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Knowledge, attitudes, and practices regarding periodontal assessment and co-management during orthodontic care among Moroccan dentists: a nationwide cross-sectional survey

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Abstract

Background Periodontal diseases are common chronic inflammatory conditions that may compromise the planning, safety, and outcomes of orthodontic treatment, particularly in adults and in patients with reduced periodontal support. In such patients, orthodontic care requires accurate periodontal diagnosis, confirmation of disease stability before treatment initiation, careful biomechanical adaptation, and close coordination with periodontal maintenance. However, the extent to which dentists providing orthodontic care integrate these principles into routine practice remains insufficiently documented, particularly in North African settings. This study assessed the knowledge, attitudes, and practices of Moroccan dentists providing orthodontic care regarding the diagnosis and management of patients with periodontal diseases.

Methods A nationwide cross-sectional online survey was conducted in Morocco between September 2025 and February 2026. Eligible participants were dentists practicing orthodontics exclusively or within general practice. The questionnaire included demographic variables, 8 knowledge items, and 9 attitude/practice items covering diagnosis, screening, treatment timing, interdisciplinary collaboration, and periodontal maintenance. Item-level descriptives used available-case denominators. Knowledge (0–7), attitude (0–2), practice (0–6), and total KAP (0–15) scores were calculated. Associations with periodontitis-case management were explored using logistic regression; correlates of KAP scores were examined using linear regression, with candidate variables selected from univariable analyses ($p < 0.20$).

Results Of 418 platform entries, 118 blank entries were excluded; 300 practitioners from 11 regions provided at least 1 valid response, including 190 complete questionnaires. Only 18.3% correctly defined periodontitis and 46.3% identified the radiographic criterion for bone loss, whereas 81.1% recognized apical displacement of the center of resistance and 70.4% identified intrusion as the movement associated with bone gain. Pre-orthodontic periodontal screening was reported by 63.0%, but systematic full-mouth 6-site probing by only 16.5%. Among periodontitis cases,

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44.4% reported formal periodontal stability confirmation before treatment initiation and 35.9% waited 3 months after active periodontal therapy. Median knowledge, attitude, and total scores were 2 (interquartile range (IQR) 0–3)/7, 1 (IQR 0–1)/2, and 6 (IQR 1–7)/15; mean practice score was 2.36 ± 1.25/6. A total of 84.0% expressed a need for continuing education.

Conclusions Moroccan dentists showed suboptimal ortho-periodontal performance, with limited comprehensive periodontal assessment and variable interdisciplinary coordination. Training should prioritize periodontal diagnosis, full-mouth assessment, and structured co-management pathways.

Keywords Periodontitis, Health knowledge, attitudes, practice, Surveys and questionnaires, Cross-sectional studies, Dentists, Referral and consultation, Decision making

Introduction

Malocclusions and dental crowding remain prevalent across contemporary populations, supporting the need for orthodontic management in children, adolescents, and adults [1]. However, these groups also present a high burden of periodontal diseases worldwide and at the national level. Globally, up to 80% of adults show signs of gingivitis or mild periodontitis (stage I–II), and more than one billion people are affected by severe forms of periodontitis (stage III–IV) [2–4]. In the United States, NHANES data indicate that periodontitis affects 42.2% of dentate adults aged ≥ 30 years, including 7.8% with severe periodontitis [5]. In Morocco, national surveillance data indicate that 42.2% of 12-year-old children present periodontal conditions, 79.2% of adults aged 35–44 years exhibit periodontitis—with 15–20% affected by severe forms—and 30% of individuals aged 65–74 years are completely edentulous [6]. Among Moroccan adolescents aged 12–18 years, Kissa et al. reported prevalences of 46.9% for gingivitis and 12.3% for periodontitis [7].

In parallel, the global demand for orthodontic treatment (OT) continues to rise. National surveys report orthodontic treatment need rates of 26.4% in Italy [8] and 35–39.5% in British and Swedish cohorts [9, 10]. In the United States, adults in active orthodontic treatment increased from 1.64 million in 2022 to an estimated 1.91 million by 2025 [11]. This epidemiological convergence, namely, high OT demand in populations with substantial periodontal needs, underscores the importance of understanding the interactions between orthodontic forces and periodontal health.

OT in patients with reduced but stable periodontal support can improve function, alignment, and aesthetics, but it requires accurate diagnosis, periodontal stability, adapted biomechanics, and maintenance-oriented co-management. Inadequate screening or coordination may expose patients to gingival inflammation, recession, clinical attachment loss, unfavorable bone remodeling, mobility, or tooth loss [12–14]. These risks are relevant when orthodontic forces are applied in periodontally susceptible patients without verified periodontal control.

Previous European surveys have described professional practices, interdisciplinary communication, and periodontal–orthodontic decision-making in adult orthodontic care [15, 16]. However, evidence remains limited from North African oral health care settings, where orthodontic training pathways, access to periodontal specialty care, and referral practices may differ substantially. Moreover, few surveys have specifically quantified periodontal diagnostic knowledge or explored practitioner-level factors associated with ortho-periodontal management decisions. Therefore, the primary objective of this nationwide cross-sectional survey was to evaluate the knowledge, attitudes, and clinical practices of Moroccan dentists providing orthodontic care regarding the management of patients with periodontal diseases. Secondary objectives were to identify key periodontal–orthodontic domains requiring educational reinforcement and to explore practitioner- and practice-level factors associated with periodontitis-case management and KAP score performance.

Materials and methods

Study design

This was a nationwide, observational, cross-sectional Knowledge, Attitudes, and Practices (KAP) survey conducted among dentists providing orthodontic care in Morocco. No intervention, follow-up, randomization, split-mouth, crossover, or equivalence component was involved. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies [17, 18]. The completed STROBE checklist was submitted as a supplementary file, and reporting was additionally cross-checked against the OHStat checklist for oral health research [19].

Participants and recruitment

Eligible participants were qualified dentists practicing in private, university, or public settings and providing orthodontic care exclusively or within general dental practice, with at least 1 year of professional experience. The anonymous self-administered questionnaire was distributed

by email and professional social media groups. Eligible dentists were invited to complete the anonymous questionnaire based on their routine clinical practice and professional judgement. Participation was voluntary. Before accessing the questionnaire, participants were provided with information about the study objectives, the voluntary nature of participation, anonymity, and confidentiality. Completion and submission of the anonymous online questionnaire were considered to indicate implied informed consent to participate.

Questionnaire development, pilot testing and interrogative modalities

The questionnaire was developed from a review of the literature on the orthodontic–periodontal interface and KAP survey methodology. The draft instrument was reviewed by the study team for clinical relevance, coverage of key periodontal–orthodontic domains, and consistency with the study objectives. It was then pilot-tested among 30 practitioners to assess item clarity, comprehension, wording, response options, survey flow, and completion feasibility. Feedback from the pilot phase was discussed by the investigators and used to refine the wording and organization of the questionnaire. The instrument was therefore considered literature-informed and pilot-tested for face and content relevance; however, it was not designed or validated as a psychometric scale. Pilot data also informed the target sample size. Using a single-proportion formula, $N = Z^2 \times p \times (1 - p) / d^2$, with $Z = 1.96$, $p = 50\%$ because no prior national ortho-periodontal KAP estimate was available, and $d = 5.7\%$, the minimum required sample was approximately 300 participants [20].

The questionnaire was developed and administered in French, which was the language used for data collection. The original French questionnaire and an English translation prepared for publication and peer-review purposes are provided as Additional file 1. The final questionnaire comprised 23 items covering demographic and professional characteristics, 8 knowledge items, and 9 attitude/practice items addressing periodontal diagnosis, screening, treatment timing, interdisciplinary collaboration, and periodontal maintenance. Single-choice, multiple-response, and graded-response formats were used. Conditional logic was applied to improve internal consistency, and potentially sensitive items were dispersed across the survey.

Survey platform and ethical considerations

Data were collected through LimeSurvey using anonymous response mode, with IP addresses and referrer links not stored. The study protocol was approved by the local Ethics Committee for Biomedical Research under reference number CERB 170 – 24.

