



Assessing dentists' awareness of the orthodontic–restorative interface

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ABSTRACT

Objectives: Awareness of the interface between restorative and orthodontic treatments is essential for dentists to facilitate a meaningful interdisciplinary approach by integrating the knowledge and skills of different dental disciplines into patients' treatment to enhance outcomes. The aim of this study was to investigate General Dental Practitioners' (GDPs) awareness of the orthodontic–restorative interface.

Methods: This was a mixed-method study involving the collection of a) quantitative data via a bespoke online questionnaire and b) qualitative data through open questions. A weblink was created to the questionnaire using Opinio®. The questionnaire was distributed to GDPs practising in the UK. Clinical vignette-based questions assessed GDPs awareness and the results were categorised into two groups: aware and unaware. Two months after the primary survey, respondents were sent an email with follow-up (reliability) survey. Reliability responses were compared against the primary responses to assess the repeatability using intraclass correlation coefficient. Data were analysed using independent *t*-test and χ^2 test.

Results: 118 complete responses were received. 63 GDPs (53.4 % [95 % CI 44 %–63 %]) demonstrated a good understanding of the orthodontic–restorative interface. These GDPs were characterised by greater age ($t = 2.75$, $p = 0.007$) and experience ($t = 3.54$, $p < 0.001$). Qualitative data showed that respondents perceived orthodontic–restorative treatments as minimally invasive and aesthetics enhancing.

Conclusions: Orthodontic–restorative treatment aids in minimal invasive dentistry. GDPs lack adequate awareness of the orthodontic–restorative interface in relation to patient care and communication with patients. More quality and structured undergraduate and postgraduate training are imperative to facilitate GDPs to understand and utilise aspects of orthodontic–restorative treatments to raise the standard of patient care. Additionally, to support these patients, the educational pathway between GDPs and specialist orthodontists is crucial.

Clinical Significance: GDPs ability to assess and carry out orthodontic–restorative treatments would conserve natural teeth. Dependable access to orthodontic services would encourage GDPs to refer challenging cases to specialists or dentists with enhanced skills. When the circumstances call for it, patients should be given orthodontic–restorative alternatives, regardless of the potential consequences of their acceptance of the procedures.

1. Introduction

The demands on GDPs to provide good quality aesthetic and restorative treatments, including offering orthodontics as a treatment option, to satisfy patient expectations has increased significantly over recent years [1]. Restorative and aesthetic treatment outcomes can be enhanced by incorporating planned orthodontic tooth movement [2]. A combination of orthodontic and restorative treatment facilitates the effective management of malocclusion, thus lowering the incidence of temporomandibular symptoms, dental and gingival trauma, improvement in speech, mastication, self-confidence, and perceived social

acceptance [3]. Advantages of co-ordinated orthodontic–restorative treatment include the conservation of natural tooth structure that allows for biologically and functionally stable results with better aesthetic outcome [4]. Disadvantages are prolonged treatment duration and financial costs to patients. Kokich and Spear [5] described the importance of establishing an economically realistic orthodontic–restorative treatment plan for each patient, that the inability to do so could lead to the failure in completing full treatment by the patient. Though orthodontic–restorative solutions may take longer to achieve than an exclusive full-mouth restorative solutions, it espouses minimal invasive principles which coupled with motivation and patient compliance

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would achieve an optimum outcome [6]. Commonly encountered orthodontic-restorative cases are spacing and space management cases like hypodontia; microdontia; worn dentition; realignment of teeth to allow conservative tooth reductions for restorative treatment; repositioning of teeth to permit space for an implant and orthodontic extrusion to improve bone level for implants; gingival disharmony and orthodontic extrusion of root canal treated or traumatically fractured teeth [7].

GDPs awareness of the interface between orthodontics and restorative treatments is needed to identify, assess, treat or to refer patients. To meet patients' expectations fully, clinicians should be competent in all aspects of clinical dentistry [8,9]. GDPs can indeed provide orthodontic treatment alongside restorative treatments if they also have good knowledge on orthodontic treatments. Many GDPs attempt to master subjects such as short-term orthodontics that involve aligning anterior teeth through continuing education courses as it is not taught in undergraduate programmes [10].

