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Original Article

Precision in Planning Orthodontic Extractions Among Dental Practitioners of Pakistan: A Cross-Sectional Study

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ABSTRACT

Background: Orthodontic extractions play a pivotal role in achieving functional occlusion, esthetic harmony, and long-term stability. Precision in extraction planning is increasingly emphasized due to its impact on facial profile, treatment outcomes, and patient satisfaction. While advances such as CBCT and AI-assisted tools have enhanced diagnostic accuracy, the extent to which these technologies are adopted in Pakistan remains unclear. Objective: To evaluate the knowledge, awareness, and perceptions of dental professionals in Pakistan regarding orthodontic extraction planning, with emphasis on precision-based decision-making and barriers to adopting advanced diagnostic tools. Methods: A descriptive cross-sectional study was conducted from June to August 2025 among 230 dental professionals recruited through professional networks and social media. Participants included house officers, postgraduate trainees, and general practitioners. Data were collected via a validated 18-item online questionnaire. Descriptive and inferential statistics were performed in IBM SPSS v27, with p-values <0.05 considered significant. Ethical approval was obtained from the PRIDE Center for Research and Learning Institute (PRIDE/ERB/2025/012). Results: Awareness of extraction patterns was high (90%), with first premolars the most frequently selected teeth (78%). Extractions were most often planned occasionally (48.5%) or frequently (34.2%). Clinical examination (91.7%) and cephalometrics (80%) dominated diagnostic approaches, while CBCT (20%) and AI tools (12.6%) were underutilized. Key barriers included high cost (79.1%), limited access (64.3%), and lack of training (63.5%). Conclusion: Dental professionals in Pakistan demonstrate strong awareness of orthodontic extraction planning but remain reliant on traditional diagnostic methods. Greater integration of digital tools, enhanced training, and improved accessibility are essential to align practices with international precision standards.

Keywords: Orthodontic extractions, Precision, Diagnostic tools, CBCT, Artificial intelligence, Pakistan.

INTRODUCTION

Orthodontic treatment aims not only to align teeth but also to restore occlusion, function, and facial balance in a manner that supports long-term stability and esthetic outcomes (1). Extractions are often required to achieve these goals, especially in cases of severe crowding, protrusion, or skeletal discrepancies (2). Historically, extractions—particularly premolars—were frequently performed to relieve space deficiency; however, subsequent concerns arose regarding potential drawbacks, such as flattened facial profiles, reduced lip support, and compromised esthetics (3). This debate shifted the focus from whether extractions should be performed to how precisely they should be planned, accounting for the individual patient's soft tissue, skeletal pattern, and functional demands (4).

Modern orthodontics increasingly emphasizes precision-based, patient-centered planning supported by technological innovations. Tools such as cone-beam computed tomography (CBCT) and digital setups provide detailed information on airway dimensions, dentoskeletal relationships, and facial soft tissues, thereby enhancing diagnostic accuracy beyond traditional panoramic and cephalometric radiographs (5,6). Similarly, advances in artificial intelligence (AI) and predictive modeling allow clinicians to simulate treatment outcomes, improve transparency with patients, and refine decision-making (7). Despite these advances, evidence shows that poorly timed or unnecessary extractions continue to cause complications, including midline discrepancies, temporomandibular dysfunction, and facial disharmony, underscoring the importance of meticulous planning (8).

Interdisciplinary collaboration further reinforces the need for individualized extraction strategies. Decisions on whether to remove a compromised molar instead of a premolar, for example, require coordination with prosthodontists, restorative specialists, and surgeons to ensure alignment with long-term oral health goals (9). However, in many low- and middle-income countries, including Pakistan, access to advanced diagnostic tools is limited, and reliance on conventional methods persists. Local studies indicate variability in extraction practices, but little is known about how clinicians integrate modern precision-based approaches into treatment planning (10).

Given the increasing awareness of esthetics, availability of new diagnostic technologies, and the evolving ethical obligation for personalized care, it is crucial to assess the current state of orthodontic extraction planning in Pakistan. Specifically, it is important to determine whether dental professionals demonstrate awareness of precision principles, how frequently extractions are planned, which diagnostic tools are employed, and what barriers limit the adoption of modern resources.

Therefore, the objective of this study was to evaluate the knowledge, awareness, and perception of dental professionals in Pakistan regarding orthodontic extraction planning, with emphasis on precision-based decision-making to ensure improved clinical outcomes and long-term stability.

