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Original Article

Assessing Diagnostic Proficiency of Final-Year Dental Students in Selected Orthodontic Cases: An In-Depth Evaluation of Clinical Competence

Péter Balogh[1*], Anna Molnár[2], Ferenc Rácz[1]

1. Department of Orthodontics and Pediatric Dentistry, Faculty of Dentistry, University of Szeged, Szeged, 6720, Hungary.
2. Department of Prosthodontics, Faculty of Dentistry, University of Szeged, Szeged, 6720, Hungary.

***E-mail** ✉ Dimitri@gmail.com

Abstract

This research investigates the ability of final-year dental students at Al-Iraqia University to accurately diagnose and refer patients with different degrees of malocclusion using a structured questionnaire. The survey included photographs and radiographs of five treated cases sourced from two textbooks. A total of 165 students were asked to evaluate each case, determine whether orthodontic or surgical intervention was indicated, and identify contributing factors to an unesthetic facial profile, such as dental irregularities. Data were analyzed using frequency distribution and Chi-square tests. Overall, students displayed a solid level of clinical competence. Unesthetic profiles and irregular teeth were the predominant reasons for recommending surgical intervention in both Class II and III cases, with mandibular retrusion emerging as the most frequently cited factor affecting aesthetics. Maxillary protrusion was less commonly recognized as a significant concern in Class II malocclusion. The study indicates that final-year students possess a strong ability to accurately identify treatment requirements across a range of malocclusion scenarios.

Key words: Clinical competence, Diagnostic proficiency, Orthodontic cases, Dental students

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Introduction

Malocclusion is defined as an improper alignment between the upper and lower teeth [1], which may be observed during jaw function, rest, or occlusion. Accurate diagnosis and timely treatment are essential for maintaining oral health, daily function, and overall quality of life [2]. Treatment plans should address the patient's expectations, enhance facial aesthetics, correct the malocclusion, and resolve any functional issues. Management strategies for skeletal discrepancies may include camouflage, functional appliances, or orthognathic surgery, depending on factors such as patient age, facial appearance, treatment demand, and malocclusion severity [3].

The American Dental Association emphasizes the importance of continuous evaluation of treatment outcomes, critical appraisal of scientific literature, and evidence-based clinical decision-making to promote comprehensive patient care, foster critical thinking, and support ongoing professional development for both students and practicing dentists [4]. The provision

of orthodontic care is influenced by multiple practitioner-related factors, including years since graduation, perceptions of undergraduate training, and participation in continuing education courses in orthodontics [5].

General dental practitioners often serve as gatekeepers to specialist care, determining if, when, and where patients should be referred [6]. Proper timing of referrals is critical; premature referrals may result in unnecessary visits, while delayed referrals can complicate treatment and extend its duration [7]. Efficient referral practices are particularly important in publicly funded dental clinics, where patient waiting lists are a significant concern. Correct prioritization, guided by orthodontic indices and treatment need assessments, can reduce delays and optimize patient care [8].

The Index of Orthodontic Treatment Need (IOTN), developed by Brook and Shaw [9], and its aesthetic component (AC) introduced by Richmond *et al.* [10], remain widely used tools to classify patients into three categories: no treatment required, borderline or possible need, and definite treatment need. Numerous studies [11–24] have examined the diagnostic abilities and treatment planning approaches of final-year dental students and general dentists for various malocclusions, with several focusing specifically on undergraduate students' competence in identifying different malocclusion types [11,13,15].

This study aims to assess the diagnostic skills and treatment decision-making of undergraduate dental students by having them complete a structured questionnaire containing photographs and radiographs of malocclusion cases, ranging from mild to severe, to determine whether they can accurately diagnose the orthodontic problem considering malocclusion severity and patient age, and make appropriate referrals for orthodontic treatment within a dental teaching hospital setting.

Materials and Methods

This study, designed as a cross-sectional evaluation, received ethical approval from the College of Dentistry at Al-Iraqia University and was conducted during the second session on 7 April 2023. The aim was to assess the clinical diagnostic skills of final-year dental students using a paper-based survey adapted from the methodology of Yilmaz *et al.* [18].

Before implementation, the questionnaire underwent initial validation by a panel of 10 experienced orthodontists to ensure its relevance and clarity. The finalized survey was administered as a 30-minute examination to 165 final-year students, who were presented with photographs and radiographs (lateral cephalometric and panoramic) of five previously treated patients. The selected cases, drawn from two textbooks [25, 26], included complete treatment documentation and represented different malocclusion types: one Class I case, two Class II cases treated with camouflage therapy, and two Class III cases managed through face mask therapy or orthognathic surgery (see Appendices A.1–A.5). These cases were chosen to cover a broad spectrum of malocclusion causes and treatment approaches, providing a meaningful diagnostic challenge. Ethical compliance included obtaining permission from the textbook authors via e-mail to use their images.

