Case study

Evaluation of the efficiency of light-curing devices used in private dental offices in Tehran in 2016

Background and Aim: Light cured composites and other restorative materials are quite common in dentistry today. Successful restorations are dependent on the efficiency of the curing light unit, eg. The intensity of emitted light and its wavelength. The aim of this study was to evaluate the efficiency units of curing, in private dental offices in Tehran. Materials and Methods: In this descriptive cross-sectional study, light curing devices in 320 private dental offices were evaluated randomly. Light intensity was measured by the radiometer, debris on the fan and cracks and scratches on the filter were directly observed and the age of the device, frequency of changing the bulb and satisfaction of the dentist with regard to the light-curing unit were recorded in a questionnaire. Data were analyzed using Spearman and t-test, with $p<0.05$ as the level of significance.

The results: The results showed that 53.75% of the units had intensities more than 300 MW/cm2. The intensity of 30.3% of curing light units was between 20 and 300 MW/cm2 and 15.9% had intensities lower than200 MW/cm2. There was a negative relation between light intensity and the age of the unit, frequency of bulb changing or scratches on the filter and debris on the fan.

***Conclusion*:** The results of this study showed that the light intensities of about 46% of light-curing units used in private dental practices and clinics were inadequate. Since factors like aging of the curing light unit, frequent bulb changing, increasing the amount of debris on the fan and scratches on the filter reduce the light intensity, regular quality control of these devices is essential.

Key Words: Light curing unit; Intensity; Radiometer; Composite resin

Introduction

Today, the clinical application of resin composites has increased. The success of composite restorations with light cure depends on the degree of polymerization and consequently the intensity of the light output of the device. Sufficient intensity, correct wavelength (420-520 nm), and sufficient time cure have an important effect on sufficient polymerization of composite resins. Various factors also affect the intensity of the light output of the device. Changes in voltage, filter failure, pollution of light cure tip, failure of electrical components, the fracture of light transmitters (filters), the small diameter of the device, the distance between the tip of the device and tooth and the length of light-curing are significant factors (1), (2).Disinfectants containing Glutaraldehyde also cause fractures on the surface of optical fiber glass leading to a decrease in the intensity of lightning (3). The size of the cavity and its location,

the thickness of the composite and its color play an important role in the amount of light passing through the deep layers (1,4,5). The sufficient light intensity of curing devices is needed to achieve the maximum polymerization. Some researchers found that 300 MW for Polymerization of composite that its thickness is 2 mm is required(6). The hardness of the composite surface is not a reliable guide for the proper curing of the device. The level of hardening could be sufficient with low light while the deep surfaces may be inadequately cured. Therefore, using a light-testing-meter is recommended to evaluate the intensity of the light output of optical devices. (6) In this regard, different studies have been conducted in different cities (11-8). The last survey in Tehran was about 20 years ago (9). Due to new devices that are used today, the present study was conducted to evaluate the efficacy of light cure devices in private dentistry offices in Tehran.

Materials and Methods:

In this cross-sectional and descriptive-analytic study, data were obtained through observation and interviews. Firstly, an information form, including the age of the device, the frequency of use of the device per day, the radiation time for each layer, the number of office hours, the amount of debris accumulated on the machine's fan, presence or absence of scratches on the filter, the dentist's satisfaction or dissatisfaction with the device, the frequency of replacing the lamp through asking questions from dentists and the observation of the machine were completed. After turning on the device and using for 1 minute, the intensity of radiation was measured in MW / cm2 by the radiometer three times. If the difference was more than25 MW / cm2 after reading numbers, the measurement should be repeated again. Among recorded numbers, the average number was measured to obtain the final result.

In order to obtain the clinical age of the device, the following formula was used:

Clinical age of the device = Duration of the device purchase (per year) × 52 (number of weeks of the year) × The number of office hours per week x The average frequency of use of the device during the day x Average exposure time for each use in seconds

Data were analyzed by SPSS software and Spearman's correlation coefficient, and also t-test. $P < 0.05$ was considered as a significant level.

Results:

The results showed that the average intensity of radiation was 432/60mW / cm2. The maximum intensity of radiation was recorded at 1000 MW /CM 2intensity below 100 MW / cm2, 25% of them below 260 MW / cm2, 50% of them below 370 MW / cm2, and 75% of the devices showed an intensity of less than 550 MW / cm2. Only 5% of light cure devices, their intensity was higher than 800 MW / cm2.

The radiation intensity of the devices was divided into three groups:

A) The radiation intensity is higher than 300 MW / cm2, which is favorable for radiation intensity. In this group, 53.75% of devices were counted.

B) The intensity of the radiation is between 201-300 MW / cm2, which requires a longer lightening time to achieve the desired results. 30.3% of the devices were in this group.

C) The radiation intensity is 200 MW / cm2 or less that can not be compensated for even if the exposure time is prolonged. 15.9 % of the devices were in this group.