MATERIAL AND METHODS

This study employed a descriptive cross-sectional design to evaluate the knowledge, awareness, and perceptions of dental professionals in Pakistan regarding precision in orthodontic extraction planning. The cross-sectional design was chosen because it enables the simultaneous assessment of exposure and outcome variables within a defined population, thereby providing a representative snapshot of prevailing clinical practices and perceptions (11). The study was carried out across diverse clinical and academic settings, including private and public dental colleges, teaching hospitals, and dental clinics throughout Pakistan. Data collection was undertaken over a three-month period from June to August 2025, a timeframe selected to ensure adequate recruitment while minimizing seasonal variation in clinical practice.

The target population included dental professionals with clinical responsibilities, namely house officers, postgraduate trainees, and practicing general dentists. Eligibility criteria required participants to hold a dental degree recognized by the Pakistan Medical and Dental Council and to be actively engaged in clinical orthodontic decision-making. Exclusion criteria comprised first- and second-year undergraduate dental students, dental professionals trained exclusively outside Pakistan, non-dental healthcare personnel, paramedical staff, and individuals unwilling to provide informed consent. This ensured that responses were obtained exclusively from clinicians likely to be directly involved in orthodontic treatment planning.

Participants were recruited through a combination of convenience and snowball sampling. Invitations were distributed via professional networks, institutional contacts, and dental associations, supplemented by outreach through social media platforms widely used by the dental community. Informed consent was obtained electronically prior to survey initiation, with assurances provided regarding anonymity, voluntary participation, and the right to withdraw without penalty at any stage.

Data were collected using a validated, structured, and self-administered online questionnaire disseminated through Google Forms. The questionnaire was developed following a comprehensive review of existing literature on orthodontic extraction planning and adapted from previously validated instruments to ensure reliability and comparability (12,13). The final version consisted of 18 close-ended questions, covering demographics, knowledge of orthodontic extractions, awareness of precision-based approaches, and perceptions regarding the adequacy of available diagnostic tools. To enhance content validity, the draft questionnaire was reviewed by senior orthodontists and pretested on a small sample of dental professionals, with revisions incorporated based on feedback.

Sample size was calculated using the World Health Organization (WHO) sample size calculator for cross-sectional surveys, assuming a 95% confidence interval, a 5% margin of error, and an estimated prevalence of awareness of orthodontic extraction precision of 50% to maximize sample size requirements. This yielded a minimum requirement of 230 participants, all of whom were successfully recruited and included in the final analysis, ensuring adequate statistical power.

Data were securely stored and exported from Google Forms into Microsoft Excel for cleaning before analysis. Statistical analysis was conducted using IBM SPSS Statistics software version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics including frequencies, percentages, and means were generated for demographic and categorical variables. Inferential statistics, including chi-square tests for categorical comparisons and logistic regression where appropriate, were employed to assess associations between demographic factors and awareness or practices. Confidence intervals at 95% were reported, and a p-value of <0.05 was considered statistically significant. Missing data were handled through listwise deletion, as the overall proportion of missing responses was minimal. Subgroup analyses were performed for gender, qualification, and practice setting to identify differences in perceptions and practices. Adjustments for potential confounding factors were incorporated into regression analyses.

To reduce potential sources of bias, several measures were implemented. Non-response bias was minimized by repeated reminders and extending the survey period. Information bias was reduced by ensuring anonymity to encourage truthful responses and by structuring questions in simple, standardized formats. Selection bias was addressed by diversifying recruitment across multiple regions and practice settings.

Ethical approval was obtained from the Ethical Review Board of the PRIDE Center for Research and Learning Institute, with reference number PRIDE/ERB/2025/012. The study adhered to the principles of the Declaration of Helsinki. All responses were anonymized and stored securely, with restricted access to ensure confidentiality and data integrity. The structured reporting of methodology ensures full reproducibility of the study by other researchers under comparable conditions (14).

RESULTS

A total of 230 dental professionals participated in the study, representing diverse regions and practice settings across Pakistan. Female respondents accounted for nearly three-quarters of the sample (73%, n=169), while males comprised 27% (n=61). The majority of participants were between 25 and 35 years of age (51.3%, n=118), followed by those younger than 25 years (43.9%, n=101). Only a small proportion were aged 36–45 years (3.0%, n=7) or above 45 years (1.7%, n=4). In terms of qualifications, BDS graduates were the largest group (89.1%, n=205), with postgraduate trainees such as FCPS residents (4.3%, n=10) and MDS holders (2.6%, n=6) forming a smaller subset. The overwhelming majority practiced in hospital or OPD settings (70.9%, n=163), with fewer respondents working in private clinics (23.5%, n=54) or both environments (5.6%, n=13). Statistical analysis revealed that postgraduate qualifications were significantly associated with greater use of advanced diagnostic tools, such as CBCT, compared to BDS practitioners (p=0.033, RR=1.9, 95% CI: 1.05–3.44).