Statistical analysis

The practitioner was the unit of analysis. The primary study variables were practitioners' periodontal–orthodontic knowledge, attitudes, and practices, assessed through item-level questionnaire responses and composite Knowledge, Attitude, Practice, and total KAP scores. For regression analyses, the response variables were self-reported management of orthodontic treatment in patients with periodontitis and the Knowledge, Attitude, Practice, and total KAP scores. Explanatory variables included demographic and professional characteristics, orthodontic training, type and sector of practice, and selected periodontal–orthodontic knowledge and practice items. No follow-up was conducted because of the cross-sectional design. Because recruitment used an open voluntary online strategy without a probability sampling frame, no sampling weights or design-based analyses were applied.

All returned questionnaires, including partially completed ones, contributed to item-level descriptive analyses using an available-case approach; denominators corresponded to the number of non-missing responses for each item. Empty platform entries were excluded before analysis. A complete questionnaire was defined as a questionnaire with responses available for all required survey items, whereas a partial questionnaire included at least one valid non-empty response but did not include all required items. No imputation was performed for missing data. Questionnaire categories were analyzed as originally coded, and composite scores were calculated only when the required component data were available. Regression analyses were performed using observations with available data for the variables included in each model.

Composite scores were calculated to summarize responses across predefined periodontal–orthodontic domains. Each selected item was coded dichotomously, with 1 point assigned to the response considered aligned with current periodontal–orthodontic principles and 0 points assigned to all other responses. For single-choice items, the predefined correct or expected response was assigned 1 point. For practice-oriented items, 1 point was assigned to the response reflecting systematic, comprehensive, or guideline-consistent management, according to the scoring framework defined before analysis. No negative scoring was applied.

The Knowledge score ranged from 0 to 7 and included seven items covering the definition of reduced periodontium, the definition of a periodontitis case, radiographic confirmation of bone loss, periodontal stability before orthodontic treatment, timing after active periodontal therapy, center-of-resistance displacement in reduced periodontium, and tooth movement associated with bone gain. The Practice score ranged from 0 to 6 and

included six items covering periodontal maintenance, disease screening before orthodontics, full-mouth probing, management of periodontitis cases, referral or co-management, and orthodontic retention in ortho-periodontal patients. The Attitude score ranged from 0 to 2 and included two items related to continuing education needs and periodontal maintenance during orthodontic treatment. The total KAP score ranged from 0 to 15 and was calculated as the sum of the Knowledge, Attitude, and Practice scores.

Composite Knowledge, Attitude, Practice, and total KAP scores were constructed as pragmatic summary indicators across predefined periodontal–orthodontic domains. Items were equally weighted because no validated weighting scheme was available for this specific ortho-periodontal KAP context. Higher scores indicated a greater number of responses aligned with evidence-based periodontal–orthodontic principles. These scores were used for descriptive and exploratory analytical purposes, rather than as validated latent psychometric constructs.

Analyses were performed using Jamovi 1.6.15.0. Categorical variables were reported as n (%). Continuous score variables were reported as mean ± standard deviation or median and interquartile range, according to distributional shape assessed using the Shapiro–Wilk test and visual inspection of histograms. Group comparisons used the chi-square test or Fisher's exact test for categorical variables and Student's t test or the Mann–Whitney U test for continuous score variables, as appropriate.

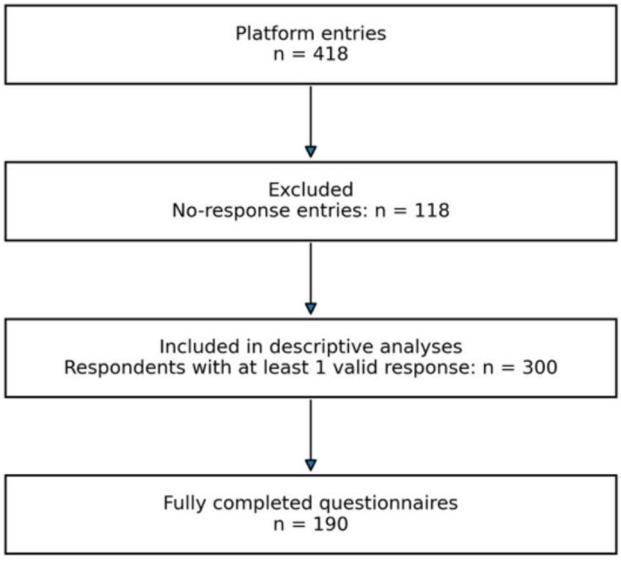


Fig. 1 Flow diagram of participant inclusion
Flow diagram showing platform entries, exclusion of blank entries, valid responses, and complete questionnaires included in the nationwide cross-sectional survey

A two-sided p value < 0.05 was considered statistically significant.

Exploratory logistic regression was performed to identify factors associated with self-reported management of orthodontic treatment in patients with periodontitis. Exploratory linear regression was used to identify factors associated with Knowledge, Attitude, Practice, and total KAP scores. Variables with $p < 0.20$ in univariable analyses were entered into the multivariable models. Regression results were reported as odds ratios or beta coefficients with 95% confidence intervals and p values.

Results

Descriptive statistics

Between September 2025 and February 2026, 418 platform entries were recorded; 118 blank entries were excluded. Overall, 300 practitioners from 11 Moroccan regions provided at least 1 valid response, including 190 complete questionnaires (Fig. 1). Thus, 110 of the 300 valid questionnaires were partially completed. These partial questionnaires were retained for item-level descriptive analyses when the relevant item response was available, whereas score-based and regression analyses used only observations with the required component data.

Most respondents worked in the private sector (231, 83.1%), 125 (45.5%) had less than 4 years of clinical experience, 73 (26.6%) practiced exclusively in orthodontics, and 47 (17.2%) held a National Specialty Diploma (Table 1). Unless otherwise indicated, percentages use available item-level denominators. Exploratory comparative and regression analyses are presented separately, with regression estimates reported with 95% confidence intervals.

Knowledge of periodontal diagnosis was limited: 55(18.3%) respondents correctly defined periodontitis, and 99 (46.3%) identified the radiographic criterion for bone loss. Conversely, 175 (81.1%) recognized apical displacement of the center of resistance in reduced periodontium, and 150 (70.4%) identified intrusion as the movement associated with bone gain (Fig. 2; Table 2).

Pre-orthodontic periodontal screening was reported by 189 (63.0%) respondents, but systematic full-mouth 6-site probing by only 34 (16.5%). Among periodontitis cases, 91 (44.4%) respondents reported receiving formal confirmation of periodontal stability from a periodontist before orthodontic treatment, and 78 (35.9%) reported waiting 3 months after active periodontal therapy. Selection of 1- to 2-month periodontal maintenance intervals during active orthodontic treatment was reported by 224 (96.6%) respondents. Overall, 252 (84.0%) practitioners expressed a need for continuing education. Detailed item-level knowledge, attitude, and practice responses are presented in Table 2. Key

Table 1 Characteristics of the surveyed dentists

Characteristics*	Values (*N* = 300)
Sex	173 (61.1%)
Female	110 (38.9%)
Male	
Age	9 (3.2%)
< 25 years	149 (52.7%)
Between 25 and 35 years	52 (18.4%)
Between 36 and 44 years	47 (16.6%)
Between 45 and 55 years	25 (8.8%)
Between 56 and 65 years	1 (0.4%)
> 65 years	
Region of clinical practice in Morocco	9 (3.2%)
L'Oriental	9 (3.2%)
Marrakech–Safi	2 (0.7%)
Drâa–Tafilalet	26 (9.3%)
Fès–Meknès	4 (1.4%)
Guelmim–Oued Noun	80 (28.6%)
Tangier–Tetouan–Al Hoceima	9 (3.2%)
Souss–Massa	57 (20.4%)
Casablanca–Settat	4 (1.4%)
Beni Mellal–Khénifra	79 (28.2%)
Rabat–Salé–Kénitra	1 (0.4%)
Laâyoune–Sakia El Hamra	
Sector of practice	11 (4.0%)
Public	36 (12.9%)
University structure	231 (83.1%)
Private sector	
Kind of orthodontic practice	73 (26.6%)
Exclusive orthodontics	201 (73.4%)
Non-exclusive orthodontics	
Year of practice	125 (45.5%)
Between 1 and 4 years	46 (16.7%)
Between 5 and 10 years	36 (13.1%)
Between 11 and 15 years	68 (24.7%)
> 15 years	
Type of basic training in orthodontics	47 (17.2%)
National Specialty Diploma	104 (38%)
University Diploma	107 (39.1%)
Certificate	16 (5.8%)
Advanced workshops and specialized seminars	

*Number and percentage

practice indicators across the ortho-periodontal care pathway are summarized in Fig. 3.