The average age of light cure devices was 6.76 years. The frequency distribution of devices in terms of radiation intensity is given in Table 1.

Table 1. Distribution of Clinical Age (Hours) based on Radiation Intensity in Dentistry Office in Tehran

Radiation Intensity Mw/cm2 / Age (Hours)	0-200	201-300	300<	total
0-5 (hour)	0(0%)	0(0%)	12(100%)	12(100%)
5-40 (hour)	5(6.94%)	5(6.94%)	62(86.11%)	72(100%)
40-80 (hour)	11(18.03%)	16(26.2%)	34(55.7%)	61(100%)
80-160 (hour)	18(20%)	32(35%)	41(45%)	91(100%)
160-450 (hour)	16(22.8%)	36(51.4%)	18(25.7%)	70(100%)
450< (hour)	1(7.14%)	8(57.14%)	5(35.71%)	14(100%)
total	51(15.9%)	97(30.3%)	172(53.75%)	320(100%)

Table 2: Distribution of the amount of debris on the cooling system of the device in terms of radiation intensity in dental offices in Tehran

Radiation intensity Mw/cm2 / The amount of debris	0-200	201-300	300<	Total
Without debris	0(0%)	1(4.35%)	22(95.65%)	23(100%)
With little debris	10(6.9%)	22(15.1%)	113(78%)	145(100%)
With more debris	32(25.66%)	74(48.68%)	32(25.66%)	152(100%)
Total	51(15.9%)	97(30.3%)	172(53.75%)	320(100%)

Table3: Frequency distribution of lamp replacement in terms of radiation intensity in dentistry offices in Tehran

Radiation intensity Mw/cm2 / lamp replacement	0-200	201-300	300<	Total
0	12(9.8%)	15(12.2%)	96(78%)	123(100%)
1	0(0%)	15(20%)	59(80%)	74(100%)
2	0(0%)	28(68.3%)	13(31.7%)	41(100%)
3	12 (36%)	21 (64%)	0(0%)	33(100%)
4&more	26(53%)	18(37%)	5(10%)	49(100%)
Total	51(15.9%)	97(30.3%)	172(53.75%)	320(100%)

The relationship between radiation intensity and clinical age was measured by the Spearman correlation coefficient. The results indicated that an increase in the age of the device leads to decreasing the intensity of the radiation (r = -0.214). This relationship was statistically significant. (P = 0/001).

The results showed that 7.2% of the devices did not have any debris on the fan. In 45.3% of them, they had a little debris on the fan, and in 47.5% they had large debris on the fan. With increasing debris on the fan, the intensity of the radiation was reduced. (R = -0.576). This relationship was statistically significant (P <0.001).

Almost all dentists, participating in this study (with the exception of 2 people) were satisfied with the function of their device (1.99%).

According to records, 38.4% of the light-curing devices have not been changed even once. Statistical analysis showed that there was a correlation between radiation intensity and a number of bulbs(r = -0.53), and the frequency of light bulb replacement was significantly reduced (P = 0.001).

45/41% of devices had a scratch or crack on the filter, and 54.58% of them were not. Through t-test, the relationship between the intensity of the device and the scratches or cracks on the filter was investigated. It was observed that, despite the cracking or scratching on the filter, the radiation intensity of the device was reduced and this relationship was statistically significant (P=0/001).

Discussion and Conclusion:

Due to the increasing use of optical composites, the importance of polymerization is increasing because their success depends on the degree of polymerization. Defective polymerization results in poor biological effects, increased water absorption, composite solubility and hardening. Also, due to the extensive use of these materials for bonding, the inadequacy of light can affect the bond strength of restorations. The maximum polymerization of the composites is influenced by factors such as the intensity of the device's radiation, the wavelength of the radiation and the duration of its illumination. Since radiation intensity is not always compensated by extending the exposure time, the intensity of the radiation should be regularly monitored. Unfortunately, eye examination of the device is not reliable because an apparently bright device may not have sufficient wavelengths(1,6). Surface hardness testing is not a reliable method, because even those devices with very low light intensity can completely polymerize the composite surface. With a dental explorer for evaluation of hardness of the composite core can not find a sign of the optimal efficiency of the light-curing device (12-14). Today, there are various types of dental radiometers that use them as an acceptable method for assessing the effectiveness of the devices and the dentist can help with its low-power curing device. In the present study, a radiometer (Demetron) was used to study the light intensity of light-curing devices. The light intensity of 46.2% of the devices was lower than the optimal level, which is similar to the results of Barghi et al(45%). (1) However, in comparison with the results of Akhavan Zanjani et al is lower. (9)

