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UK dental students' ability and confidence in applying the Index of Orthodontic Treatment Need and determining appropriate orthodontic referral

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Abstract

Introduction: The aim was to assess the ability and confidence of UK undergraduate dental students in applying the Index of Orthodontic Treatment Need (IOTN) and determining appropriate orthodontic referral.

Materials and Methods: This was a cross-sectional survey using a case-based online questionnaire. Fourth and fifth year undergraduate dental students were recruited from UK dental schools through their university and social media. Six cases were presented and participants were asked to provide an IOTN score and judgement about referral. Participants were asked about their confidence, experience and orthodontic teaching.

Results: Sixty-nine responses were returned. A quarter of participants reported having used IOTN before in a clinical setting. Clinical experience with IOTN influenced confidence. Familiarity with making orthodontic referrals was low and only one participant reported having made an orthodontic referral. Correct IOTN scores were given by 68% of participants for a large 14 mm overjet (5a) case, 43% of participants for an impacted canine (5i) case and 26% of participants for an impacted premolar (5i) case. Incorrect IOTN was most common in hypodontia cases with only 19% correctly identifying mild hypodontia (4h) and 28% identifying severe hypodontia (5h). For the majority of cases, incorrect answers about referral were due to confusion between specialist practitioner and orthodontic consultant pathways.

Conclusions: Dental students' ability and confidence in correctly applying the IOTN Dental Health Component and selecting the appropriate referral pathway was inadequate. Responses suggest a lack of clinical experience in assessing patients, applying the IOTN and making referrals. The low response rate is disappointing and limits the scope for making recommendations.

KEYWORDS
ability, confidence, Index of Orthodontic Treatment Need, orthodontic referral, undergraduate

1 | INTRODUCTION

The Index of Orthodontic Treatment Need (IOTN) was adopted in UK primary care in 2006 to standardise the assessment of treatment need. The IOTN compromises two parts. The first is the Dental Health Component (DHC), which consists of a grade from 1 'No need for treatment' to 5 'Great need for treatment', along with a letter that indicates the worst occlusal trait. The second part is the Aesthetic Component (AC), which rates dental attractiveness on a scale of 1–10.[1] The DHC was developed to prioritise occlusal traits that are most likely to cause harm, for example, impacted teeth and large overjets, whilst the AC reflects the aesthetic impairment caused by the malocclusion. Currently, in the UK, an IOTN score of 3.6 (DHC 3 and AC 6) or higher is used to indicate those who would benefit most from orthodontic treatment and may be eligible for National Health Service (NHS)-funded orthodontic treatment.

Guidelines for Commissioning Dental Specialties for Orthodontics[2] were published to describe the development of dental care pathways, with the ambition of transforming services to deliver better outcomes and use resources effectively. Descriptors are used to define the complexity of an orthodontic case, taking into account the type of malocclusion, technical difficulty in improving function and aesthetics and any patient modifying factors. The guidelines are aimed at those with responsibility for commissioning NHS services, but the complexity descriptors may assist referrers to identify the most appropriate referral pathway. Level 1 describes the recognition of normal and abnormal development and making referrals. Level 2 includes interceptive treatment and simple appliance treatment, which can be carried out by a dentist with appropriate competencies. Level 3 is for complex malocclusions that require treatment to be carried out by a specialist; Level 3a indicates a level of complexity suitable for Orthodontic Specialist services, whereas Level 3b is the most complex cases requiring Consultant Orthodontist or equivalent. Level 3b includes cleft lip and/or palate orthodontics, severe skeletal discrepancies requiring orthognathic surgery and malocclusions requiring multidisciplinary team input. Patient-modifying factors, such as medical history, social factors or patient anxiety may increase complexity and therefore alter the referral pathway.

General dental practitioners (GDPs) are the gatekeepers for recognising abnormalities and making referral to specialist services. It is, therefore, essential that GDPs are able to identify key traits of malocclusion and apply the IOTN accurately. Consequently, it is important that by the end of their undergraduate training, dental students should be familiar with the IOTN and have the necessary knowledge, experience and confidence to apply it accurately to different malocclusions. To date, the majority of research has evaluated IOTN in terms of scope for calibrating dental students[3,4] and the ability of GDPs and orthodontic specialists to use the index.[5–7] A study evaluating GDPs' knowledge and use of IOTN in Scotland found that of 231 participants, only 40% used IOTN to assess referral eligibility.[5] Half the participants reported a lack of training was a key barrier to use. A further study assessing the ability of different types of dental registrants to provide an appropriate IOTN score found both Dental Foundation Trainees and GDPs achieved fair to poor agreement with experts.[6] These groups were also found to more often judge a case to require treatment when it did not.

The aim of this study was to investigate the ability and confidence of 4th and 5th year undergraduate dental students in the UK when applying the DHC of the IOTN and determining appropriate referral.

2 | MATERIALS AND METHODS

A cross-sectional survey of UK dental students was undertaken using an online survey based on clinical cases. Ethical approval was obtained from the University of Leeds Dental Ethics Committee (granted 13.10.2020).

2.1 | Population

The target population was 4th and 5th year undergraduate dental students in the UK. Senior undergraduate dental students were selected because it was expected that they would have received orthodontic teaching and have more experience in applying the IOTN.