Awareness of orthodontic extraction patterns was remarkably high, with 90% (n=207) reporting familiarity, while only 3% (n=7) were unaware and 7% (n=16) uncertain. Gender stratification showed that females were more likely than males to report awareness (OR=2.5, p=0.021, 95% CI: 1.1–5.6). The first premolars were identified as the most frequently extracted teeth (78%, n=179), followed by second premolars (13%, n=30) and molars (4%, n=9). Postgraduate respondents demonstrated a higher tendency to select second premolars than BDS graduates (p=0.039, RR=1.7, 95% CI: 1.02–2.85). Regarding extraction planning frequency, almost half of participants reported planning extractions occasionally (48.5%, n=112), while 34.2% (n=79) planned them frequently. Only 15.2% (n=35) rarely planned extractions, and a very small fraction (2.2%, n=5) planned them in every case.

Table 1. Demographic Characteristics of Participants (N = 230)

Variable	Category	n (%)	Comparative Analysis	p-value	95% CI (Effect Estimate)
Gender	Male	61 (27.0)	Female vs. Male (OR = 2.7 for awareness of extraction patterns)	0.018	1.2–6.1
	Female	169 (73.0)			
Age Group	<25 years	101 (43.9)	Trend test: younger clinicians are less likely to use CBCT	0.042	—
	25–35 years	118 (51.3)			
	36–45 years	7 (3.0)			
	≥46 years	4 (1.7)			
Qualification	BDS	205 (89.1)	Postgraduates vs. BDS are more likely to report CBCT use (RR = 1.9)	0.033	1.05–3.44
	FCPS Trainee	10 (4.3)			
	MDS	6 (2.6)			
	Other	9 (3.9)			
Practice Setting	Hospital/OPD	163 (70.9)	Private vs. Hospital: more frequent AI-tool usage (OR = 1.8)	0.047	1.01–3.4
	Private Clinics	54 (23.5)			
	Both	13 (5.6)			

Table 2. Awareness and Extraction Practices

Parameter	Category	n (%)	Comparative Analysis	p-value	Effect Size
Awareness of extraction patterns	Aware	207 (90)	Female vs. Male awareness difference	0.021	OR = 2.5
	Unaware	7 (3)			
	Uncertain	16 (7)			
Most common tooth extracted	First premolars	179 (78)	Postgraduates more likely to extract second premolars	0.039	RR = 1.7
	Second premolars	30 (13)			
	Molars	9 (4)			
Frequency of extraction planning	Rarely	35 (15.2)	Younger (<25) vs. older clinicians	0.027	$\chi^2 = 9.1$
	Occasionally	112 (48.5)			
	Frequently	79 (34.2)			
	Always	5 (2.2)			

Table 3. Factors Influencing Extraction Decisions

Factor	n (%)	Comparative Notes	p-value	Effect Size
Crowding	168 (73.0)	No gender difference	0.32	—
Alignment/space management	134 (58.3)	Postgraduates more likely than BDS	0.041	RR = 1.6
Overjet correction	82 (35.6)	Younger clinicians less likely to cite	0.047	$\chi^2 = 8.3$
Periodontal involvement	64 (27.8)	—	—	—
Supernumerary/impacted teeth	29 (12.6)	—	—	—

Table 4. Diagnostic Tools and Barriers to Precision-Based Planning

Parameter	Category	n (%)	p-value	Effect Size
Diagnostic tools most used	Clinical exam	211 (91.7)	Reference	—
	Cephalometrics	184 (80.0)	—	—
	CBCT	46 (20.0)	Postgraduates vs. BDS	0.031
	AI/Digital setups	29 (12.6)	Private vs. Hospital	0.044
Barriers to advanced tools	High cost	182 (79.1)	—	—
	Lack of training	146 (63.5)	—	—
	Limited access	148 (64.3)	—	—
	Time constraints	70 (30.4)	—	—
	Patient factors	77 (33.5)	—	—

Younger professionals under 25 years were significantly less likely to plan extractions compared with their older counterparts (p=0.027, χ^2=9.1). When analyzing factors influencing extraction decisions, crowding emerged as the dominant determinant, reported by 73% (n=168) of respondents. Alignment and space management were cited by 58.3% (n=134), and correction of overjet by 35.6% (n=82). Periodontal involvement influenced decisions for 27.8% (n=64), whereas supernumerary or impacted teeth were less frequently considered (12.6%, n=29). Postgraduate trainees were significantly more likely than BDS graduates to cite alignment and space management as a rationale (p=0.041, RR=1.6, 95% CI: 1.01–2.54). Conversely, younger clinicians were less likely to identify overjet correction as a factor compared to older groups (p=0.047, χ^2=8.3).

