What's new for the clinician – summaries of recently published papers (September 2025)

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1. COMPARISON OF DENTAL CURING UNITS AND OUTPUT MODES REGARDING RADIANT FLUX, TIP DIAMETER, RADIANT EMITTANCE, SCATTERING, AND PENETRATION DEPTH

Dental light-curing units (LCU) are important parts of the photocuring process of resin-based composite (RBC) materials, yet the specifications and the proper use of the LCU to achieve success in restorative procedures are often overlooked in daily practice[1] . Although adequate light curing is required for the RBCs to reach the manufacturer's intended properties and thereby long-term clinical success, it is not the only potential reason for failure[1]. Other than the exposure time, the parameters related to the clinical application procedure," such as the inclination of the light tip, the distance of the tip to the restoration surface of the RBC, the location of the restoration, and even the morphology of the restoration surface all may influence the clinical success[1]. In addition, the mechanical and optical properties of the RBC may affect the quality of polymerization, thus having an important effect on the outcome[1] . However, among all these mentioned clinical parameters, clinicians often downplay the parameters related directly to the light-curing unit (LCU), such as the quality and the features.

Light-emitting diodes (LEDs) are the most often used sources in dental LCUs. LED devices are smaller and deliver better luminous efficacy compared to the other light sources, and they can produce light with less heat generation. The parameters related directly to the light-curing unit (LCU) can also significantly impact polymerization of the RBC, hence impacting on clinical outcome measures such as sensitivity, longevity, etc. Some of these features include:-

Radiant flux refers to the total power of light emitted by the curing unit, measured in milliwatts (mW). High-power LCU output modes (radiant flux >1,000mW) deliver more energy than low-power modes. The choice of output mode significantly impacts the total energy delivered, which in turn affects polymerization quality and depth.

The Tip diameter determines the area of coverage: a larger tip diameter can cover broader restorations in a single exposure, reducing the risk of unpolymerized regions. Even small changes in active tip diameter produce large changes in radiant emittance (power per unit area). Narrower tips can create intense "hot spots," risking uneven curing or tissue damage.

Radiant emittance (also called irradiance, mW/cm^2) is calculated from radiant flux divided by the tip area. Greater radiant emittance is positively correlated with deeper light penetration and more effective polymerization.

Light scattering refers to the spread and diffusion of curing light as it exits the LCU tip and passes through dental tissues or restorative materials. Scattering negatively correlates with radiant emittance, tip diameter, and penetration depth, meaning more scattering reduces the effective curing depth and energy reaching deep layers.

Penetration depth—how far light efficiently reaches into the resin-based composite—is critical for optimal curing, especially for "bulk fill" materials designed for 4mm+ cure depths. Greater penetration depth can be expected with higher radiant emittance and larger tips. Top-quality LCUs provide energy that penetrates deeply and uniformly. Depth of cure assessments often compare the bottom hardness to the top (aiming for >95% relative bottom/top hardness), and under-cured regions can be revealed through solvent testing or hardness profiles.

Table 1 provides a summary of these concepts and their clinical importance

Table 1: Important features in your Light Curing Unit to consider before purchase

Factor	Impact on Curing	Clinical Importance
Radiant Flux	Higher flux = more total energy; boosts cure depth	Fast, deep, uniform curing of restorations
Tip Diameter	Larger tip = wider coverage; less risk of missed spots	Match to restoration size for effective curing
Radiant Emittance	Higher irradiance = deeper, more complete cure	Prevents undercured regions, reduces failures
Scattering	More scattering = less penetration, more energy loss	Minimize with optimal tip design/materials
Penetration Depth	Determines how thick a layer can be polymerized	Bulk-fill composites require 4mm+ effective curing

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Korkut and colleagues (2025)[1] reported on a study that compared 10 dental LED polymerization devices and the curing modes quantitatively in terms of radiant flux, spectral emission, radiant emittance, tip diameter, scattering, and related penetration depth. The hypotheses (h1) of the study were: (I) The calculated radiant emittances based on the measured internal tip diameter deviate beyond ±10% of the manufacturers' stated radiant emittances, (II) The radiant emittance and internal tip diameter have positive correlations with the total penetration depth of the dental light-curing devices, (III) Different output modes of the same LCU present significantly different scattering and penetration depth values.