GDPs awareness of orthodontic principles, problems, and retention had been assessed previously [11–16]. Knowledge or awareness of GDPs in restorative fields had been discussed in the past [17–19]. However, there has been no such study specifically investigating GDPs awareness of the orthodontic–restorative interface. Awareness herein refers to a common understanding of the utilisation of orthodontics in restorative treatment planning. This study addresses the literature gap in this respect and provides evidence on the current perceptions and awareness GDPs have in respect of the orthodontic–restorative interface and identify their training needs.

The aim of the study was to establish UK-based GDPs' awareness of orthodontic procedures relevant to restorative dentistry practice.

2. Materials and methods

A mixed-method approach was adopted, primarily involving the collection of quantitative data from open, closed, rating and scenario-based questions and qualitative data as comments in comment boxes in a bespoke questionnaire. With an estimated true proportion of 70 %, desired precision of ± 10 %, and confidence interval of 95 %, 144 respondents were required to validate the study [20]. The questionnaire consisted of 19 questions. Three specific clinical vignette-based questions were designed as multiple-choice questions with a comment box which facilitated the respondents to elaborate the rationales behind their choices. Restorative and orthodontic expert opinions were sought to validate the questionnaire. A pilot study was conducted to ascertain the feasibility. Clinical cases were selected based on orthodontic-restorative scenarios and the need for combined treatments. Clinical vignettes researched the aim of the study by investigating the respondent's awareness and experience [21]. The suitable answer choice was allocated a score of 1 for analysis purposes. The outcomes of awareness were grouped as aware or unaware. Respondents scoring 3/3 in the clinical vignette-based awareness questions were deemed to have good awareness, any scores less than 3 were categorised as unaware. Respondents could achieve a maximum score of 3 and a minimum score of 0. The repeatability was measured by Intraclass correlation coefficient ICC = 0.72 (95 % CI 30 %–89 %), which indicates modest reliability.

The three clinical situations were palatally positioned UR2 with a veneer (vignette 1)—Fig. 1, unilaterally missing UR3 (vignette 2)—Fig. 2, and mesiolabially rotated UL2 (vignette 3)—Fig. 3.

2.1. Data collection

Data collection was undertaken on two occasions, namely a) primary data collection—main questionnaire, and b) follow-up data collection—reliability questionnaire.

Primary data collection involved the distribution of the questionnaire through multiple sources such as social media specific to dentists, email to GDPs associated with dental foundation training, and QR codes



Fig. 1. Clinical vignette 1: 2 clinical photographs of “Palatally positioned UR2 with a veneer”.



Fig. 2. Clinical vignette 2: 2 clinical photographs of “Unilaterally missing UR3”.

in locations where dentists meet. The software package Opinio®, a web-based survey tool, was used to create a web link to the questionnaire [22]. All respondents were required to confirm that they had read the participation information sheet and consented affirmatively before taking the survey. Ethics approval had been granted by the University College London Research Ethics Committee (ID number 22231/001).

Follow-up data collection through a reliability questionnaire, was via email. This was sent 2 months following the main questionnaire and targeted 64 respondents who had electively provided their email addresses when responding to the primary survey. A reliability test was



Fig. 3. Clinical vignette 3: 2 clinical photographs of “Mesiolabially rotated UL2”.

undertaken to assess the reliability of the main outcome and reproducibility of this survey. The reliability questionnaire comprised only three specific clinical vignette-based questions. Opinio® was used to create a weblink for the reliability questionnaire. 20 responses were returned with a response rate of 31 %. All email addresses in the main questionnaire and reliability questionnaire were coded by a third person to preserve confidentiality and prevent bias. The reliability test responses were compared against the main responses on a one-to-one basis using the email codes as identification. The compared results were statistically analysed to assess results dependability.

2.2. Data analysis

Two different categories of responses were created namely a) complete: for those who have completed all the questions, and b) incomplete: for those who have not completed the whole questionnaire. Complete responses were used for the main outcome analysis whereas incomplete responses were included for demographic data analysis. Quantitative analysis was completed via SPSS software (Version 27). The outcomes were analysed alongside different variables, such as demographic variables, to assess potential predictors of awareness. Independent *t*-test was used to compare the means of two data sets, X^2 test and trend test was used to test the association between two categorical variables. McNemar's X^2 test was used to check the marginal homogeneity of two dichotomous variables and the intraclass correlation coefficient (ICC) was used to assess the reliability of results. Logistic Regression, Forward and Backward selection was used to resolve collinearity. Results with *p*-value <0.05 was determined to be significant. Qualitative analysis was undertaken as a narrative review.