Median knowledge, attitude, and total scores were 2 (interquartile range [IQR], 0–3)/7, 1 (IQR, 0–1)/2, and 6 (IQR, 1–7)/15, respectively; mean practice score was 2.36 ± 1.25/6 (Table 3).

Comparative statistics

The following comparative and regression analyses were exploratory and are presented separately from the descriptive item-level and score-based results. Based on sociodemographic characteristics, the comparison between surveyed practitioners who manage patients diagnosed with periodontitis ($n = 68$) and those who do not ($n = 232$) showed the following results. Exploratory comparisons showed no statistically significant differences in periodontitis-case management by age, years of practice, or sector. Respondents were stratified according to self-reported management of orthodontic treatment in patients with periodontitis (Fig. 4).

Self-reported management differed according to type of basic orthodontic training ($p = 0.029$), correct definition of periodontitis ($p = 0.002$), pre-orthodontic periodontal screening ($p < 0.001$), and full-mouth probing category ($p = 0.014$) (Table 4).

Stratification by type of basic orthodontic training showed additional differences in selected knowledge, attitude, and practice indicators, including periodontitis definition, treatment timing, center-of-resistance displacement, periodontitis-case management, referral pattern, retention strategy, and perceived need for continuing education (Table 5).

Regression analysis

After adjusting for all factors (type of basic orthodontic training, knowledge of the definition of periodontitis, screening for periodontal diseases before starting orthodontic treatment, and performance of full-mouth periodontal probing [6 sites per tooth] before orthodontic treatment), full-mouth probing—both for suspicious teeth and for all teeth—remained significantly associated with the management of orthodontic treatment in patients with periodontitis in the multivariate analysis (logistic regression) (OR = 0.09 - CI95%:0.01–0.7 and OR = 0.07 - CI95%: 0.009-0.6 respectively). Given the exploratory nature of the model and the coding of outcome categories, these findings should be interpreted cautiously (Table 6; Fig. 5).

In univariate analysis, all knowledge-related variables were significantly associated with higher knowledge scores. Correct knowledge of the definition of a reduced periodontium (β = 1.19; 95% CI, 0.56 to 1.81), the definition of a case of periodontitis (β = 1.30; 95% CI, 0.99 to 1.61), radiographic criteria for confirming bone loss (β = 1.17; 95% CI, 0.90 to 1.44), and key aspects of periodontal maintenance during orthodontic treatment (β = 1.79; 95% CI, 1.01 to 2.56) was associated with higher knowledge scores. Practitioners working in a university setting also had higher knowledge scores than those in private practice (β = 0.60; 95% CI, 0.18 to 1.04), whereas no significant difference was observed for those working in the public sector. In multivariable linear models, correct responses related to reduced periodontium, periodontitis definition, radiographic bone loss, and periodontal maintenance were associated with higher knowledge and total KAP scores, whereas no studied variable remained significantly associated with attitude or practice scores (Table 3).

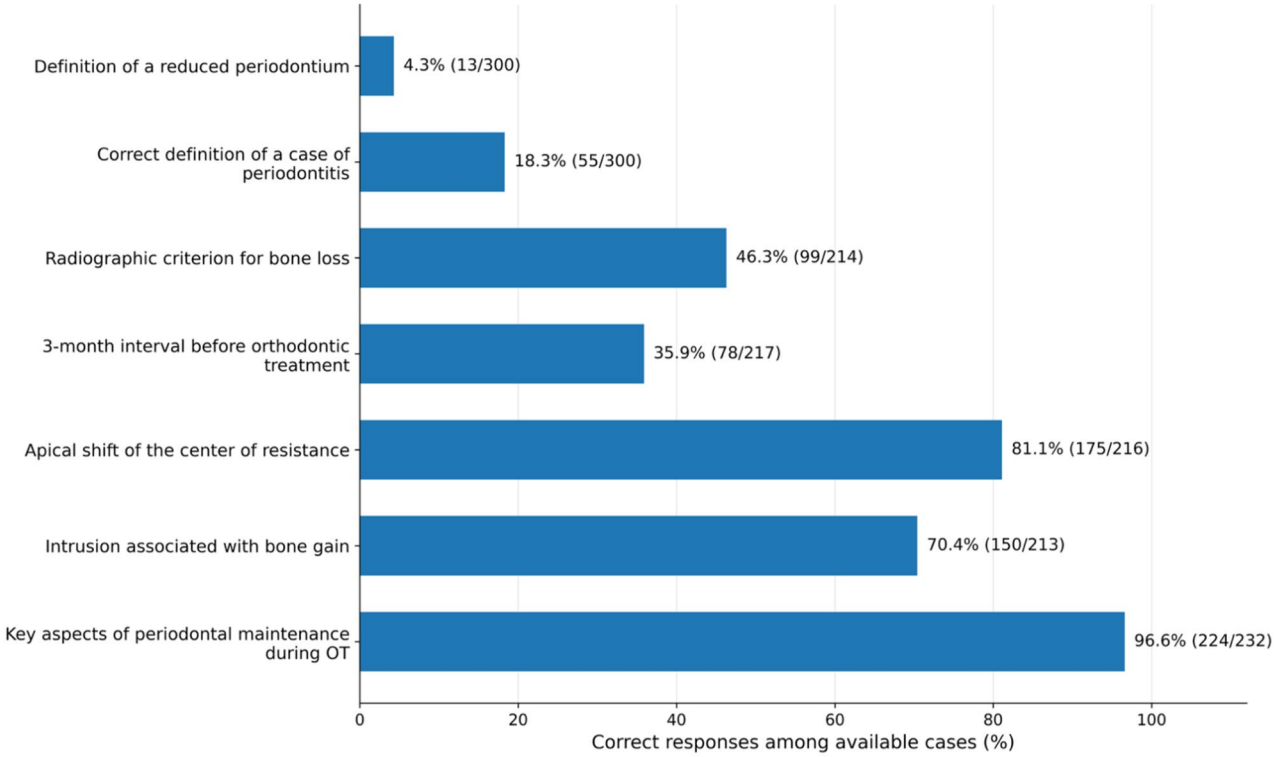


Fig. 2 Knowledge indicators related to periodontal–orthodontic management
Bar chart showing the proportion of respondents with correct answers for selected periodontal–orthodontic knowledge items, including periodontitis definition, radiographic bone loss criterion, reduced periodontium, center-of-resistance displacement, and tooth movement associated with bone gain. Percentages are based on available responses for each item

Discussion

This cross-sectional study provides updated national data on the knowledge, attitudes, and clinical practices of Moroccan dentists providing orthodontic care for patients with periodontal diseases. The findings indicate suboptimal overall performance, characterized by gaps in core periodontal diagnostic knowledge, variable understanding of orthodontic biomechanics in reduced periodontium, and inconsistent interdisciplinary and peri-orthodontic management practices. These results are consistent with other surveys, which similarly report heterogeneity among orthodontists and general dentists when dealing with the periodontal dimension of orthodontic care [16, 21]. These findings extend previous European evidence, particularly the French survey by Saloux et al. [16], by shifting the focus from interprofessional communication, periodontal monitoring during adult orthodontic treatment, and perceived treatment failures to periodontal diagnostic competency, full-mouth periodontal probing, periodontal stability confirmation, and score-based KAP performance among orthodontic care providers in a North African setting.

The most prominent gap concerned periodontal diagnosis and assessment. Knowledge of periodontal diagnosis remained limited, with only 55 (18.3%) respondents correctly defining a case of periodontitis and 99 (46.3%) correctly identifying the radiographic criterion for bone loss. These findings align with previous surveys where practitioners showed limited theoretical comprehension of periodontal diagnosis [22]. However, periodontal examination practices were inconsistent: while 189 (63%) participants reported performing pre-orthodontic periodontal screening, only 33 (16.5%) performed systematic full-mouth 6-site probing. Comparable studies have documented similar inconsistencies, emphasizing that orthodontists often underutilize comprehensive periodontal screening despite acknowledging their importance [16, 23, 24]. Such gaps may compromise the early detection of inflammatory or destructive changes that could influence orthodontic planning.

