about how often they charge their LCUs referred only to those dentists who used cordless lamps. Most of the interviewed participants – 71.4%, answered that they placed their LCUs on the charging station when the battery was completely discharged or when they heard the sound indicator. A small part of the dentists – 8.8%, informed that they charged their LCUs at the end of the working day and 20.2% pointed out that they kept their devices on the charging station all the time (Fig. 2a).

The participants in the questionnaire were asked if they knew what the output power (light intensity) of their LCUs was. We have received the following results (Fig. 2b):

- Three people (2.7%) pointed out that their LCU’s output was between 400 and 800 mW/cm²;
- Twenty-seven clinicians (24.1%) said that the light intensity of their LCU was between 800 and 1200 mW/cm²;
- Twenty-five dentists (22.3%) declared that their device’s output was higher than 1200 mW/cm²;
- Fifty-seven dentists, which is more than the half of them – 50.8%, reported that they did not know the output of their LCU.

Dentists were asked if they used eye protection against the harmful blue light from LCUs. Only 9 people, or 8%, declared that they wore orange protective glasses (“blue blockers”) when working with LCUs, while most of the participants in the survey – 80 people, or 71.4%, protected their eyes with the orange filter attached to the curing lamp. The rest of the respondents - 23 people (20.6%) did not use any eye protection (Fig. 3).
On the question if they disinfected their LCUs after each patient, all of the dentists responded positively. Fig. 4 shows the answer of the question about the autoclaving of the light curing tips. Only 11 dentists (9.8%) assured us that they did this no less than once a week, 22 practitioners (19.6%) did this type of sterilization no less than once a month and 66.1%, or 74 people, informed us that this happened only a few times a year. Five dentists (4.5%) did not autoclave their light curing tips at all.

Clinicians were asked about the light curing mode they used on their LCUs. Most of the dentists – 81, declared that they used the continuous mode, 30 people pointed out that they used the soft start mode and only 1 worked with the flashing mode. On the question about the usual thickness of the layers when working with conventional composite, the answers were as follows (Fig. 5a.):

- up to 1 mm – 23 people or 20.5%
- up to 2 mm – 65 clinicians or 58%
- up to 3 mm - 22 people or 19.7%
- up to 4 mm – 2 clinicians or 1.8%

The answers of the question about the curing time for each composite layer were divided into 4
groups (Fig. 5b.). Twenty-six people, or 23.2%, said that they cured for 10 seconds, 70 participants, or 62.5% – 20 seconds; 6 people, or 5.4% – 30 seconds, and 10 clinicians, or 8.9% - 40 seconds. Most of the dentists polymerized their last composite layer for 40 seconds (49 people, or 43.8%), followed by 20 seconds (33 people, or 29.4%), 30 seconds (21 clinicians, or 18.8%), and finally by 60 seconds (9 clinicians, or 8%) (Fig. 5c).

Dentists were also asked if they used glycerin as an oxygen barrier to prevent the formation of an oxygen-inhibited layer. Twenty-five colleagues, or 22.3%, answered that they used it and 87 people, or 77.7%, informed that they did not use it when placing composite fillings.

On the question about the distance of the LCU tip from the restoration surface, 24 dentists (21.4%) declared that they held it in contact with the tooth. Sixty-nine practitioners (61.6%) informed that the distance was up to 3mm, and 17 people (15.2%) said that it was up to 6 mm. Only two clinicians pointed out that they held the LCU tip at a distance longer than 6 mm from the restoration surface (Fig. 6).

On the question, if they held the light curing tip perpendicular to the restoration surface (when possible), 96 dentists, or 85.7%, answered positively and 16 people, or 14.3%, responded negatively.

The last question of the questionnaire was about the use of modeling liquid by the dentists for moistening their modeling instruments or brushes. The results obtained are shown on Fig. 7. Most of the participants – 36, or 32.1%, did not use any kind of modeling liquid. Twenty-seven dentists (24.1%) used a non-self-etching bonding agent, containing primer and adhesive; 24 people (21.4%) used composite primer; 18 interviewed (16.1%) - pure adhesive, 6 clinicians (5.4 %) used self-etching adhesive, while 1 dentist used specially designed for this purpose modeling liquid – GC composite modeling liquid.