The desired intensity of radiation is 300mW / cm2 for light-curing devices (6). According to the study of Rueggeberg et al, The intensity of light in 51 devices, which was less than 200 MW / cm2, Should not be used (2). The difference between the results of this study with the research of Akhavan Zanjani et al is an increase in knowledge of dentists over the past 10 years(9). The variation of light-curing devices in different countries may be due to the difference between the results of this study and those of Barghi et al. (1) and Dunne et al. (6). In this study, based on statistical records, the frequency of light bulbs has been reduced by increasing the frequency of radiation, which is similar to the results obtained from Akhavan Zanjani et al(9). By contrast, In the study of Miyazaki and his colleagues, the replacement of the lamp has greatly influenced the light intensity of the light-curing device. He immediately examined the intensity of the radiation after changing the bulb and did not take into account the age-related factors during replacement times (15). However, as the age increases, the number of lamp changes can be increased and the effect of increasing age on the decrease in the intensity of light will dominate the number of bulbs. In the present study, the filtration status of devices was investigated in terms of cracks or scratches, but the degree or amount of crack or scratch has not been recorded. The results show that there is a negative relationship between the presence of scratches on the filter radiation intensity of the device, which was also reported in Barghi et al. (1). This can be explained by the difficulty in filter performance and its negative effect on the light output intensity. In the study of the status of ventilators of devices in terms of the amount of debris on it, in this study, 7/2% had no debris, 45.3% had low debris

and 47.5% had high debris. While Barghi et al investigated the contamination of the fan and the tip of fiberoptic in the study, it was due to the good care of dentists by the light cure device (1). This difference in results can be due to the difference in the criteria of the subjects in the measurement of infection rates. In this study, there was a relationship between debris and contamination on the fan by decreasing the radiation intensity of the device, which was also observed in Barghi et al. (1). An interesting point was that 99% of dentists were satisfied with their device, although the intensity of the radiation was not optimal. In total, this study, which included 240 Light Curing devices in private offices in Tehran in 2016, showed that: About 46% of light-curing devices had less than optimal radiation intensity. With some factors such as increasing the age of devices, the frequency of bulb replacement, debris on the fan and the presence of cracking or scratching, the radiation intensity filter has been reduced. The majority of dentists are satisfied with the hardness of the surface of the composite restorations and are satisfied with their device and are not aware of the effect of voltage fluctuations on the light intensity of the device.

References:

1- Barghi N, Berry T, Hatton C. Evaluating intensity output of curing lights in private dental offices. J Am Dent Assoc 1994;125(7):992-6.

2- Rueggeberg FA, Caughman WF, Curtis JW. Factors affecting cure at depths within light-activated resin composites.Am J Dent 1993; 6(2):91-5.

3- Dugan WT, Hartleb JH. Influence of a glutaraldehyde disinfecting solution on curing light effectiveness. Gen Dent1989; 37(1):40-3.

4- Swartz ML, Phillips RW, Rhodes B. Visible light-activated resins depth of cure. J Am Dent Assoc 1983; 106(5): 634-7.

5- Friedman J, Hassan R. Comparison study of visible curing lights and hardness of light-cured restorative materials. J Prosthet Dent 1984; 52(4):504 -6.

6- Dunne. SM, Davies BR, Millar BJ. A survey of the effectiveness of dental light-curing units and a comparison of light testing devices. Br Dent J 1996; 180(11):411-6.

7- Rueggeberg FA, Caughman WF, Curtis JW. Effect of light intensity and exposure duration on the cure of resin composite. Oper Dent 1994; 19(1):26-32.

8. Savadi oskuee. Q, Pour Abbas. R Hafez Quran. The Effectiveness of Light Curing Devices in Private and Therapeutic Centers of Tabriz in 1380. Journal of Dental Medicine, Shaheed Beheshti University of Medical Sciences, 1383, p. 82-95.

9. Akhavan Zanjani et al. &Ghasemi A. & Nosohi N., An Investigation of the Severity of Light Curing Devices in Tehran Offices in 1997. Journal of Dental Medicine, Shaheed Beheshti University of Medical Sciences, 2001, No. 17-24: 19.

10. Moazami Sam, Fathi. K, the study of the Sufficiency of Light Cure Devices in Mashhad's Private Clinics, Faculty of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran.

11. Doloure, Mesbah Kiaie M. Evaluation of the performance of light-curing devices in private dental offices in Rasht. Number 1084. Dentistry. Faculty of Dentistry, Gilan University of Medical Sciences & Health Services, 2003

12. Hansen EK, Asmussen E. Reliability of three dental radiometers. Scand J Dent Res 1993; 101(2):115-9.

13. Fowler CS. Swartz ML, Moore BK. Efficacy testing of visible-light-curing units. Oper Dent 1994; 19(2):47-52.

14. Pilo R, Oelgiesser D, Cardash HS. A survey of output intensity and potential for depth of cure among light-curing units in clinical use. J Dent 1999; 27(3): 235-41.

15- Miyazaki M, Hattori T, Ichiishi Y. Evaluation of curing units used in private dental offices. Oper Dent 1998; 23(2): 50-4.