Materials and methods

The radiant flux, spectral emission, radiant emittance, light source width, beam light scattering degree, main penetration depth (MPD), and total penetration depth (TPD) of ten different, brand-new LED light-curing units and different curing modes were quantitatively compared. All the LCUs were in class 2 and type 2 classification, and only the continuous irradiation modes were examined according to the ISO standards. The LCUs and exposure modes are listed in Table 2

A laboratory-grade spectroradiometer, also called the MiniGig radiometer, was used to measure the output from the LCUs. This spectroradiometer measures the radiant flux and the emission spectrum [11] between 360 nm and 830 nm, with a claimed accuracy of ± 4%. Before the measurements, the MSC15-W was calibrated by Gigahertz-Optik's calibration laboratory for spectral responsivity and radiant emittance according to ISO/IEC 17,025. A single operator performed three measurements for each device/curing mode.

The internal tip diameters were measured by a single operator using a digital caliper by placing it at the inner ends of each curing unit's glass tip. It was performed to check if the real tip diameter agrees with the manufacturer's declared one. Then the measured internal tip diameter for each LCU was entered into the meter software. The data from each LCU were exported as an.xlsx file. Then, ten different dental LCUs and output modes were divided into two main groups as high-power and low-power, according to the measured radiant flux (mW) values. Although there is no classification of the LCUs regarding the radiant flux values in the literature, the grouping was needed to perform the statistical analyses more accurately and to observe the possible significant differences between the LCUs. Following many manufacturers' recent polymerization recommendations for the resin-based restorative materials, 1000 mW was considered as the border between the two groups. The LCUs/output modes emitting

Table 2

LED Light-Curing Unit	Emission	Wavelength Region (nm)	Curing Mode	Manufacturer	Serial Number
SmartLite Pro	Single Peak	450–480	Standard	Dentsply Sirona	H04545
Ruby	Single Peak	385–515	P1 P2	Inci Dental	MC7AB0051
Valo Grand	Multi Peak	385–515	Standard Power High Power Plus Xtra Power	Ultradent Products	S14404
Valo Cordless	Multi Peak	395–480	Standard Power High Power Plus Xtra Power	Ultradent Products	S41744
Valo X	Multi Peak	380–515	Standard Power Xtra Power	Ultradent Products	3F001580
Woodpecker Led B	Single Peak	420–480	Standard	Guilin Woodpecker Medical	L14A0373E
Elipar DeepCure-S	Single Peak	430–480	Standard	3 M ESPE	6741744
Bluephase PowerCure	Multi Peak	385–515	H T 3 S	Ivoclar Vivadent	1428009403
Bluephase N	Multi Peak	385–515	Low High	Ivoclar Vivadent	1020014381
D-light Pro	Multi Peak	400–480	LP	GC Corp.	0419

radiant flux above 1000 mW were included in the high-power group, while the rest were in the low-power group.

The radiant flux data collected by the spectroradiometer were used to calculate two different radiant emittance values for each LCU/curing mode and compared to the radiant emittance stated by the manufacturer. One was calculated using the indicated tip diameters, and the other was calculated using the measured internal tip diameters of the LCUs. The calculations used the radiant flux (mW)/tip area (cm^2). Also, the difference in percentage (%) between the manufacturer's stated radiant emittance and the radiant emittance by the measured internal tip diameter was calculated for each LCU/curing mode to assess the deviation from the indicated radiant emittance.

The features of the light-curing units, such as light source width, scattering, and penetration depth (MPD and TPD), were also evaluated using two-dimensional (2D) high-resolution macro photographs of the light paths through a 0.005% solution of Rhodamine B.