Students were tasked with evaluating each case and determining whether orthodontic treatment, orthognathic surgery, or neither was indicated. They were also asked to specify the rationale for recommending surgery—whether due to tooth misalignment or an unesthetic facial profile—and to identify the underlying factors contributing to the unesthetic profile. Students completed the questionnaire while reviewing the case materials, and their responses were later compared with the ideal answers outlined in the textbooks.

Questionnaire Structure

1. Does this patient require orthodontic treatment?
    a. Yes
    b. No
2. If Yes, is orthognathic surgery necessary?
    a. Yes
    b. No
3. If surgery is indicated, what is the primary reason?
    a. Unesthetic profile combined with tooth misalignment
    b. Tooth misalignment only

4. If unesthetic profile is involved, which factors contribute to it?
    a. Protruded mandible
    b. Retruded mandible
    c. Protruded maxilla
    d. Retruded maxilla

Statistical analysis

Responses were analyzed using SPSS version 25. Descriptive statistics (frequencies and percentages) were calculated for each question and case, and differences between student responses were evaluated using the Chi-square test, with a significance threshold of 0.05.

Results

All 165 participating students completed the 20-question survey based on five orthodontic cases, resulting in a 100% response rate **(Table 1)**.

Table 1. Frequency distribution and comparison of the responses of the participants

Questions	Answers	Case No. 1 Class III Face Mask Treatment	Case No. 2 Class II Camouflage Treatment	Case No. 3 Class I	Case No. 4 Class II Camouflage Treatment	Case No. 5 Class III Orthognathic Surgery
Q1	Need orthodontic treatment	137 (83%)	120 (73%)	151 (92%)	147 (89%)	159 (96%)
	No need for orthodontic treatment	28 (17%)	45 (27%)	14 (8%)	18 (11%)	6 (4%)
	p-value	≤0.001	≤0.001	≤0.001	≤0.001	≤0.001
Q2	Need orthognathic surgery	9 (7%)	13 (11%)	22 (15%)	23 (16%)	126 (79%)
	No need for orthognathic surgery	128 (93%)	107 (89%)	129 (85%)	124 (84%)	33 (21%)
	p-value	≤0.001	≤0.001	≤0.001	≤0.001	≤0.001
Q3	Unesthetic profile and irregular teeth	9 (100%)	11 (85%)	17 (77%)	23 (100%)	124 (98%)
	Irregular teeth	0 (0%)	2 (15%)	5 (23%)	0 (0%)	2 (2%)
	p-value	-	0.022	0.017	-	≤0.001
Q4	Protruded mandible	0 (0%)	0 (0%)	0 (0%)	1 (4%)	101 (81%)
	Retruded mandible	8 (89%)	3 (27%)	5 (29%)	6 (26%)	0 (0%)
	Protruded Maxilla	0 (0%)	8 (73%)	12 (71%)	16 (70%)	0 (0%)
	Retruded Maxilla	1 (11%)	0 (0%)	0 (0%)	0 (0%)	23 (19%)
	p-value	0.039	0.277	0.143	≤0.001	≤0.001

For question 1, which assessed whether orthodontic treatment was necessary, a majority of participants correctly identified the need for treatment across all five malocclusion cases, with percentages of 83%, 73%, 92%, 89%, and 96%, respectively. Notably, 27% of students chose “no treatment” for the Class II camouflage case, and 17% did so for the Class III face mask

case, representing incorrect selections. The remaining cases showed relatively few incorrect responses, and the differences were statistically significant according to the Chi-square test **(Table 1)**.

Regarding question 2, which examined the necessity of orthognathic surgery, 79% of students correctly identified Class III cases as requiring surgery. The other cases were predominantly recognized as not needing surgical intervention, with the Chi-square test indicating a highly significant difference. For cases deemed to require surgery, question 3 revealed that the main reasons cited were an unesthetic profile and irregular teeth.

For question 4, concerning factors contributing to an unesthetic profile, analysis of facial photographs and cephalometric data showed that for the fifth case, 81% of participants identified a protruded mandible, while 19% selected a retruded maxilla, with the difference reaching statistical significance.

Discussion

Accurate diagnosis is a cornerstone of effective orthodontic treatment planning, as it allows for proper identification of malocclusions, skeletal discrepancies, and formulation of appropriate treatment strategies. Research has highlighted that dental students often lack confidence and proficiency in orthodontic diagnosis, pointing to potential gaps in undergraduate education.