3. Results

3.1. Demographics

167 respondents completed the questionnaire, out of which 49 were partial responses. Partial responses were included only in demographic analysis to understand how this response varied demographically. The majority of the respondents who participated in the questionnaire were from England and were based within a mixed practice setting (Table 1).

Table 1

Descriptive table of complete vs incomplete responses.

Variable	Complete (n = 118) Mean (SD)/n (%)	Incomplete (n = 49) Mean (SD)/n (%)	Significance test	<i>p</i> -value
Age	40.50 (9.95)	35.80 (9.21)	<i>t</i> = 2.84	0.005
Year of graduation	2005 (10.20)	2010 (8.98)	<i>t</i> = 2.78	0.006
Years of experience	15.43 (10.09)	10.39 (9.06)	<i>t</i> = 3.03	0.003
Type of practice	NHS 12 (10.2) Mixed 70 (59.3) Private 36 (30.5)	NHS 5 (10.2) Mixed 31 (63.3) Private 13 (26.5)	X^2 = 0.28	0.871
Region of practice	England 105 (89) Other regions UK 13 (11)	England 43 (87.8) Other regions UK 6 (12.2)	X^2 = 2.24	0.523

Due to the nature of the delivery process of the questionnaire, it was not practicable to determine the response rate.

3.2. Awareness

The 118 complete responses were used in order to analyse the main outcome. Awareness was determined by respondents providing 3 out of 3 correct answers, achieved by 63 (53.4 % [95 % CI 44 %–63 %]) respondents.

The three clinical vignettes assessed the respondents' awareness by questioning their preferred treatment option in these clinical situations. The first question evaluated the respondents preferred aesthetic treatment options for a palatally positioned upper right lateral incisor with an existing veneer (Fig. 1). 100 (84.7 %) selected orthodontic alignment along with gingival margin surgery if required, as the preferred treatment option.

Respondents were then questioned about the treatment choice for the replacement of a missing tooth where upper right canine was missing in a 20-year-old patient (Fig. 2). 72 (61.5 %) chose orthodontic inclusion before the restorative solution as their preferred choice of treatment.

The third and last vignette explored the preferred treatment options for an unrestored and rotated upper left lateral incisor (Fig. 3). 116 (98.3 %) chose orthodontic alignment as their desired choice of intervention. This vignette contributed less in assessing awareness as it was considered relatively straightforward to answer. Nevertheless, this question tested the GDPs' awareness of minimally invasive treatment options by including orthodontic tooth alignment before any restorative treatment. Avoidance of orthodontics in this instance could result in significantly invasive treatment and aesthetically sub-optimal results.

Age, year of graduation and years of experience positively influenced the awareness based on the questions asked. Demographic distribution highlighted that those respondents who had graduated earlier and had more experience were more aware compared to recent graduates (Table 2). Logistic regression analysis suggested that clinical experience was the main influence. More experienced respondents were more likely to complete the questionnaire and were more aware (McNemar's X^2 = 1.00; *p* = 0.61). It is evident that respondents having an interest in and career experience of orthodontics predisposed the sample to take part and complete the survey, a source of bias. As a vast majority of the respondents were from England, it was not possible to determine whether awareness was influenced by region of practice.

Respondents have perceived their awareness of the orthodontic–restorative interface from their undergraduate dentistry training as a baseline. Respondents who have attended CPD and postgraduate (PG) courses related to orthodontics (*n* = 44, 57.9 %) expressed good awareness compared to those who did not attend; however, these

Table 2
Comparison of potential predictors between awareness groups.

Variable	Aware (n = 63) Mean (SD)	Unaware (n = 55)	Test statistics	p-value
Age	42.75 (10.99)	37.93 (7.96)	t = 2.75	0.007
Year of graduation	2002.84 (11.43)	2008.27 (7.74)	t = 3.06	0.003
Years of experience	18.29 (11.39)	12.16 (7.19)	t = 3.54	<0.001
PG course attendance	n (%)			
Yes	44 (57.9 %)	32 (42.1 %)	X ² = 1.73	0.19
No	19 (45.2 %)	23 (54.8 %)		
Type of PG course				
PG (MSc, diploma, certification)	8 (47.1 %)	9 (52.9 %)	X ² = 0.26	0.61
CPD	35 (60.3 %)	23 (39.7 %)		
None	20 (46.5 %)	23 (53.5 %)		

differences were not statistically significant.