Results

Regarding the spectroradiometer results, the Valo Cordless, Valo Grand, Valo X, and Bluephase PowerCure were multiple-emission peak LED units that delivered a broader spectrum of light, while the Ruby had a single-emission peak LED. Of note, the violet emission was greater for the Valo units compared to the Bluephase. The measured internal tip diameters were different than the stated diameters for all LCUs except the Valo X device, which remained the same. The Valo X Xtra Power mode delivered the highest radiant flux value (2704 ± 5^{B}), followed by the Valo Grand Xtra Power mode (2576 ± 6^{F}) and Valo Grand High Power mode (1929 ± 10^{E}), respectively. The lowest radiant flux was from the Valo Grand Standard Power mode (1148 ± 5^{D}). Regarding both the calculated radiant emittances based on the manufacturer's stated tip diameter and the measured internal tip diameter, the Bluephase PowerCure 3 S mode delivered the highest radiant emittances (2312 ± 15.5^{A} and 2719 ± 18.5^{a}, respectively), followed by the Valo Grand Xtra Power mode (2278 ± 5.51^{B} and 2316 ± 5.51^{b}, respectively) and Valo X Xtra Power mode (2203 ± 4^{C} and 2203 ± 4.51^{c}, respectively). The Valo Grand Standard Power mode delivered the lowest radiant emittance (1015 ± 4.4^{H} and 1032 ± 4.51^{h}, respectively) for both calculations. The Valo Grand Xtra Power mode had the largest deviation from the stated radiant emittance (27.6% lower), followed by the Ruby P1 mode (21.3% lower). The Valo X Xtra Power mode (0.2% higher) and Valo X Standard Power mode (0.7% lower) were the devices/curing modes with the smallest deviation from the stated radiant emittance.

Regarding the image processing results for the LCUs, the greatest light source width was from the Valo X device Extra Power mode, while the lowest was observed for the Woodpecker Led B device ($P<.001$) (Table 4). The greatest scattering was from the Bluephase PowerCure device 3 S mode, and the lowest was from the Valo X device Extra Power mode ($P<.001$). The Valo X in the Extra Power mode had the highest MPD and TPD among all ($P<.001$). The lowest MPD was observed for the D-Light Pro device Low Power mode, and the lowest TPD was observed for the Bluephase PowerCure device 3 S mode.

Regardless of the light-curing unit brand or curing mode, positive very strong correlations were observed for Total penetration depth (TPD), light source width, and radiant emittance ($P<.001$). Also, the TPD and the measured internal tip diameter were positively correlated at a moderate level ($P<.001$). However, scattering had a negative correlation with the TPD ($P=.014$). The measured internal tip diameter had a very strong positive correlation with the light source width ($P<.001$). A positive, strong correlation was also found between the light source width and radiant emittance ($P<.001$). Radiant emittance and scattering had a negative correlation ($P=.003$), likely the scattering and tip diameter ($P=.007$). A weak negative correlation was found between the measured internal tip diameter and the radiant emittance ($P<.001$)

Conclusions

Dental LCUs should be selected for clinical use by considering some specific features. The radiant emittance can deviate from the manufacturer's stated values by up to 27.6%. Regular measurements for the radiant emittance by a spectroradiometer are recommended to assess the amount of deviation, adjust the curing time accordingly, and thereby calibrate the clinical curing dose. Greater penetration depth can be expected when using LCUs with greater radiant emittance and tip diameter. The curing mode was considered ineffective on the scattering pattern of the light beam.

Implications for practice

Effective light-curing is a complicated clinical procedure in dentistry requiring many parameters. There might be some deviations in these features from the manufacturer's stated values. Clinicians should select the LCUs by considering the radiant flux, tip diameter, radiant emittance, light scattering, and penetration depth features to succeed in clinical restorative procedures.