The variability in recommended waiting periods before initiating orthodontic forces in previously treated periodontitis further illustrates uncertainty in clinical decision-making. Although periodontal wound healing and soft-tissue maturation follow relatively predictable timelines, multiple practitioner surveys report wide divergence in clinicians' perceptions of when orthodontic loading becomes safe after active therapy [16, 25]. Biological evidence indicates that orthodontic forces initiate a controlled sterile inflammatory cascade driving coupled

Table 2 Item-level knowledge, attitudes, and practices regarding periodontal–orthodontic management among surveyed dentists

Section / Characteristics*	Values
A. Periodontal–orthodontic knowledge	
Definition of a reduced periodontium ($n=300$)	
Yes	13 (4.3%)
No	287 (95.7%)
Definition of a periodontitis case ($n=217$)	
Presence of gingival recessions	19 (8.8%)
Clinical attachment loss detectable interdentally on ≥ 2 non-adjacent teeth	55 (25.3%)
Bleeding on periodontal probing	13 (6.0%)
Clinical attachment loss detectable interdentally on ≥ 4 non-adjacent teeth	111 (51.2%)
Presence of periodontal pockets associated with proximal caries	19 (8.8%)
Correct definition of a periodontitis case ($n=300$)	
Yes	55 (18.3%)
No	245 (81.7%)
The radiological criterion to confirm bone loss ($n=214$)	
Distance greater than 1 mm between the CEJ and the alveolar bone crest	5 (2.3%)
Distance greater than 2 mm between the CEJ and the alveolar bone crest	99 (46.3%)
Distance greater than 3 mm between the CEJ and the alveolar bone crest	110 (51.4%)
The center of resistance of a tooth with reduced periodontium ($n=216$)	
Shifts coronally	28 (13.1%)
Shifts apically	175 (81.1%)
Remains stable	11 (5.1%)
Movement associated with bone gain ($n=213$)	
Extrusion	37 (17.4%)
Intrusion	150 (70.4%)
Tipping	4 (1.9%)
Translation	22 (10.3%)
B. Pre-orthodontic periodontal assessment and referral practices	
Disease screening before OT ($n=300$)	
Yes	189 (63%)
No	111 (37%)
Full-mouth probing (6 sites per tooth) ($n=206$)	
For no teeth	21 (10.2%)
For suspicious teeth	151 (73.3%)
For all teeth	34 (16.5%)
Referral of the patient in case of periodontitis diagnosis ($n=206$)	
Periodontist	113 (54.9%)
General practitioner	4 (1.9%)
Yourself	89 (43.2%)
Usual method of communication with the collaborator (periodontist or general practitioner) ($n=207$)	
Phone	42 (20.3%)
Prescription/referral	76 (36.7%)
E-mail	6 (2.9%)
Orally through the patient	7 (3.4%)
I manage both the orthodontic and periodontal treatment myself	76 (36.7%)
C. Management of patients with periodontitis during orthodontic care	
Frequency of Management of periodontitis patients ($n=205$)	
Rarely (1 new case per month)	123 (60%)
Occasionally (1 new case per week)	53 (25.9%)
Frequently (more than 1 new case per week)	15 (7.3%)
Never	14 (6.8%)
Self-reported management of periodontitis patients ($n=300$)	
Yes	68 (22.7%)
No	232 (77.3%)

Table 2 (continued)

Section / Characteristics*	Values
Confirmation of periodontal stability from the periodontist before orthodontic treatment (periodontitis cases) (*n* = 205)	
Yes	91 (44.4%)
No	9 (4.4%)
Occasionally	29 (14.1%)
I manage both the orthodontic and periodontal treatment myself	76 (37.1%)
Interval between periodontal and orthodontic treatment (periodontitis cases) (*n* = 217)	
1 month	17 (7.8%)
2 months	28 (12.9%)
3 months	78 (35.9%)
6 months	94 (43.3%)
Provision or referral of periodontal maintenance for ortho-periodontal patients during orthodontic treatment (*n* = 204)	
Rarely	23 (11.3%)
Occasionally	38 (18.6%)
Usually	53 (26%)
Never	5 (2.5%)
I personally provide the peri-orthodontic periodontal maintenance	85 (41.7%)
Orthodontic retention in ortho-periodontal patients (*n* = 205)	
Clear aligner/retainer	15 (7.3%)
Fixed orthodontic retainer	51 (24.9%)
Fixed retainer + clear aligner	134 (65.4%)
Hawley appliance	5 (2.4%)
Need for continuing education in ortho-periodontal case management (*n* = 300)	
Yes	252 (84%)
No	48 (16%)
D. Knowledge and practices regarding periodontal maintenance during orthodontic treatment	
Key aspects of PM during orthodontic treatment (*n* = 232)	
PM is provided every 1–2 months during active orthodontic treatment; oral hygiene and clinical evaluation of the gingiva are performed at each session; supra- and subgingival scaling is performed at each session	224 (96.6%)
PM is provided every 6 months during active orthodontic treatment; periodontal probing is performed at each PM session	8 (3.4%)

CEJ cementoenamel junction, *OT* Orthodontic treatment, *PM* Periodontal maintenance

*Values are presented as n (%). Percentages were calculated using the number of available responses for each questionnaire item (available-case analysis); therefore, denominators vary across variables because partially completed questionnaires were retained in the descriptive analyses

bone remodeling [26, 27]. In patients with reduced but stable periodontium, this remodeling remains feasible but requires verified periodontal stability, lighter force systems, and closer monitoring [25, 28, 29]. The heterogeneity observed in our sample suggests insufficient integration of these biological concepts into postgraduate orthodontic education.

The management of periodontally compromised patients during orthodontic treatment requires structured interdisciplinary collaboration, yet our findings indicate notable practice variability. Only 91 (44.4%) reported receiving formal confirmation of periodontal stability before initiating orthodontic treatment, indicating variability in interdisciplinary coordination. Comparable studies emphasize that communication between orthodontists and periodontists is often fragmented or informal, despite the evidence linking coordinated care to better outcomes in compromised or high-risk patients [16, 25]. This suggests an opportunity to improve standardized interdisciplinary referral pathways in Moroccan clinical practice.

The score-based analyses further reinforce the relevance of core periodontal domains in ortho-periodontal care. After adjustment, variables related to the definition of a reduced periodontium, the definition of a case of periodontitis, radiographic criteria for bone loss, and key aspects of periodontal maintenance remained significantly associated with the knowledge score, and the same domains were also significantly associated with the total KAP score. Taken together, these findings suggest that these domains represent fundamental competencies in ortho-periodontal care and may serve as priority targets for educational intervention. Such deficiencies are clinically important because incomplete periodontal knowledge may translate into under-recognition of treatment-related soft-tissue risks. Gingival recession has been reported in longitudinal and cross-sectional studies, with post-treatment prevalence reaching up to 41.7%, particularly in patients undergoing labial movement of