Dental schools must ensure that their graduates are capable of meeting the population's oral health needs, and this requires ongoing evaluation of course quality and clinical training [27]. Future dental practitioners should be able to identify occlusal and dentofacial abnormalities in patients and refer appropriately for orthodontic care [11]. It is widely recommended that clinicians understand both the treatment options available and the optimal timing for intervention [17]. However, O'Brien *et al.* [7] reported that nearly 45% of orthodontic referrals were inappropriate, suggesting that structured referral guidelines might support general dentists in identifying suitable patients for specialist care [14]. Despite such guidelines, changes in referral behavior among general practitioners appear limited. Pediatric and general dentists provide the majority of orthodontic referrals, while orthodontists benefit from extended training and clinical experience in managing a wide range of malocclusions—training that general dentists only encounter during their dental school education [16].

This study aimed to evaluate the diagnostic abilities of final-year dental students, identify factors affecting their decision-making, and provide recommendations for enhancing orthodontic education. It represents the first study of its kind in Iraq and may serve as a preliminary investigation for larger-scale research in the future. Additionally, no prior assessments of case referral practices have been reported in this context.

The findings suggest that students demonstrated a reasonable level of orthodontic competence, as the proportion of correct responses across all malocclusion cases was high. Most participants appeared to possess adequate knowledge to diagnose the cases, with only a minority selecting incorrect options indicating no need for treatment. This performance likely reflects the strength of the existing curriculum, although exam-related stress or time constraints may have contributed to some errors. These results contrast with findings from other studies [28, 29], which reported lower diagnostic accuracy among dental students.

In a study conducted in Iran examining final-year dental students' willingness to perform orthodontic treatments in their future careers, Sadeghian *et al.* [28] reported that only 15 percent of students felt confident in diagnosing and managing orthodontic cases upon graduation. Many participants questioned the sufficiency of the hours devoted to orthodontics in their curriculum and expressed concerns about both the theoretical and practical aspects of their training. A notable proportion of students indicated a desire for further orthodontic education after completing their degree.

Similarly, a qualitative study by Ismail *et al.* [29] found that final-year dental students and recent graduates often felt unprepared to diagnose orthodontic conditions or develop appropriate treatment plans. Participants highlighted that their education was predominantly theoretical, with limited hands-on experience, which contributed to low confidence in clinical situations. They emphasized that additional clinically oriented orthodontic training would have been valuable to enhance their competence.

Management of Class III malocclusions, including maxillary growth stimulation, modification, or restriction, typically requires intervention during the growth period with either intraoral or extraoral appliances, making these cases particularly

challenging in terms of diagnosis and treatment [26]. Some researchers have suggested that undergraduate training should prioritize accurate diagnosis over treatment planning [27]. Current dental curricula should therefore shift toward developing students' competency in recognizing and diagnosing malocclusions, as preparing students to manage complex treatments independently is not practical or feasible.

This study addresses both clinical competence and diagnostic proficiency, emphasizing the importance of practical training within dental teaching hospitals. Canavero *et al.* [13] observed that undergraduate students struggled to accurately diagnose Class II malocclusions and often lacked a clear understanding of basic treatment protocols. While increased overjet was typically identified, other features such as increased overbite were less frequently recognized, indicating a need for more comprehensive training in evaluating diverse malocclusion characteristics.

Yilmaz *et al.* [18] noted that the Class II camouflage case requiring treatment was less frequently recognized compared to other malocclusion types in the current study. Conversely, Class II cases requiring orthognathic surgery were associated with higher treatment needs, which contrasts with previous findings [18] that reported a lower proportion of patients indicated for surgical intervention.

Students must possess thorough knowledge of orthognathic surgery, which is generally elective and often performed primarily for aesthetic reasons. Accurate interpretation of photographs, cephalometric radiographs, and understanding of the envelope of discrepancy are essential for diagnosing such cases. In the present study, students frequently identified that Class II camouflage cases did not require orthognathic surgery, which was appropriate based on patient age and cephalometric analysis; the recommended treatment in these cases involved extraction of the four first premolars, while orthognathic surgery was reserved for severe skeletal discrepancies.

A study using the Diagnostic Thinking Inventory to evaluate clinical reasoning skills among dental students in Karachi revealed overall weak performance. Students demonstrated low scores in both knowledge structuring and cognitive flexibility, both of which were directly linked to diagnostic ability. Interestingly, female students outperformed their male counterparts in diagnostic thinking skills [30].

Tuncer *et al.* [20] reported that final-year dental students responded positively to case-based orthodontic learning, with the most notable impact observed in student motivation to provide feedback on orthodontic case diagnosis and treatment planning, without perceiving it as additional workload. Based on these findings, it is recommended that dental education incorporate structured measures to enhance diagnostic training, such as increasing practical experience, employing case-based learning, and providing access to digital and 3D diagnostic tools. Furthermore, group discussions and regular examinations are important to assess and reinforce the competence of future dentists in diagnosing and referring orthodontic cases.

