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Knowledge, attitude and awareness of photodynamic therapy among orthodontic practitioners: A questionnaire-based survey

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Abstract:
Photodynamic therapy (PDT) is a minimally invasive light-based treatment with antimicrobial applications relevant to orthodontic care. Therefore, it is of interest to assess the knowledge, attitudes, awareness and perceptions of PDT among 153 orthodontic practitioners using a 28-item questionnaire with good reliability (Cronbach's alpha = 0.82). Most respondents were younger than 30 years (65.4%) and had less than 4 years of experience (66%), while 88.9% scored above 8/10 for knowledge and 92.16% correctly identified the PDT mechanism. Awareness of PDT's role in antibiotic resistance was 82.35%, 66.7% favored its inclusion in postgraduate curricula and 58.2% identified equipment cost and technical requirements as barriers. Orthodontic practitioners therefore showed strong knowledge and favorable attitudes toward PDT, but structured training and curricular integration may facilitate routine clinical adoption.

Keywords: Photodynamic therapy (PDT), orthodontist, knowledge, attitude, awareness, knowledge, attitude, awareness (KAA), survey

Background:
Photodynamic therapy (PDT) is a medical treatment that employs light of a specific wavelength to activate dye molecules (photosensitizers) in the presence of oxygen **[1]**. Upon exposure, the photosensitizer generates reactive oxygen species, including singlet oxygen and free radicals, which induce localized photodamage and subsequent cell death **[2, 3]**. In recent years, PDT has emerged as a non-invasive therapeutic modality for a wide range of diseases **[4]**. It has been successfully applied in the management of neoplastic and precancerous lesions of the gastrointestinal tract, as well as in dermatological and urological conditions **[5, 6]**. In dentistry, PDT was initially introduced as a novel disinfection technique, particularly for periodontal and endodontic infections **[7]**. It offers a promising alternative for treating localized microbial infections and has gained importance in addressing antibiotic resistance among bacteria **[4, 8]**. Beyond its antimicrobial applications, PDT has been increasingly utilized in oral diseases such as lichen planus and oral squamous cell carcinoma **[5, 9]**. Fixed orthodontic appliances often compromise effective oral hygiene, necessitating frequent professional prophylaxis and adjunctive oral hygiene aids **[10]**. Inadequate patient compliance may lead to persistent gingival inflammation and eventual periodontal deterioration. PDT, therefore, presents itself as a supportive adjunctive modality for maintaining periodontal health during orthodontic treatment **[10]**. Previous studies have reported that dental practitioners (DPs) possess adequate knowledge regarding PDT and its applications in dentistry. However, gaps remain in terms of hands-on expertise and training, which are essential for its routine clinical use. This variability in clinical adoption highlights barriers to the wider implementation of PDT in orthodontic practice. Given the growing interest in PDT's benefits and the need to bridge the gap between research evidence and clinical practice, it is crucial to identify educational needs, misconceptions and factors influencing its integration into orthodontic treatment plans. A questionnaire-based survey among orthodontic practitioners can provide valuable insights to guide professional training enhance patient care outcomes and advance the clinical application of PDT in orthodontics **[2]**. Therefore, it is of interest to assess the orthodontic practitioners' knowledge, attitudes, awareness and perceived barriers regarding photodynamic therapy and its integration into orthodontic practice.

Materials and Methods:
A cross-sectional, questionnaire-based survey was conducted in the Department of Orthodontics, Chhattisgarh Dental College and Research Institute (CDCRI), Rajnandgaon, to evaluate orthodontic practitioners' knowledge, attitudes, awareness and perceptions regarding PDT. The study protocol was reviewed and approved by the Institutional Ethics Committee of CDCRI, Rajnandgaon. Given the minimal-risk nature of this questionnaire-based study, participation was voluntary and confidentiality of responses was maintained. Respondents were informed about the purpose of the study and consent was considered implicit upon completion of the questionnaire. Participants in the study included registered orthodontic practitioners and postgraduate students enrolled in