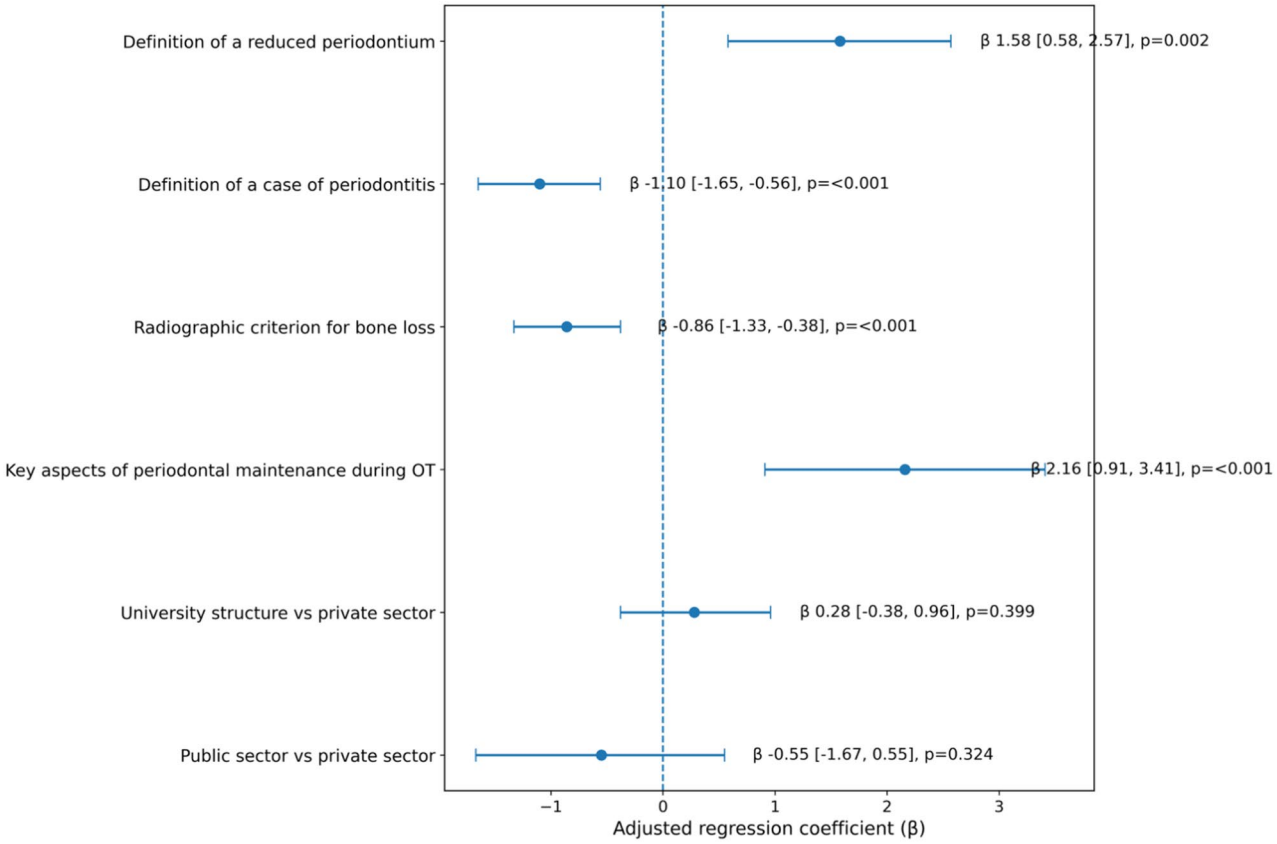


Fig. 3 Key practice indicators across the ortho-periodontal care pathway
Bars represent the proportion of respondents endorsing selected diagnostic, management, referral, and maintenance practices among available cases. The number of respondents and the corresponding denominator are shown for each indicator. OT, orthodontic treatment

the mandibular incisors or presenting with pre-existing periodontal compromise [30].

The comparative and multivariable analyses add an important interpretive layer. The type of basic orthodontic training was associated with selected knowledge and practice indicators, including periodontitis-case management, suggesting that training background may partly shape diagnostic understanding and clinical decision-making in ortho-periodontal care, although these exploratory findings should be interpreted cautiously because subgroup sizes were unequal. After multivariable adjustment, practitioners working in university settings achieved higher knowledge scores than those practicing in the private sector, which may reflect greater exposure to academic teaching, interdisciplinary collaboration, and evidence-based continuing professional development. In contrast, no variables remained independently associated with attitude or practice scores after adjustment, suggesting that these domains may be influenced by organizational, behavioural, or contextual factors beyond those measured in the present survey. Furthermore, comprehensive full-mouth periodontal probing remained independently associated with the management of patients with periodontitis, emphasizing the importance of thorough periodontal assessment as a fundamental component of clinical decision-making in ortho-periodontal care. Given the cross-sectional design, these findings should be interpreted as associations rather than causal relationships and may help inform future educational and implementation strategies.

These findings also have implications for adolescent orthodontic care, where crowding and eruptive changes may complicate oral hygiene and periodontal screening. Moroccan data showing destructive periodontal conditions among adolescents and young adults support the need for routine periodontal assessment in orthodontic pathways [7, 31, 32]. Although almost half of the respondents had fewer than four years of professional experience, exploratory analyses did not identify significant differences in periodontitis-case management according to age or years of practice. These findings suggest that educational needs are not confined to a particular career stage and support strengthening undergraduate education, postgraduate orthodontic training, and continuing professional development in periodontal assessment and interdisciplinary ortho-periodontal management [15].

Table 3 Factors associated with knowledge, attitude, practice, and total KAP scores

Outcome	Characteristics	Category	Univariate β	Univariate 95% CI	Univariate *p*	Multivariable β	Multivariable 95% CI	Multivariable *p*
Knowledge score	Definition of a reduced periodontium	YES	1.19	[0.56–1.81]	< 0.001	0.85	[0.39–1.3]	< 0.001
Knowledge score	Definition of a case of periodontitis	YES	1.30	[0.99–1.61]	< 0.001	1.01	[0.76–1.26]	< 0.001
Knowledge score	The radiological criterion to confirm bone loss	YES	1.17	[0.9–1.44]	< 0.001	0.93	[0.71–1.15]	< 0.001
Knowledge score	Key aspects of PM during orthodontic treatment	YES	1.79	[1.01–2.56]	< 0.001	1.39	[0.82–1.96]	< 0.001
Knowledge score	Sector of practice	Private sector	1			1		
Knowledge score	Sector of practice	University structure	0.6	[0.18–1.04]	0.005	0.36	[0.05–0.68]	0.022
Knowledge score	Sector of practice	Public sector	0.35	[-0.39-1.08]	0.33	0.13	[-0.37- 0.63]	0.61
Attitude score	Definition of a reduced periodontium	YES	0.61	[0.23–0.99]	0.002	0.3	[-0.06-0.7]	0.1
Attitude score	Definition of a case of periodontitis	YES	0.03	[-0.17-0.24]	0.73	0.01	[-0.19-0.2]	0.872
Attitude score	The radiological criterion to confirm bone loss	YES	-0.05	[-0.2-0.12]	0.56	-0.03	[-0.22-0.14]	0.681
Attitude score	Key aspects of PM during orthodontic treatment	YES	0.3	[-0.17-0.78]	0.215	0.16	[-0.31-0.64]	0.49
Attitude score	Sector of practice	Private sector	1			1		
Attitude score	Sector of practice	University structure	0.08	[-0.15- 0.33]	0.472	0.05	[-0.2- 0.32]	0.682
Attitude score	Sector of practice	Public sector	-0.05	[-0.47- 0.36]	0.808	-0.28	[-0.7- 0.14]	0.198
Practice score	Definition of a reduced periodontium	YES	0.99	[0.3–1.68]	0.005	0.3	[-0.31-0.93]	0.332
Practice score	Definition of a case of periodontitis	YES	0.03	[-0.30-0.3]	0.829	0.08	[-0.26-0.43]	0.624
Practice score	The radiological criterion to confirm bone loss	YES	-0.14	[-0.4-0.15]	0.342	-0.19	[-0.5-0.1]	0.197
Practice score	Key aspects of PM during orthodontic treatment	YES	0.76	[-0.03-1.58]	0.06	0.54	[-0.23-1.33]	0.168
Practice score	Sector of practice	Private sector	1			1		
Practice score	Sector of practice	University structure	0.04	[-0.39-0.48]	0.83	-0.23	[-0.67- 0.19]	0.279
Practice score	Sector of practice	Public sector	0.4	[-0.6-0.94]	0.71	-0.33	[-1.07-0.39]	0.365
Total score	Definition of a reduced periodontium	YES	2.01	[0.97–3.08]	< 0.001	1.47	[0.52–2.43]	0.003
Total score	Definition of a case of periodontitis	YES	1.39	[0.83–1.94]	< 0.001	1.12	[0.60—1.65]	< 0.001
Total score	The radiological criterion to confirm bone loss	YES	0.97	[0.47–1.47]	< 0.001	0.68	[0.22–1.15]	0.004
Total score	Key aspects of PM during orthodontic treatment	YES	2.68	[1.38–3.98]	< 0.001	2.11	[0.91–3.30]	< 0.001
Total score	Sector of practice	Private sector	1			1		
Total score	Sector of practice	University structure	0.32	[-0.39- 1.05]	0.54	0.18	[-0.40-0.84]	0.584
Total score	Sector of practice	Public sector	-0.39	[-1.67- 1.05]	0.36	-0.55	[-1.67- 0.56]	0.333
Total KAP Scores								
Knowledge score			2 (0–3)					
Attitude score			1 (0–1)					
Practice score			2.36 ± 1.25					
Total Score			6 (1–7)					