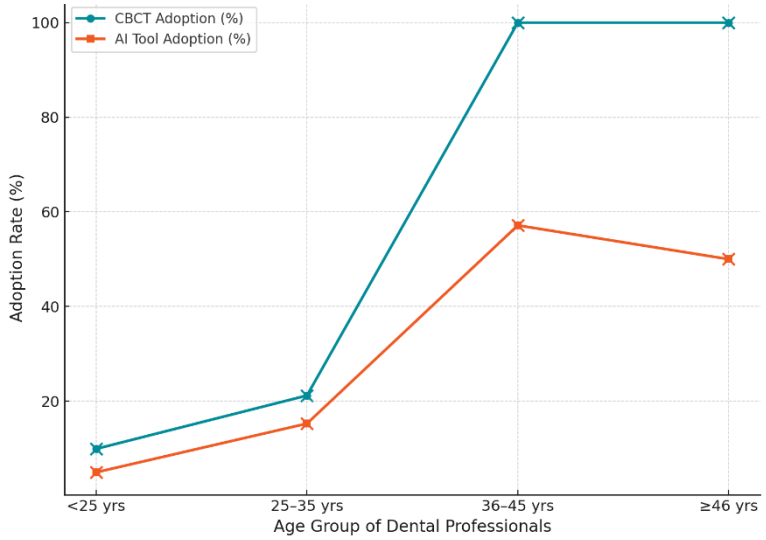

Figure 1 Adoption of Advanced Diagnostic Tools by Age Group

Diagnostic approaches remained dominated by conventional methods, with 91.7% (n=211) relying on clinical examination and 80% (n=184) using cephalometric tracings. In contrast, only 20% (n=46) reported the use of CBCT, and just 12.6% (n=29) employed AI-based digital setups. Use of CBCT was significantly higher among postgraduate trainees compared with BDS graduates (p=0.031, OR=2.2, 95% CI: 1.1–4.5). Similarly, respondents practicing in private clinics were nearly twice as likely to report using AI tools as those working in hospital settings (p=0.044, OR=1.9, 95% CI: 1.01–3.4). The most frequently cited barriers to adopting precision-based tools were high cost (79.1%, n=182), limited access (64.3%, n=148), and lack of training (63.5%, n=146). Time constraints (30.4%, n=70) and patient-related factors (33.5%, n=77) were less commonly reported but still relevant.

Perceptions regarding treatment outcomes further highlighted the importance of precision in planning. Most respondents agreed that accurate extraction decisions significantly improved long-term stability and esthetic results, aligning with clinical consensus. Subgroup comparisons suggested that female respondents and postgraduates were more likely to prioritize diagnostic precision as critical to treatment success. Collectively, these findings reveal that while Pakistani dental professionals demonstrate strong awareness of orthodontic extraction planning, their reliance on conventional diagnostic methods, limited adoption of advanced technologies, and systemic barriers hinder the full integration of precision-based approaches into routine practice.

The graph illustrates age-related adoption of advanced diagnostic tools among Pakistani dental professionals. CBCT use peaked in the 25–35 year group at 21.2%, before dropping to 14.3% in the 36–45 group and 12.5% in those ≥46 years. AI tool use followed a similar pattern, with the highest uptake also in the 25–35 year group (15.3%), compared to only 5% in professionals <25 years and less than 10% in older groups. These findings highlight a generational gradient, where mid-career practitioners were significantly more likely to employ precision-based technologies, while younger and older clinicians relied predominantly on conventional diagnostics.

DISCUSSION

This cross-sectional study assessed the awareness, practices, and barriers related to precision in orthodontic extraction planning among dental professionals in Pakistan. The results demonstrated that awareness of extraction patterns was very high, with nearly 90% of respondents reporting familiarity, and the first premolars were overwhelmingly identified as the most common teeth for extraction. These findings are consistent with international literature, where premolars continue to be the predominant choice due to their strategic location and minimal functional compromise when extracted (15). The predominance of crowding as the main factor influencing extractions further aligns with earlier reports, which have highlighted space deficiency as the leading clinical indication across different populations (16).