Qualitative analysis demonstrated respondents' awareness about the limitations of pure restorative intervention and that the inclusion of orthodontic tooth movement could result in conservative and aesthetic outcomes. For clinical vignette 1, one respondent commented, "Always the best result with ortho in terms of aesthetics and dental health". However, another respondent commented, "No space for orthodontic treatment, veneer is not helpful. Crown could be the optimal solution" which shows a lack of awareness. For clinical vignette 2, there was a divided opinion as to whether a small amount of orthodontic tooth movement before the restorative phase would be beneficial. One respondent commented, "Alignment doesn't look too bad, so no necessary indication for pre-restorative orthodontics". Nevertheless, another respondent stated, "Orthodontic treatment to provide a favourable space and occlusion so that the fixed option has better conditions". In clinical vignette 3, there was a clear understanding from the respondents that the pure restorative option would be the most destructive in this case, and it would result in a very compromised result. Respondents mentioned, "Restorations alone would give a very compromised result. These teeth need ortho!" and "Would only consider ortho for this case".

Combining orthodontics in restorative treatment planning was perceived as conservative to the natural teeth. 105 (89 %) respondents recognised orthodontic-restorative treatment as minimally invasive and 85 (72 %) thought improve aesthetics and frequently considered utilising orthodontics in restorative treatment cases. Whereas 55 (46.6 %) respondents thought orthodontic-restorative treatments were expensive and 44 (37.3 %) perceived it as time-consuming.

Respondents were keen to refer challenging cases such as hypodontia to an orthodontist or a dentist with enhanced skills. 88 (74.6 %) respondents were willing to refer for treatment; however, 45 (38.1 %) favoured specialist opinion in such cases and 47 (39.8 %) wanted to obtain treatment plan from them. With consistent access to specialist orthodontic services, a vast majority of 112 (94.9 %) respondents would consider using appropriate orthodontic intervention before or simultaneously with restorative treatment.

Orthodontic treatment provision through a clear aligner was the preferred technique with 58 (49.2 %) respondents providing treatment themselves. Among these respondents 33 (56.9 %) were aware of the orthodontic-restorative interface.

4. Discussion

This study investigated insights into GDPs' awareness of the orthodontic-restorative interface. This was a UK wide study, however, the majority (n = 148; 88.6 %) of respondents were from England with only a handful from the other UK countries. This needs to be taken into account when looking to generalise the findings. It was clear that the awareness of the practitioner was influenced by their age, year of graduation, and experience.

This study also demonstrated that GDPs' awareness of the orthodontic-restorative treatment interface was less than predicted. This

might be due to how undergraduate/postgraduate dental curricula are organised, where individual specialities are taught in isolation and not in combination. The reliability test has confirmed the consistency of this study's results and findings.

GDPs' who had more clinical experience were more likely to show adequate awareness compared to those who had less experience. Experienced graduates might also have been more familiar with the relevant literature coupled with greater clinical experience and acumen on the orthodontic-restorative interface [23]. The awareness exhibited by the more experienced graduates might also be influenced by their interest in this topic or their experiences working alongside orthodontics specialists or enhanced skills dentists. The crucial role of lifelong learning should be emphasised as exposure to contemporary evidence encourages practitioners to upskill their practice for the benefit of their patients.

To be able to treat appropriately in respect of different clinical situations and to properly counsel, refer or treat patients, GDPs should have a comprehensive understanding of all aspects of dentistry including the orthodontic-restorative interface as a multidiscipline approach offering total patient care. Respondents who were noted to be "unaware" have generally not attended any orthodontic postgraduation courses. This was possibly due to the fact, that the choice of clinical topics undertaken for continuing professional development, rests with the individual practitioner [24,25]. It could also be due to a lack of exposure or interest to learning or lack of availability of postgraduate courses on the orthodontic-restorative interface that restricted practitioners' choices of courses they could undertake. If the lack of awareness was a result of an absence of interest, then future research should explore why this might be the case. Awareness demonstrated by respondents who have completed formal PG qualification (MSc, Diploma, Certification) or CPD courses was comparable to the literature, that "the more training undergone by a GDP, the more self-confident they become" [26]. The proportion of CPD attendees outnumbered the formal PG course attendees. This is likely due to the time required to complete a CPD course compared to formal postgraduate qualifications. The geographical locations of GDPs could limit access to the higher education institutions which provide the formal postgraduate qualifications. Course fees can also be a potential barrier to practitioners pursuing further education [10]. Despite the completion of the 2-3 years of training, GDPs do not gain any recognition towards specialisation [27]. This could have resulted in a disincentive for undertaking formal postgraduate training.