Values for score distributions are reported as median (interquartile range) or mean ± standard deviation, as indicated

β Linear regression coefficient, *CI* Confidence interval, *PM* Periodontal maintenance, *KAP* Knowledge Attitude and Practices

*Statistically significant at $P < 0.05$. a: M (IQ): median and interquartile range; b: mean ± standard deviation

Several limitations should be considered. The cross-sectional design precludes causal or temporal inference. Practices were self-reported and may not fully reflect chairside behavior or the quality and consistency with which periodontal examinations, including full-mouth six-site probing, are performed in routine clinical practice. Online voluntary recruitment may have introduced selection bias, limiting generalizability to all

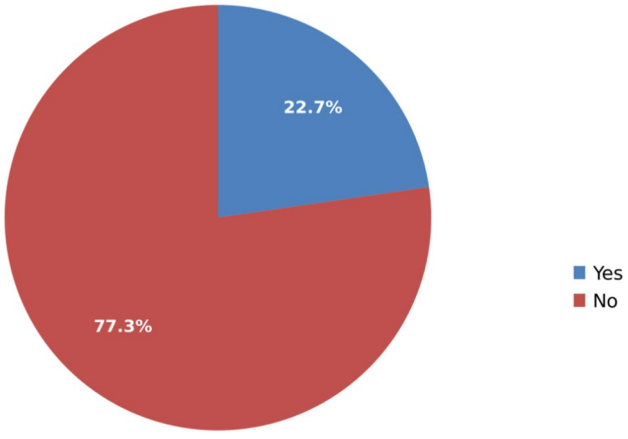


Fig. 4 Self-reported management of orthodontic treatment in patients with periodontitis
Pie chart showing the proportion of respondents who reported managing

dentists providing orthodontic care in Morocco, particularly those less connected to professional networks or less interested in ortho-periodontal topics. In addition, because the survey used an open online dissemination strategy, the number of eligible practitioners who were reached by the invitation was unknown, and a conventional response rate could not be estimated. The questionnaire was literature-informed and pilot-tested for clarity, feasibility, and face/content relevance, but no formal psychometric validation was performed. Consequently, the Knowledge, Attitude, Practice, and total KAP scores should be interpreted as exploratory summary indicators rather than validated psychometric scales, which may limit direct comparison with other studies. Available-case analyses allowed partial questionnaires to contribute to item-level estimates and avoided excluding respondents who provided valid responses to

Table 4 Sociodemographic and professional comparison of practitioners managing versus not managing orthodontic treatment in patients with periodontitis

Variables	Management of patients diagnosed with periodontitis *n* = 68	Non-management of patients diagnosed with periodontitis *n* = 232	*p*
Age			0.505
< 25 years	0 (0.0%)	9 (4.2%)	
Between 25 and 35 years	37 (54.4%)	112 (52.1%)	
Between 36 and 44 years	12 (17.6%)	40 (18.6%)	
Between 45 and 55 years	14 (20.6%)	33(15.3%)	
Between 56 and 65 years	5 (7.4%)	20(9.3%)	
> 65 years	0(0.0%)	1(0.5%)	
Year of practice			0.532
Between 1 and 4 years	29 (42.6%)	96 (46.6%)	
Between 5 and 10 years	9 (13.2%)	37 (17.9%)	
Between 11 and 15 years	9 (13.2%)	27 (13%)	
> 15 years	21 (30.9%)	47 (22.7%)	
Sector of practice			0.240
Public	4 (5.9%)	7(3.3%)	
University structure	12 (17.6%)	24(11.4%)	
Private sector	52 (76.5%)	179(85.2%)	
Type of basic training in orthodontics			0.029
National Specialty Diploma	18 (26.9%)	29(14%)	
University Diploma	24 (35.8%)	80 (38.6%)	
Certificate	19 (28.4%)	88 (42.5%)	
Advanced workshops and specialized seminars	6 (9%)	10 (4.8%)	
Definition of a reduced periodontium			0.164
Yes	5(7.4%)	8(3.4%)	
No	63(92.6%)	224(96.6%)	
Definition of a periodontitis case			0.002
Yes	21(30.9%)	34(14.7%)	
No	47(69.1%)	198(85.3%)	
Disease screening before OT			< 0.001
Yes	5(7.4%)	106(45.7%)	
No	63(92.6%)	126(54.3%)	
Full-mouth probing (6 sites per tooth)			0.014
- For no teeth	1(1.5%)	20 (14.5%)	
- For suspicious teeth	54(79.4%)	97(70.3%)	
- For all teeth	13(19.1%)	21(15.2%)	

OT Orthodontic Treatment

Table 5 Periodontal–orthodontic knowledge, attitudes, and practices according to type of basic orthodontic training

Domain	Variable	National Specialty Diploma (*n* = 47)	University Diploma (*n* = 104)	Certificate (*n* = 107)	Advanced workshops/ seminars (*n* = 16)	*p*
Knowledge	Correct definition of reduced periodontium	1 (2.1%)	5 (4.8%)	5 (4.7%)	1 (6.2%)	0.741
Knowledge	Correct definition of periodontitis	15 (31.9%)	22 (21.2%)	12 (11.2%)	5 (31.2%)	**0.013**
Knowledge	Correct radiographic criterion for bone loss	22 (55.0%)	37 (46.2%)	31 (39.2%)	7 (63.6%)	0.249
Knowledge	Three-month interval after active periodontal therapy before OT	19 (40.4%)	19 (18.3%)	32 (29.9%)	5 (31.2%)	**0.032**
Knowledge	Correctly identified apical shift of the center of resistance	38 (80.9%)	66 (64.1%)	61 (57.0%)	8 (50.0%)	**0.025**
Knowledge	Intrusion identified as tooth movement associated with bone gain	26 (55.3%)	57 (54.8%)	57 (53.3%)	8 (50.0%)	0.980
Knowledge	Key aspects of PM during orthodontic treatment	0 (0.0%)	1 (1.0%)	6 (5.6%)	0 (0.0%)	0.170
Attitude	Maintenance usually ensured/referred or personally provided during OT	27 (57.4%)	55 (52.9%)	51 (47.7%)	11 (68.8%)	0.367
Attitude	Reported need for continuing education in ortho-periodontal care	35 (74.5%)	79 (76.0%)	97 (90.7%)	15 (93.8%)	**0.009**
Practice	Systematic periodontal disease screening before OT	38 (80.9%)	70(67.3%)	68 (63.7%)	10 (62.5%)	0.189
Practice	Full-mouth periodontal probing for all teeth before OT	31 (66.0%)	53 (51.0%)	55 (51.4%)	10 (62.5%)	0.612
Practice	Regular management of patients diagnosed with periodontitis	18 (38.3%)	24 (23.1%)	19 (17.8%)	6 (37.5%)	**0.029**
Practice	Referral to a periodontist when periodontitis is diagnosed	37 (33.3%)	40 (36.0%)	30 (27.0%)	4 (3.6%)	**< 0.001**
Practice	Formal confirmation of periodontal stability before OT	21 (44.7%)	38 (36.5%)	41 (39.0%)	8 (50.0%)	0.648
Practice	Fixed retainer plus clear aligner selected for retention	15 (38.5%)	11 (14.3%)	22 (29.3%)	2 (16.7%)	**0.020**

Values are presented as n (%). Associations between type of basic orthodontic training and categorical outcomes were assessed using Pearson's chi-square test and the Fisher–Freeman–Halton exact test, when appropriate. Bold *p* values indicate statistically significant associations at $p < 0.05$. OT, orthodontic treatment; PM, periodontal maintenance

specific items. However, this approach produced variable denominators across items and may have affected comparability between estimates. If questionnaire completion was related to respondent characteristics, interest in ortho-periodontal care, or knowledge level, missing data may have influenced some descriptive proportions and score-based analyses. The direction and magnitude of selection, self-report, and missing-data bias could not be fully quantified; if more engaged practitioners were more likely to participate or complete the questionnaire, guideline-concordant practices may have been overestimated.