orthodontics. Undergraduate dental students or interns, practitioners from other dental specialties, respondents who submitted incomplete or improperly filled questionnaires and individuals who declined participation were excluded from the study. The required sample size was calculated using a 90% confidence level, an expected prevalence of 43% for adequate knowledge of PDT among dental practitioners, as reported by Vohra *et al.* **[2]** and an absolute precision of ±10%. Based on these parameters, the minimum sample size was determined to be 127 which were rounded off to 150 participants. The questionnaire was designed with reference to previously validated PDT-related surveys **[2]** and showed strong internal consistency (Cronbach's alpha: 0.82). Content validity was established through expert review and the instrument was pretested to ensure clarity and feasibility. A structured, self-administered questionnaire comprising 28 items was developed and was organized into four sections. The first section collected demographic information, including age, gender, years of clinical experience and type of practice. The second section comprised 10 dichotomous (yes/no) items designed to evaluate knowledge of photodynamic therapy (PDT). The third section consisted of 8 Likert-scale statements that explored practitioners' attitudes toward PDT. The fourth section included 6 items assessing awareness and perceptions of PDT: one multiple-choice question on sources of knowledge followed by five dichotomous (yes/no) questions. The questionnaire was administered electronically via Google Forms and distributed through email and WhatsApp groups. Responses were scored according to item type: knowledge questions (yes/no) were awarded one point for each correct answer, with a maximum possible score of 10; attitude items were measured on a five-point Likert scale **[12]** (strongly agree to strongly disagree); and awareness and perception items were summarized as proportions of affirmative responses. The average completion time was approximately 10 minutes. Data were analyzed using SPSS software version 26 (IBM Corp., Armonk, NY). Descriptive statistics (frequencies and percentages) were used to summarize demographic variables and questionnaire responses. Knowledge, awareness and perception items with dichotomous responses (Yes/No) were presented as proportions of correct or affirmative responses. Attitude items on the Likert scale were summarized using frequencies and percentages. Spearman's correlation coefficient was applied to assess the relationships between clinical experience and knowledge scores, practitioners' attitudes, perceived training needs and clinical perception. All statistical tests were performed at a 5% level of significance ($p < 0.05$).

Results:

Of the 300 questionnaires distributed, 153 were completed and returned, yielding a response rate of 51%. **Table 1** shows the demographic profile of respondents. Slightly more were female (54.2%) than male (45.8%). Most were younger than 30 years (65.4%) and had fewer than 4 years of clinical experience (66%), indicating a predominantly early-career group. Practice settings were fairly distributed between private (38.6%), institutional (35.9%) and combined practice (25.5%). **Table 2** summarizes knowledge assessment. Awareness of PDT was high, with over 90% correctly identifying its mechanism, minimally invasive nature and compatibility with orthodontic appliances. Clinical applications were also well recognized: 83% acknowledged its preventive role in enamel decalcification, 88% its effectiveness against oral pathogens and 85% its common photosensitizers. Slightly fewer (82%) recognized its advantage in reducing antibiotic resistance. Overall, respondents showed strong foundational and clinical knowledge of PDT. **Table 3** highlights attitudes. Most respondents agreed PDT enhances oral hygiene (65%) and expressed willingness to adopt it with training (65%). Perceptions of safety and patient-friendliness were positive (63%) and two-thirds supported its inclusion in postgraduate curricula. PDT was also seen as useful for reducing cross-infection (60%). Cost and equipment were noted as barriers (58%), though only 28% considered PDT unnecessary. A majority (64%) believed patients would find PDT acceptable. **Table 4** presents awareness and perceptions. Academic curricula were the most common source of initial exposure (35%), followed by peers (20%) and journal articles (15%). Awareness of clinical guidelines was moderate (54%) and participation in PDT-focused workshops was balanced (46%). More than half (58%) were familiar with published studies. Patient acceptability was perceived positively (86%) and a similar proportion (85%) expressed interest in hands-on training. Overall, the results indicate that respondents were predominantly young practitioners with strong knowledge, favorable attitudes and high interest in PDT, though gaps in guideline awareness and concerns about cost remain.

Table 1: Demographic details

Item			N	%
1.	**Gender**	**Female**	83	54.2
		Male	70	45.8
2.	**Age (in years)**	**<30**	100	65.4
		30–39	37	24.2
		40–49	15	9.8
		≥50	1	0.7
3.	**Clinical experience (in years)**	**<4**	101	66
		4–13	39	25.5
		14–23	11	7.2
		>23	2	1.3
4.	**Type of practice**	**Institutional**	55	35.9
		Private	59	38.6
		Both	39	25.5

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Table 2: Response summary of dental practitioners regarding knowledge