Several factors influence diagnostic proficiency among final-year dental students. Variations in orthodontic curricula across dental schools contribute to discrepancies in student competence. In a scoping review, Raghavan *et al.* [31] highlighted considerable differences in curriculum content, learning outcomes, and assessment methods, recommending standardization to align programs with professional standards and better prepare students for clinical practice.

The balance between theoretical instruction and practical experience also affects the development of diagnostic skills. Students reported that practical sessions often focused on procedural tasks, such as wire bending, while providing limited exposure to real-world diagnostic activities, restricting the growth of clinical reasoning and decision-making abilities [29].

Clinical exposure and hands-on practice are critical for building diagnostic confidence. For instance, a study at Cardiff University found that 69% of fourth-year dental students felt confident managing orthodontic emergencies after supervised patient care. Students emphasized the importance of integrating theoretical knowledge with practical clinical experience and valued structured, supportive clinical learning environments [32]. However, many students still report insufficient clinical exposure during undergraduate training. Limited opportunities to engage in the full spectrum of patient diagnosis and treatment planning hinder the development of essential competencies. Expanding clinical rotations and offering a broader case mix can enhance diagnostic proficiency [31].

Assessment and feedback mechanisms represent another key factor. Effective development of diagnostic skills relies on frequent evaluation and constructive feedback. Traditional assessment methods may not adequately capture students' diagnostic abilities, whereas formative assessments—such as case-based discussions, reflective exercises, or situational

tasks—provide actionable feedback and opportunities for improvement. Supplementing baseline knowledge with simulation exercises and roleplay can further strengthen clinical reasoning, offering a safe environment to practice complex case diagnosis and share thought processes that build confidence and competence.

One limitation of the present study is that it was conducted at a single dental college with a relatively small sample size, which may introduce bias. Additionally, the excitement surrounding students' impending graduation could have influenced their performance. Future research should involve larger sample sizes, a greater variety of cases, and include multiple dental colleges nationwide to obtain a more comprehensive understanding of the knowledge and clinical preparedness of future dentists.

Recommendations to Enhance Diagnostic Proficiency:

1. Curriculum Enhancement: Dental programs should revise curricula to balance foundational knowledge with sufficient practical application opportunities. Combining lectures with hands-on clinical experiences can help students translate theoretical concepts into real-world practice.
2. Standardization of Learning Objectives: Establishing uniform learning outcomes and competencies in orthodontic education across institutions can promote consistency. Aligning curricula with regulatory and professional standards ensures that students are adequately prepared to meet clinical practice expectations.
3. Expanded Clinical Exposure: Providing supervised clinical experiences across a wide range of malocclusion cases and treatment scenarios strengthens students' diagnostic abilities. Structured clinical rotations and mentorship programs offer valuable opportunities for experiential learning and patient care guidance.
4. Innovative Teaching Methods: Simulation-based training, case-based learning, and role-playing exercises are essential for developing clinical reasoning and decision-making skills. Educational strategies that realistically replicate clinical challenges allow students to apply theoretical knowledge in practical, problem-solving contexts.
5. Ongoing Assessment and Feedback: Formative assessments and regular feedback help students identify their strengths and weaknesses, fostering self-awareness and promoting skill development through reflective practice and self-directed learning.
6. Faculty Development: Investing in faculty training to adopt innovative teaching and assessment methods enhances their capacity to guide students effectively. Faculty should be professionally and pedagogically equipped to create active learning experiences, mentor students, and implement novel educational strategies.

The results indicate that final-year dental students generally recognize when orthodontic treatment is needed and can detect major skeletal anomalies. However, they face challenges in making detailed diagnostic distinctions, such as differentiating between jaw components and identifying borderline cases versus normal anatomical variations. To address these gaps, educational strategies should include:

1. Increased structured exposure to borderline and complex cases.
2. Enhanced training in cephalometric analysis and facial profile assessment.
3. Greater use of 3D imaging and visual tools to reinforce diagnostic skills.

Overall, these findings provide a valuable diagnostic benchmark, highlighting both strengths and areas for improvement in orthodontic training for final-year dental students.

Conclusions

Undergraduate dental students demonstrated a satisfactory level of clinical competence and diagnostic ability across a spectrum of malocclusion cases, from mild to severe. They were generally capable of evaluating the need for orthodontic treatment while taking into account both the malocclusion severity and the patient's age. Class II and III malocclusions were most frequently identified as requiring orthognathic surgery, with an unesthetic facial profile and irregular dentition being the primary factors prompting surgical referral.

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