Future research could build on these findings by extending the assessment of periodontal diagnostic competency among dentists providing orthodontic care. In addition to the core diagnostic concepts and clinical management domains evaluated in the present survey, future studies may incorporate the contemporary staging and grading classification of periodontitis, together with case-based clinical scenarios, to provide a more

Table 6 Factors associated with the modelled periodontitis-case management outcome using univariable and multivariable logistic regression

Characteristics	Category	Management of patients diagnosed with periodontitis *n* = 68	Univariate analysis			Multivariable analysis		
			OR	(95%CI)	*p*	OR	(95% CI)	*p*
Type of basic training in orthodontics	Certificate	9 (28%)	1	[0.16–0.75]	0.007	0.41	[0.17–0.9]	0.044
	National Specialty Diploma	18 (26.9%)	0.34	[0.36–1.41]	0.339	0.75	[0.36–1.5]	0.455
	University Diploma	24 (35.8%)	0.72	[0.11–1.11]	0.075	0.34	[0.09–1.2]	0.107
	Advanced workshops and specialized seminars	6 (9%)	0.36					
Definition of a periodontitis case	YES	21 (30.9%)	2.6	[1.38–4.89]	0.003	1.3	[0.67–2.74]	0.391
Disease screening before OT	YES	5 (7.4)	10.6	[4.11–27.31]	< 0.001	1.3	[0.45–4.1]	0.56
Full-mouth probing (6 sites per tooth)	For no teeth	1 (1.5)	1	[0.01–0.68]	0.02	0.09	[0.01–0.7]	0.02
	For suspicious teeth	54 (79.4%)	0.089	[0.009–0.676]	0.02	0.07	[0.009-0.6]	0.01
	For all teeth	13 (19.1%)	0.08					

OR Odds ratio, *CI* Confidence interval, *OT* Orthodontic treatment

*Statistically significant at $p < 0.05$. The logistic regression model was exploratory; odds ratios should be interpreted according to the coding of the modelled outcome and reference categories

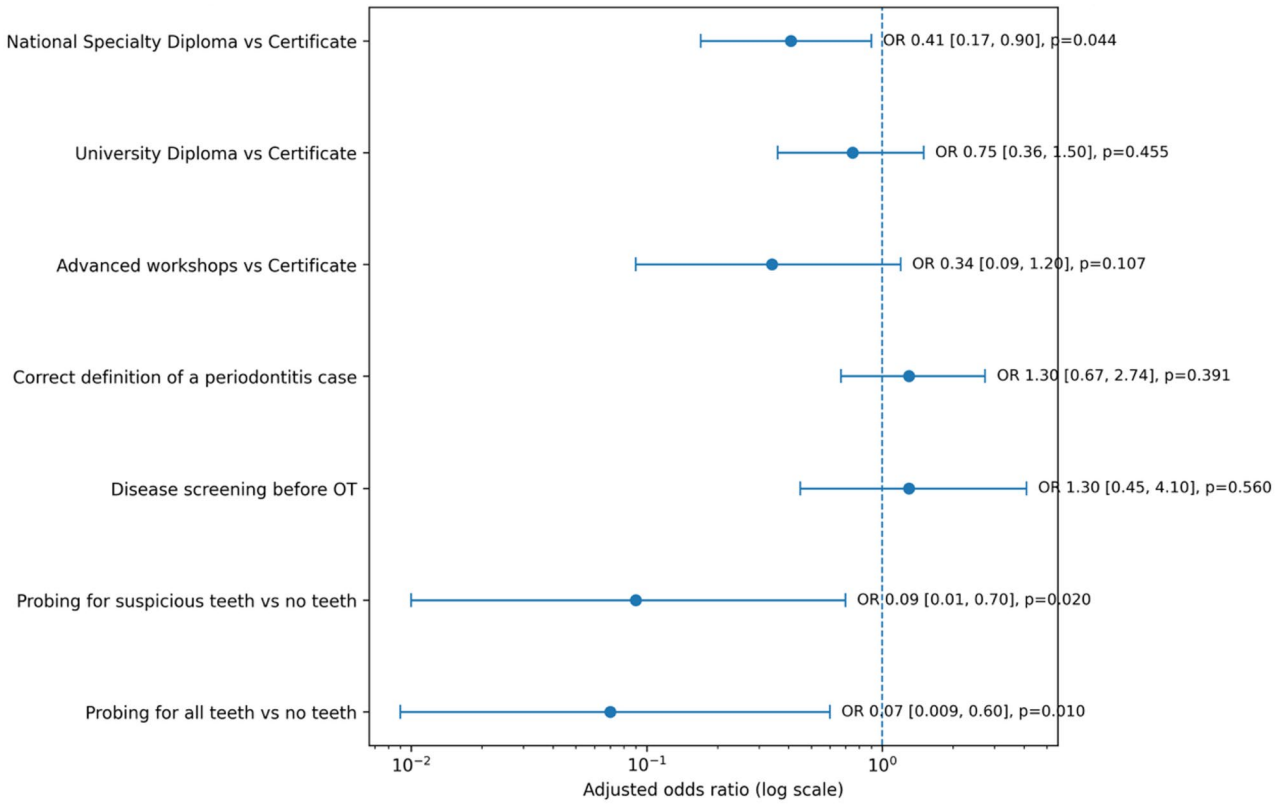


Fig. 5 Forest plot of adjusted odds ratios for the modelled periodontitis-case management outcome
Forest plot showing adjusted odds ratios and 95% confidence intervals for factors associated with the modelled periodontitis-case management outcome, based on the multivariable logistic regression model reported in Table 6. The vertical dashed line indicates the null value (OR = 1)

comprehensive evaluation of diagnostic reasoning, treatment planning, and interdisciplinary decision-making in ortho-periodontal care.

Taken together, these limitations and future research directions should be considered when interpreting the findings. Nevertheless, the present study provides one of the first nationwide assessments of ortho-periodontal knowledge, attitudes, and practices among Moroccan dentists providing orthodontic care. Its strengths include the nationwide recruitment of practitioners from diverse geographical regions and professional settings, providing a broad overview of current clinical perspectives in Morocco. The questionnaire was developed from the available literature, refined through pilot testing, and administered anonymously through the LimeSurvey platform, a widely used research survey system designed to support data protection and privacy principles, including GDPR-aligned data management features. Anonymous data collection reduced the potential for interviewer influence and encouraged candid participation. The analytical strategy combined item-level descriptive analyses, score-based comparisons, and multivariable modelling, allowing complementary evaluation of both specific clinical behaviours and overall KAP performance. Methodological transparency was further strengthened through explicit score construction, available-case reporting, and adherence to STROBE and OHStat reporting recommendations. Finally, the inclusion of both the original French questionnaire and its English translation as supplementary material enhances transparency, reproducibility, and facilitates comparison with future studies. Collectively, these features strengthen the methodological rigor, transparency, reproducibility, and practical relevance of the findings for identifying educational priorities and informing interdisciplinary ortho-periodontal care.

Conclusions

This nationwide cross-sectional survey identified important gaps in periodontal knowledge and variability in self-reported clinical practices related to the orthodontic management of patients with periodontal diseases among Moroccan dentists providing orthodontic care. These findings highlight opportunities to strengthen periodontal education, interdisciplinary collaboration, and evidence-based clinical training. Because the findings are based on self-reported practices from a voluntary cross-sectional survey, they should be interpreted cautiously and may not fully reflect actual clinical behavior.