**DISCUSSION**

Most of the interviewed dentists use LED LCUs and none of them uses halogen LCUs. These results show that although they were mostly used in the recent past, today halogen LCUs have more of a historical significance.

Many practitioners place their LCUs on the charging station only when the battery is completely discharged. This approach can be extremely unpleasant in cases where LCU’s output power is dependent on the level of battery charge. A research shows that in some models the light intensity decreases when the battery gets discharged (16).

More than half of the dentists do not know the output power of their LCUs. This is a highly disturbing result, because light intensity is one of the main factors affecting the polymerization of RBC.

Surprising and very worrying is the fact that 23 practitioners (20.6%) do not use any eye protection. Chronic exposure to low levels of blue light may cause accelerated retinal aging and degeneration (11). Studies also show that the cumulative maximum permissible daily ocular exposure time to blue light at a distance of 30 cm for plasma arc LCUs is 6 seconds, and for the high-powered LED LCUs is 28 seconds (13). The opinion of many authors is that the best way to lower the risk of eye damage is to wear
orange protective glasses (17). It means that only 8% of the interviewed dentists use adequate protection when working with LCUs.

Most of the dentists autoclave their LCU tips only a few times a year and a small part of them do not autoclave them at all. Reading these results leads to the conclusion that most of the dentists do not apply adequate infection control when working with LCUs. Hence, there is a great chance for contamination of the light curing tips with blood and saliva, which increases the risk of cross infections in dental offices (14).

The optimal thickness of conventional composite layers is 2 mm (18). More than 21% of the dentists do not meet that requirement, because they place portions of 3 mm or more, which can lead to incomplete polymerization of the material.

A reduction in the conversion degree of RBC is sometimes due to the increased distance between the LCU tip and the restoration surface. According to some researchers, the reduction is 50% when the distance is increased from 0 to 6 mm (19), while according to others the distance must not be more than 3 mm (20). Therefore, we can make a conclusion that approximately 17% of the interviewed dentists do not follow the necessary requirements when light curing RBCs, because they hold the LCU tip at more than 3 mm from the restoration surface.

The incorrect angulation leads also to a reduction in the light intensity – holding the light curing tip at 45° to the surface reduces the light intensity by 56% (21). The results from the research show that 14% of the clinicians do not follow this requirement.

The use of 5th and 6th generation adhesive as a modelling liquid affects negatively the restoration properties. So, it can be concluded that approximately 29% of the interviewed dentists make this kind of mistake when they place composite fillings.

**CONCLUSION**

Nowadays most dentists use LED LCUs, while halogen LCUs used in the recent past have now more of a historical significance. It was established that most of the practitioners (75%) prefer cordless LCUs. Most of the interviewed people (71.4%) place their curing lamps on the charging stations when their battery is completely discharged, which leads to a risk of decreasing LCU output in some battery-dependent models. It is disturbing that more than half of the participants in the survey (50.8%) do not know their LCU output, because light intensity is one of the main factors determining the necessary curing time. Only 8% of the dentists wear orange glasses when working with LCUs and 20.6% do not use any protection, which leads to a serious risk of eye damage. All of the interviewed people disinfect their LCUs after each patient. However, it is worrying that 2/3 of the dentists (66.1%) autoclave their LCU tips only a few times a year. Most of the colleagues use the continuous mode of their LCUs (71.4%), although studies show that soft start mode leads to lower polymerization shrinkage. More than the half of the clinicians (58%) follow the classic rule for 2 mm layers when working with conventional composite. Seventeen percent of the colleagues hold the curing tip at more than 3 mm from the restoration surface, which can lead to a reduction in light intensity. One third of the dentists (33%) do not moisten their modeling instruments and 29% use 5th, 6th and 7th generation adhesive, which affects negatively the restoration properties.

This research will help dentists to improve their knowledge about LCUs and the polymerization process of RBCs, which will significantly improve the quality of their composite restorations.

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