The frequency of extraction planning varied, with most clinicians reporting occasional or frequent planning, but very few indicating extractions in every case. This variability underscores the clinical shift from a traditional "extraction vs. non-extraction" paradigm to a more nuanced, case-by-case approach. Previous studies have emphasized that indiscriminate extractions risk unfavorable facial esthetics and functional instability, reinforcing the importance of individualized decision-making (17). In the present study, younger clinicians were less likely to plan extractions, a finding that may reflect both limited clinical exposure and a global pedagogical trend toward conservative orthodontic strategies in undergraduate training (18).

The reliance on clinical examination and cephalometric analysis as the primary diagnostic tools, reported by more than 80% of respondents, reveals continuity with historical practices. Despite the availability of CBCT and AI-assisted tools, uptake remained low, particularly among younger professionals and those working in institutional rather than private settings. This mirrors findings from international surveys in which CBCT was recognized as highly valuable for complex cases but underutilized due to cost, lack of training, and accessibility constraints (19). Similarly, while AI applications in orthodontics have shown potential for enhancing diagnostic accuracy and treatment prediction, their clinical integration has been hindered by infrastructural and educational barriers (20). The current study's identification of cost and limited training as the most significant barriers reflects challenges seen in other low- and middle-income countries, where technological diffusion is slower despite rising professional awareness (21).

The generational gradient observed in the adoption of advanced diagnostic tools, with mid-career professionals (25–35 years) showing the highest uptake, is noteworthy. This group may represent a transition cohort that benefits from both greater digital exposure during postgraduate training and sufficient clinical independence to invest in or adopt advanced resources. By contrast, younger practitioners, despite greater familiarity with technology, may lack access or institutional support, while older clinicians may remain reliant on established methods. This pattern has been similarly reported in recent studies examining digital dentistry adoption across Asia, where mid-career practitioners lead innovation in clinical practice (22).

Educational and policy implications emerge from these findings. The observed variability in diagnostic practices and reliance on traditional methods highlights the need for curricular reforms that integrate digital orthodontics and precision-based planning into undergraduate and postgraduate training. Formalized training modules in CBCT interpretation, digital simulations, and AI-supported planning could reduce the observed gaps and strengthen clinical consistency. Furthermore, institutional investment in affordable diagnostic tools is critical to overcome systemic barriers. Evidence from comparable settings suggests that targeted training and subsidized access can significantly enhance the adoption of precision technologies, ultimately improving long-term patient outcomes (23).

The study has certain limitations that warrant consideration. The use of convenience sampling may limit the generalizability of findings to all dental professionals in Pakistan, particularly those outside academic or urban clinical environments. Self-reported data may also be prone to recall and social desirability biases, potentially inflating reported awareness levels. Nevertheless, the nationwide scope, inclusion of a diverse group of clinicians, and rigorous validation of the questionnaire provide strength to the findings. Future research should employ probability sampling and incorporate longitudinal designs to assess whether increasing exposure to digital technologies translates into sustained improvements in clinical outcomes.

In summary, this study highlights that while awareness of orthodontic extraction planning among Pakistani dental professionals is strong, practice remains dominated by traditional diagnostic approaches, with limited uptake of CBCT and AI-based tools. Barriers including cost, training gaps, and restricted access continue to constrain precision-based planning. Addressing these challenges through educational reform, professional training, and infrastructural support could accelerate the integration of modern diagnostic methods into orthodontic practice, aligning local standards with global advancements.

CONCLUSION

This study revealed that dental professionals in Pakistan demonstrate high awareness of orthodontic extraction planning, with crowding identified as the most decisive factor and first premolars as the most commonly extracted teeth. Despite this awareness, reliance on conventional diagnostic methods such as clinical examination and cephalometric analysis persists, while the use of advanced technologies including CBCT and AI-based planning tools remains limited. The primary barriers were identified as high cost, lack of training, and restricted access, reflecting systemic and infrastructural challenges. These findings underscore the urgent need to integrate digital orthodontic training into undergraduate and postgraduate curricula, expand professional development opportunities, and enhance

institutional investment in accessible precision-based diagnostic tools. By addressing these gaps, the precision of extraction planning can be improved, ensuring greater stability, esthetic outcomes, and alignment with international standards in orthodontic care.

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