Abbreviations

CEJ	Cementoenamel junction
CERB	Comité d'éthique pour la recherche biomédicale (Ethics Committee for Biomedical Research)
CI	Confidence interval
CReSS	Research Center of Health Sciences
IQR	Interquartile range
KAP	Knowledge, attitudes, and practices
NHANES	National Health and Nutrition Examination Survey
OHStat	Observational Studies and Clinical Trials in Oral Health
OR	Odds ratio
OT	Orthodontic treatment
PM	Periodontal maintenance
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-026-09653-0.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

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Authors' contributions

A.H. Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation, Resources, Data interpretation, Writing – original draft, Writing – review and editing, Supervision, Project administration. S.H. Conceptualization, Writing – review and editing, Investigation. K. S. Writing – review and editing, Visualization, Investigation. M.A. Data interpretation, Validation, Writing – review and editing. S. B. J. Investigation, Writing – review and editing. A. C. Validation, Writing – review and editing. S.G. Formal analysis, Data interpretation, Validation, Writing – review and editing. Y.H. Investigation, Writing – review and editing. G.K. Investigation, Formal analysis, Software, Data curation, Data interpretation, Writing – review and editing.

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Data availability

The dataset generated and analyzed during the current study is available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee for Biomedical Research (CERB) of Mohammed V University in Rabat, Faculty of Medicine and Pharmacy of Rabat, Morocco (approval number CERB 170 – 24). The study was conducted in accordance with the Declaration of Helsinki and applicable ethical guidelines and regulations. Before accessing the questionnaire, participants received information about the study objectives, the voluntary nature of participation, anonymity, and confidentiality. Because the survey was anonymous and participation was voluntary, completion and submission of the questionnaire were considered to indicate implied informed consent. Data were collected using LimeSurvey in anonymous response mode, and no IP addresses or referrer links were stored.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Theodoridou MZ, Herclides A, Lamnisos D. Need for orthodontic treatment and oral health-related quality of life in children and adolescents - A systematic review. Community Dent Health. 2024;41(1):5–13.
2. Tonetti MS, Sanz M. Implementation of the new classification of periodontal diseases: Decision-making algorithms for clinical practice and education. J Clin Periodontol. 2019;46(4):398–405.
3. Cui Y, Tian G, Li R, Shi Y, Zhou T, Yan Y. Epidemiological and sociodemographic transitions of severe periodontitis incidence, prevalence, and disability-adjusted life years for 21 world regions and globally from 1990 to 2019: An age-period-cohort analysis. J Periodontol. 2023;94(2):193–203.
4. Wu L, Huang CM, Wang Q, Wei J, Xie L, Hu CY. Burden of severe periodontitis: new insights based on a systematic analysis from the Global Burden of Disease Study 2021. BMC Oral Health. 2025;25(1):861.
5. Eke PI, Borgnakke WS, Genco RJ. Recent epidemiologic trends in periodontitis in the USA. Periodontol 2000. 2020;82(1):257–67.
6. Programme National de Santé Bucco-dentaire. Morocco's Ministery of Health; 2017.
7. Kissa J, Albandar JM, El Houari B, Khlil N, Amine K, Chemlali S, Mikou S, Gharibi A, El Ouadnassi I, Tricha L, et al. National survey of periodontal diseases in adolescents and young adults in Morocco. J Clin Periodontol. 2022;49(5):439–47.
8. El-Angbawi A, McIntyre G, Fleming PS, Bearn D. Non-surgical adjunctive interventions for accelerating tooth movement in patients undergoing orthodontic treatment. Cochrane Database Syst Rev. 2023;6(6):Cd010887.
9. Chestnutt IG, Burden DJ, Steele JG, Pitts NB, Nuttall NM, Morris AJ. The orthodontic condition of children in the United Kingdom, 2003. Br Dent J. 2006;200(11):609–12. quiz 638.
10. Josefsson E, Bjerklin K, Lindsten R. Malocclusion frequency in Swedish and immigrant adolescents–influence of origin on orthodontic treatment need. Eur J Orthod. 2007;29(1):79–87.
11. Economics of orthodontics survey report. American Association of Orthodontics.; July 2025.
12. Gkantidis N, Christou P, Topouzelis N. The orthodontic-periodontic interrelationship in integrated treatment challenges: a systematic review. J Rehabil. 2010;37(5):377–90.
13. Tietmann C, Jepsen S, Heibrok H, Wenzel S, Jepsen K. Long-term stability of regenerative periodontal surgery and orthodontic tooth movement in

stage IV periodontitis: 10-year data of a retrospective study. J Periodontol. 2023;94(10):1176–86.
14. Liu Y, Li CX, Nie J, Mi CB, Li YM. Interactions between Orthodontic Treatment and Gingival Tissue. Chin J Dent Res. 2023;26(1):11–8.
15. Kalina E, Machoy M, Górski B. Interdisciplinary Approaches by Polish Orthodontists, Periodontists, and Oral Surgeons to Soft Tissue Augmentation in Adult Patients: A Survey Study. Appl Sci. 2024;14(21):9647.
16. Saloux A, Couatarmanach A, Chauvel B, Jeanne S, Brezulier D. Knowledge, attitudes and professional practices of ortho-periodontal care of adults: a cross-sectional survey in France. BMC Oral Health. 2022;22(1):142.
17. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann Intern Med. 2007;147(8):573–7.
18. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019;13(Suppl 1):S31–4.
19. Best AM, Lang TA, Greenberg BL, Gunsolley JC, Ioannidou E. The OHStat Guidelines for Reporting Observational Studies and Clinical Trials in Oral Health Research: Manuscript Checklist. J Dent Res. 2024;103(11):1076–82.
20. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013;35(2):121–6.
21. Costa R, Vedovello SAS, Furletti-Góes VF, Custodio W, Venezian GC. Orthodontist and periodontist's knowledge, attitudes and aspects of clinical practice, regarding fixed lower orthodontic retainers. Dent Press J Orthod. 2021;26(4):e2119276.
22. Brkanović S, Lapter Varga M, Meštrović S. Knowledge and Attitude towards Orthodontic Treatment among Non-Orthodontic Specialists: An Online Survey in Croatia. Dent J (Basel) 2022, 10(1).
23. Mansoor M, Monis D, Anjum R, Siddiqui TA, Mir HA, Nazir R. A cross-sectional study to correlate oral hygiene habit among orthodontic patients with their clinical findings and periodontal treatment need. BMC Oral Health. 2024;24(1):903.
24. Marusamy KO, Alsibaie RB, Mostanteq NM, Alzahrani L, Aljuhani DH, Lashkar R. Awareness and Periodontal Health Practices of Fixed Orthodontic Appliance Patients: A Questionnaire-Based Survey. Cureus. 2024;16(5):e60335.
25. Erbe C, Heger S, Kasaj A, Berres M, Wehrbein H. Orthodontic treatment in periodontally compromised patients: a systematic review. Clin Oral Invest. 2023;27(1):79–89.
26. Huang H, Williams RC, Kyrkanides S. Accelerated orthodontic tooth movement: molecular mechanisms. Am J Orthod Dentofac Orthop. 2014;146(5):620–32.
27. Yang CY, Jeon HH, Alshabab A, Lee YJ, Chung CH, Graves DT. RANKL deletion in periodontal ligament and bone lining cells blocks orthodontic tooth movement. Int J Oral Sci. 2018;10(1):3.
28. Gehlot M, Sharma R, Tewari S, Kumar D, Gupta A. Effect of orthodontic treatment on periodontal health of periodontally compromised patients. Angle Orthod. 2022;92(3):324–32.
29. Feller L, Khammissa RA, Schechter I, Thomadakis G, Fourie J, Lemmer J. Biological Events in Periodontal Ligament and Alveolar Bone Associated with Application of Orthodontic Forces. ScientificWorldJournal. 2015;2015:876509.
30. Cadenas de Llano-Pérula M, Castro AB, Danneels M, Schelfhout A, Teughels W, Willems G. Risk factors for gingival recessions after orthodontic treatment: a systematic review. Eur J Orthod. 2023;45(5):528–44.
31. Nobre CM, Fernandes-Costa AN, de Melo Soares MS, Pugliesi DM, de Vasconcelos Gurgel BC. Periodontal disease detection in primary and mixed dentitions. Eur Arch Paediatr Dent. 2016;17(5):407–11.
32. Kissa J, Chemlali S, El Houari B, Amine K, Khlil N, Mikou S, Nadifi S, Albandar JM. Aggressive and chronic periodontitis in a population of Moroccan school students. J Clin Periodontol. 2016;43(11):934–9.

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