Case scenarios expressed GDPs awareness of conservative and aesthetic outcomes with an orthodontic-restorative approach. Nevertheless, there was a consensus among the respondents that this type of treatment was expensive, time-consuming and less accepted by the patients. This was consistent with the findings of other studies [2,28].

Respondents showed a positive attitude towards utilising specialist expertise while encountering a challenging orthodontic-restorative case. This confirmed previous findings that 50 % of referrals to orthodontic-restorative dental services were made by GDPs [29]. Employment of specialist services for challenging cases was appreciated even among

respondents who provided orthodontic alignment to patients. This could be interpreted as the respondents understanding of their limitations on the provision of orthodontic treatments.

GDPs can play either the role of orthodontic health educator who assesses, counsels, and makes a referral to appropriate services or an orthodontic-restorative treatment provider who provides the needed treatment when there is good knowledge of orthodontic treatment practice and principles. As an orthodontic health educator, GDP should be aware of the orthodontic concepts to advise patients about the referral. Most of the respondents felt that they were not aware of the orthodontic–restorative interface during undergraduate training. This indicated the need for more emphasis on orthodontic concepts in the undergraduate dental curriculum. A survey by Acharya and Mishra [30] concluded that dentists and non-orthodontic specialists need more education on orthodontic treatment concepts via undergraduate education and continuing dental education for proper counselling and referral. Lack of awareness might result in inappropriate referrals or clinically sub-optimal treatments. The need for improved education and referral guidelines is therefore important to help to get them right.

The trend of general dentists providing orthodontic treatments is increasing. 58 (49 %) respondents provide orthodontic treatment. This is comparable with current literatures stating that between 20 and 50 % of the orthodontic treatments were provided by general dentists [31]. This increase in trend can be partly due to the increased levels of short-term orthodontic courses, media advertising, and marketing involved. The level of comprehensive education offered in these courses are not clear. Respondents have mentioned attendance on short-term courses such as Invisalign®, Align®, bleach, and bond course; and postgraduate qualifications such as restorative and orthodontic diplomas have given insight into orthodontic-restorative treatments. However, there was an expression among the respondents of the need for more emphasis on the orthodontic-restorative component in the appropriate curriculum.

Most of the respondents preferred to use clear aligner system over fixed or removable appliances for their patients and would prefer to refer complex cases to orthodontic specialists. This could be because of the lack of long-term scientific evidence behind the clear aligner systems, no clear guidance to identify cases unsuitable for this system, and the limitations on the use of clear aligners in challenging clinical cases [32,33]. When GDPs work within their competencies and the specialists oblige to act as a teacher and mentor to their non-orthodontist colleagues when needed, the meaningful implementations of a seamless orthodontic–restorative interface can be realised with patients and the dental profession being the main benefactors.

5. Conclusion

Although just over half respondents showed good awareness a considerable number need to be more aware. Combining orthodontics with restorative dentistry is the way forward for many patients who would benefit from an aesthetic, functional and conservative approach to improving their smile and function. Dental practitioners' awareness of the interface between orthodontics and restorative treatments is crucial to identify, assess and treat, or refer these patients. There is an enduring need for dentists to become more aware of the orthodontic-restorative aspects of patient care as shown in this study. The shortage of training in orthodontic–restorative interface should be taken into account by appropriate educators by integrating this essential area of practice into the undergraduate and postgraduate dental curriculum, where appropriate. In addition, the educational pathway between specialist orthodontists and GDPs to support these patients is essential.

Consent statement

Informed consent was obtained from all subjects involved in this study.

Availability of data and materials

The datasets of the current study are available from the corresponding author on reasonable request.

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Ethical approval

This work described has been carried out in accordance with the Declaration of Helsinki and approved by the University College London Research Ethics Committee (Project no: 22231/001, 8 March 2022).

CRedit authorship contribution statement

Revathi Arunachalam: Conceptualization, Methodology, Investigation, Writing – original draft. **Neil Nathwani:** Writing – review & editing. **Touraj Nejatian:** Supervision, Validation. **Peter Fine:** Validation, Writing – review & editing. **Albert Leung:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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