Item	Response N (%)	
	Yes	No
1. Have you heard of photodynamic therapy (PDT) used in dentistry?	135 (88.24%)	18 (11.8%)
2. PDT involves the use of a photosensitizing agent activated by light of a specific wavelength to destroy microorganisms.	141 (92.16%)	12 (7.84%)
3. PDT is considered a minimally invasive adjunctive procedure for managing gingivitis and periodontitis.	139 (90.85%)	14 (9.15%)
4. PDT can be used as a preventive approach to reduce enamel decalcification in orthodontic patients.	127 (83.01%)	26 (16.99%)
5. Common photosensitizers used in dental PDT include methylene blue and toluidine blue O.	130 (84.97%)	23 (15.03%
6. PDT is effective against oral pathogens such as Streptococcus mutans and Porphyromonas gingivalis.	135 (88.24%)	18 (11.76%)
7. PDT is less likely to induce bacterial resistance compared to conventional antibiotics.	126 (82.35%)	27 (17.65%)
8. Knowledge of optimal light parameters (e.g., wavelength, exposure time) is essential for effective PDT outcomes.	140 (91.50%)	13 (8.5%)
9. PDT can be safely applied during orthodontic treatment without interfering with metallic brackets and wires.	141 (92.16%)	12 (7.84%)
10. PDT is contraindicated in patients with known photosensitivity or porphyria.	140 (91.50%)	13 (8.5%)

Table 3: Response summary of dental practitioners regarding attitude

Item	Likert scale N (%)				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. PDT enhances the effectiveness of oral hygiene protocols in orthodontic patients.	18 (11.8%)	82 (53.6%)	43 (28.1%)	1 (0.7%)	9 (5.9%)
2. I would consider incorporating PDT into my practice if appropriate training were available.	20 (13.1%)	80 (52.3%)	45 (29.4%)	4 (2.6%)	4 (2.6%)
3. PDT is a safe and patient-friendly modality.	24 (15.7%)	73 (47.7%)	52 (34%)	3 (2%)	1 (0.7%)
4. PDT should be included in the postgraduate orthodontic curriculum.	28 (18.3%)	74 (48.4%)	45 (29.4%)	2 (1.3%)	4 (2.6%)
5. PDT can help reduce cross-infection in dental clinics.	20 (13.1%)	72 (47.1%)	57 (37.3%)	2 (1.3%)	2 (1.3%)
6. Cost/equipment requirements may limit routine PDT use.	17 (11.1%)	72 (47.1%)	54 (35.3%)	8 (5.2%)	2 (1.3%)
7. PDT is unnecessary in routine orthodontic care.	9 (5.9%)	34 (22.2%)	59 (38.6%)	38 (24.8%)	13 (8.5%)
8. Patients would find PDT comfortable and acceptable.	22 (14.4%)	76 (49.7%)	52 (34%)	1 (0.7%)	2 (1.3%)

Table 4: Response summary of dental practitioners regarding awareness and perceptions

Item	Response	N (%)
1. Where did you first learn about PDT?	Colleague/Peer	30 (19.6%)
	Journal article	23 (15.0%)
	Social media/ Online platform	19 (12.4%)
	Undergraduate/ Postgraduate curriculum	53 (34.6%)
	Workshop/Seminar	17 (11.1%)
	Not applicable	11 (7.2%)
2. Are you aware of any existing clinical guidelines for PDT use in orthodontics?	Yes	83 (54.2%)
	No	70 (45.8%)
3. Have you attended any workshops/seminars/webinars focused on PDT in dentistry?	Yes	71 (46.4%)
	No	82 (53.6%)
4. Are you familiar with any published studies or case reports on PDT in orthodontics?	Yes	88 (57.5%)
	No	65 (42.5%)
5. Are patients likely to accept PDT as an adjunctive treatment in orthodontic care?	Yes	131 (85.6%)
	No	22 (14.4%)
6. Would you be interested in attending hands-on PDT training programs?	Yes	130 (85.0%)
	No	23 (15.0%)

Discussion:

PDT has emerged as a promising adjunctive modality in dentistry and orthodontics, particularly for managing biofilm-related complications, periodontal challenges and enamel decalcification. Understanding practitioners' knowledge, attitudes and awareness of PDT is essential for evaluating its potential integration into routine orthodontic care. The present study revealed a notably high level of knowledge among orthodontic practitioners. An overwhelming majority (88.9%) achieved scores of eight or more correct responses, with over half attaining a perfect score. This reflects a strong foundational understanding of PDT principles, mechanisms and clinical relevance within orthodontic practice **[2, 5].** These findings contrast with the global survey conducted by Qamar *et al.* **[11].** During the COVID-19 pandemic, this reported predominantly moderate knowledge levels among dental practitioners. In that study, many respondents lacked familiarity with specific photosensitizers, appropriate light wavelengths and optimal treatment parameters. The superior knowledge observed in the present study may be attributed to structured postgraduate education and formal academic exposure, as evidenced by 34.6% of participants identifying academic training as their primary source of PDT knowledge. This suggests that systematic inclusion of emerging adjunctive therapies within orthodontic