REFERENCE

1. Korkut, B., Saygili, C.C., Murat, N. *et al.* Comparison of dental curing units and output modes regarding radiant flux, tip diameter, radiant emittance, scattering, and penetration depth. *Clin Oral Invest 29*, 395 (2025). https://0-doi-org.innopac.wits.ac.za/10.1007/s00784-025-06482-3

2. SPACE CLOSURE AFTER PREMOLAR EXTRACTION USING CLEAR ALIGNERS: A SYSTEMATIC REVIEW WITH META-ANALYSIS

There is substantial evidence from clinical studies and systematic reviews that space closure following premolar extractions in orthodontics is a well-studied and effective phase of treatment. Space closure after premolar extraction is recommended in various situations, such as severe crowding, unilateral agenesis, bimaxillary protrusion, convex facial profiles, and significant cephalometric discrepancies. The most common method for space closure following premolar extraction involves canine distalization and, in some cases, the first premolar, followed by anterior teeth retraction (ATR). This process requires effective anchorage control of molars and, occasionally, second premolars. Distalization, ATR, and anchorage control involve complex movements, such as inclinations, extrusion, torque, rotations, and translation of the teeth. Precise clinical execution is essential to prevent unwanted movements and ensure effective treatment.

Space closure using various orthodontic mechanics, such as en masse retraction (ER) or two-step retraction (TSR), is

generally effective but the time required for closure varies. ER tends to close spaces faster than TSR, with studies reporting closure times ranging from several months up to a year or more depending on technique and patient factors. Bodily movement of teeth to close premolar extraction spaces presents challenges, particularly when using clear aligners, which may be less predictable in producing bodily tooth movement compared to fixed appliances. Stability of space closure and relapse tendencies after treatment have been studied, with some evidence showing relapse can occur, though careful retention and treatment planning mitigate this risk.

Several pre-post studies and clinical trials evaluated the effectiveness of clear aligners in space closure after premolar extraction. Most studies investigated the Invisalign® G6 protocol system, which was specifically designed by Align Technology® to enhance ATR and anchorage control. G6 protocol has optimized retraction and anchorage attachments to maximize posterior anchorage and canine bodily movement. The ATR occurs after 1/3 of canine retraction, and clear aligners are designed to avoid tipping and extrusion of anterior teeth [2]. However, studies suggest that clear aligners can lead to various unwanted effects during space closure, such as crown tipping, extrusion of anterior teeth, and loss of anchorage of molars and second premolars. Invisalign offers patients the advantage of removability, which improves oral hygiene and comfort during extraction space closure, but it requires good compliance for effective results. Thus, clinical evidence supports Invisalign's use for space closure after premolar extraction, though treatment time and success may vary depending on case complexity, and sometimes fixed appliances might be preferred for difficult cases. Due to the high demand for space closure following premolar extraction and for clear aligners' treatment, *Vicioni-Marques et al (2025)[1] and colleagues undertook a* systematic review that sought to synthesize the available evidence from clinical trials and pre-post observational studies to evaluate the efficacy, predictability, and resistance to unwanted tooth movement of clear aligners in space closure after premolar extraction.

Methods

This systematic review was conducted using Cochrane and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The research question was developed using the PICOS format as follows:

- P (Population): Orthodontic patients during permanent dentition requiring extraction of upper or lower first or second premolars.
- I (Intervention): Space closure after premolar extraction using clear aligners.
- C (Comparison): Pre-treatment (pre-post studies), fixed orthodontic appliances, or different computer-aided techniques.
- O (Outcome): Efficacy and predictability of computer-aided techniques in space closing after premolar extraction, focusing on effects on canines, molars, anterior teeth, and resistance to unwanted tooth movement.
- S (Study design): Pre-post observational studies or randomized and non-randomized clinical trials (quasi-experiments).

Narrative reviews, case reports, in vitro, in situ (finite models), opinion articles, and studies that included patients with genetic syndrome and facial malformations were excluded.

The literature search was carried out until November 12, 2024, in five databases (PubMed, Web of Science, Embase, Scopus, Cochrane Library). The gray literature was searched using Google Scholar. Additional studies were identified from the reference list of the included studies. The search strategy was structured.

The selection of articles for possible inclusion involved screening titles and abstracts. Manuscripts meeting the eligibility criteria were retrieved for full-text evaluation. Finally, manuscripts that did not meet the established selection criteria after full-text evaluation were excluded.