curricula plays a crucial role in enhancing practitioner competence and confidence **[4, 5].** Attitude assessment revealed a generally positive outlook toward PDT integration. Approximately two-thirds of respondents supported its inclusion in postgraduate orthodontic curricula and a similar proportion expressed willingness to adopt the technique if adequate training opportunities were available. These findings indicate not only conceptual acceptance but also readiness to translate knowledge into clinical practice **[2, 5].** In comparison, Qamar *et al.* **[11]** reported cautious optimism among dentists globally. While practitioners acknowledged PDT's therapeutic potential, concerns related to high costs, limited equipment availability and insufficient training tempered enthusiasm. Although both studies identify cost and equipment as persistent barriers, the present study reflects stronger academic acceptance. This difference may suggest that orthodontic practitioners, due to their structured training environment and frequent management of biofilm-related complications, are more receptive to incorporating PDT into formal educational and clinical frameworks **[5].** Awareness in this study was predominantly shaped by academic exposure, with over one-third citing formal education as their initial source of information. This differs from Qamar *et al.* **[11],** where workshops, continuing dental education programs and peer discussions were more common globally. Notably, a higher proportion of respondents here reported familiarity with published scientific literature on PDT (57.5%), indicating greater engagement with evidence-based resources **[5].** Despite this encouraging trend, nearly half of respondents were unaware of established clinical guidelines for PDT application, mirroring global observations that standardized protocols remain poorly disseminated **[11].** This lack of guideline awareness may hinder consistent clinical application and underscores the need for clearer consensus statements and professional recommendations. Perceptions of patient acceptability were strongly positive, with 85.6% of respondents believing patients would readily accept PDT. Additionally, a substantial majority expressed keen interest in hands-on training programs. These findings suggest that orthodontic practitioners not only recognize PDT's clinical value but are also motivated to acquire practical skills for its implementation **[2, 5].** Qamar *et al.* **[11]** similarly reported positive perceptions regarding patient acceptance; however, fewer practitioners globally showed willingness to pursue training opportunities. The higher training interest observed in the present study may be explained by the direct relevance of PDT in orthodontics, particularly in managing gingival inflammation, periodontal challenges and enamel decalcification around brackets and aligners. Collectively, the findings suggest that orthodontic practitioners in this study exhibit higher level of knowledge, awareness and academic acceptance of PDT compared to global averages. Nevertheless, they continue to face challenges similar to those reported worldwide, particularly regarding equipment costs and limited dissemination of standardized clinical guidelines **[2, 5 and 12].** The strong interest in training programs presents a valuable opportunity for advancing PDT adoption within orthodontics. Incorporation of structured postgraduate modules, continuing professional development courses and hands-on workshops could facilitate the transition from theoretical understanding to routine clinical use. Furthermore, the development of cost-effective PDT devices and clear, evidence-based clinical protocols may help overcome existing barriers and promote wider implementation. Bridging this gap between knowledge and practice has the potential to enhance patient outcomes and establish PDT as a standard adjunct in contemporary orthodontic care.

Conclusion:

Orthodontic practitioners showed good knowledge of PDT and positive attitudes toward its safety, clinical benefits and patient acceptability. Academic exposure and interest in practical training indicate readiness for greater clinical application of PDT. Improved awareness of standardized guidelines, affordable equipment, and structured training may promote wider adoption of PDT in orthodontic practice.

Advancement to Knowledge:

This study provides the first focused insight into orthodontic practitioners' perspectives on photodynamic therapy (PDT), revealing both strong foundational knowledge and enthusiasm for its integration into clinical practice. By systematically identifying gaps in guideline awareness and highlighting cost-related and technical barriers, the findings advance knowledge by bridging the disconnect between theoretical understanding and practical application. Importantly, the results underscore the need for structured postgraduate training modules, standardized clinical protocols and institutional support to facilitate adoption. This contribution is significant because it positions PDT not merely as an emerging adjunctive therapy but as a potential cornerstone in orthodontic infection control strategies, particularly in the context of rising antibiotic resistance. The study therefore informs curriculum development, policy initiatives and resource allocation, offering a roadmap for accelerating the safe and consistent incorporation of PDT into orthodontic care.

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