The data extraction process was carried out independently by three reviewers. Data collected from each article included: included: the authors, year of publication, study design, clinical setting, sample characteristics, intervention, including clear aligner brand, duration of treatment, and control group, when applicable, methods of evaluation, results, and conclusion.

The Cochrane risk-of-bias tools were used to assess the quality of the included studies. The analysis was conducted by two authors, and any disagreements were resolved by a third reviewer. The ROBINS-I tool was applied to non-randomized studies (pre-post studies and non-randomized clinical trials). For randomized clinical trials, the ROB-2 tool was used.

Meta-analysis was only attempted where data were comparable. The heterogeneity among studies was evaluated using I^2. Due to the pre-post design of studies included in the meta-analysis, the Standardized Paired Difference (SPD) estimated the effect size.

A detailed qualitative synthesis of the evidence of the included studies was performed using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE). This tool considered aspects such as the type of study, risk of bias, consistency, directness, and precision of the articles.

Results

The systematic search identified 900 records, including 888 articles and 12 registrations. A total of 23 manuscripts were selected for full-text evaluation of which14 articles, encompassing 510 participants were selected for inclusion. The selected articles were published from 2008 to 2024, all in English.

Four studies had a low risk of bias, while ten had a high risk of bias. The results from pre-post studies indicated that clear aligner treatment was significantly less effective than predicted in achieving Anterior Teeth Retraction (SPD= -0.87; 95% CI = -1.15 to -0.60; 95% PI= -1.14 to -0.59; $p<0.001$; number of studies=4), resulting in more lingual tipping (SPD=1.09; 95% CI=0.46 to 1.73; 95% PI= -1.01 to 3.19; $p=0.001$; number of studies=3) and extrusion of anterior teeth (SPD=0.88, 95% CI=0.47 to 1.29; 95% PI= -0.16 to 1.92; $p<0.001$; number of studies=4) than predicted. The achieved distal tipping of canine (SPD=1.42; 95% CI=0.35 to 2.51; 95% PI= -2.5 to 5.40; $p=0.009$; number of studies=3) and mesial tipping of first molars (SPD=1.68; 95% CI=1.17 to 2.20; 95% PI=0.34 to 3.01; $p<0.001$; number of studies=3;) were also greater than predicted. Clinical trials comparing clear aligner treatment and fixed appliances provide limited evidence.

Conclusion

The findings suggest that clear aligner treatment may not be effective or predictable for space closure following premolar extraction due to its limited capacity to promote the bodily movement of the teeth and control anchorage. *Evidence indicates that fixed appliances might be superior to clear aligner treatment.* Limitations of the evidence include bias across studies, with the certainty of evidence ranging from low to very low. Future research should focus on improving prediction models and exploring the potential benefits of accessories to enhance clear aligner treatment effectiveness.

Implications for practice:

The need for patient demands for clear aligner treatment must be balanced by patients compliance and motivation to use appliance and individual factors such as oral hygiene concerns. However, it is important that the clinicians inform patients of all options and the evidence of efficacy thereof.

REFERENCE

1. Vicioni-Marques, F., Reis, C.L.B., de Almeida, A.P.V. *et al.* Space closure after premolar extraction using clear aligners: a systematic review with meta-analysis. *Clin Oral Invest* 29, 435 (2025). *https://0-doi-org.innopac.wits.ac.za/10.1007/s00784-025-06475-2*

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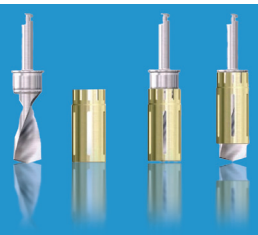

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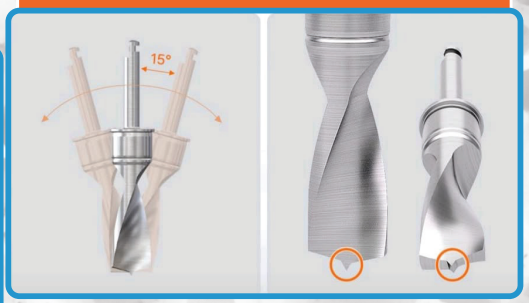

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