2.2 | Online questionnaire

The questionnaire was developed by the research team specifically for this study. It consisted of:

- Participant demographics (University, year of study, intention to work in the UK or overseas)
- Orthodontic teaching (type of teaching, year[s] when orthodontics is taught, recall of teaching about IOTN and orthodontic referrals)
- Self-reported experience and confidence with IOTN and referral pathways
- Six clinical cases with questions about IOTN score, referral and confidence in selecting the IOTN and referral.

Free text boxes were included to allow participants to quantify their answers and provide additional detail. Dental students are of a similar age and experience so it was not felt that collecting additional demographic data would add any further information but may reduce willingness to complete the questionnaire.

The cases included digital study models, an orthopantograph and standardised information that may be needed to identify the IOTN DHC and referral pathway (patient concern, age, medical and dental history, overjet, maximum contact point displacement). The cases were selected from a bank of those used on the Yorkshire Orthodontic Therapy Course with input from representatives from

TABLE 1 Summary of IOTN and referral pathway for cases

Case	Brief description of case	IOTN	Referral pathway and reasoning	Referral timing
1	17 years old No missing or impacted teeth, overjet 9 mm, maximum contact point displacement 7 mm	4a	3a May then require 3b referral to discuss orthognathic surgery	Immediate
2	14 years old No missing teeth, overjet 14 mm, maximum open bite 1 mm, maximum contact point displacement 9 mm	5a	3a Requires specialist-level care	Immediate
3	13 years old Impacted UR3, overjet 6 mm, Maximum contact point displacement 4 mm	5i	3a Single impacted tooth can be managed in primary care with oral surgery liaison	Immediate
4	14 years old Missing UL1 with space loss, lateral incisors in crossbite, maximum contact point displacement 4.5 mm	4h	3b May require interdisciplinary planning	Immediate
5	13 years old Missing first and second premolars in two quadrants, overjet 2 mm, maximum contact point displacement 5 mm	5h	3b Requires interdisciplinary planning	Immediate
6	13 years old Impacted LL5, UR3 buccal bulge visible, overjet 12 mm, maximum contact point displacement 7 mm	5i	3a Requires specialist-level care	Immediate

the target population (Table 1). The aim was to select a range of common malocclusions that required referral to orthodontic specialist (3a) or orthodontic consultants (3b). The cases had the appropriate level of consent for use and the IOTN scores were confirmed by a calibrated assessor.

The questionnaire was programmed using OnlineSurveys, a UK-based, data protection-compliant survey tool. The questionnaire was piloted with four 5th year dental students at the University of Leeds to test face validity. Based on feedback, changes were made to improve the clarity. The number of cases was reduced from eight to six allowing for questionnaire completion in around 10 min. To reflect the real clinical setting, permission was sought to include a copy of the British Orthodontic Society IOTN chart for participants to use during the IOTN assessment. No other formal validation testing was undertaken and due to the limited number of cases, there was no inclusion of a repeat case to test reliability. The full questionnaire is included in the Appendix S1.

2.3 | Recruitment

Recruitment was undertaken through dental schools and social media. Undergraduate Orthodontic Leads and/or Student Support Offices of the 16 Dental Schools in the UK were contacted to request permission to distribute the questionnaire. Once consent had been granted, a summary of the research, the participant information sheet and a link to the questionnaire were distributed to 4th and 5th year dental students through this contact. A number of reminders were sent to the contact to request distribution of the questionnaire, however, not all contacts responded to confirm that the questionnaire had been shared. Undergraduate student dental societies were contacted through social media platforms to extend recruitment. It was not possible to directly contact students due to restrictions around sharing email addresses.

There was no hypothesis, primary outcome or clinically important difference on which to base a sample size calculation. It was agreed we would aim to recruit 150–200 responses, based on a similar study.[6] To encourage participation, students were given the opportunity to win one of ten £10 Starbucks vouchers.

2.4 | Data collection and analysis

Each participant was assigned a unique identifier by the survey tool and results were collected and stored using only this identifier. Responses were automatically collated into Microsoft Excel, which was only accessible to the research team through a password-protected portal.

Data were analysed to describe:

- The proportion of participants who provided the correct and incorrect IOTN score per case, with reason for incorrect score.
- The proportion of participants who would refer and to which referral pathway.
- Levels of reported confidence in applying IOTN and making referrals.
- Reported confidence based on the accuracy of IOTN score and referral pathways answers.

Due to insufficient number of responses, it was not possible to perform inferential statistics.

3 | RESULTS

The survey was open between October 2020 and January 2021. A total of 69 responses were received, of which 41 were 5th year and 28 were 4th year undergraduate dental students. The majority of participants were from the University of Leeds ($n = 26$) and the University of Manchester ($n = 10$). It was expected that the invitation to participate would reach all 4th and 5th year dental students in the UK, giving a potential sample of around 2500 participants; however, there were no responses from students at the University of Birmingham, University of Plymouth, Newcastle University, Kings College London and Barts and The London so it is unclear whether the invitation was distributed. Students from the University of Bristol had not received their orthodontic teaching at the time of the survey so were not invited to take part. The majority of participants ($n = 53$) reported an intention to work in the UK.

3.1 | IOTN and orthodontic referral teaching

Orthodontic teaching was reported to commence in the 3rd year ($n = 32$, 46%) and 4th year ($n = 28$, 41%) by the majority of participants; however, there were inconsistencies in the answers given by students from the same dental school. Almost all participants reported receiving orthodontic teaching through lectures/e-lectures ($n = 68$, 99%) and case-based seminars ($n = 56$, 81%). Clinical experience in orthodontic clinics was limited to a few dental schools and included undertaking an orthodontic assessment ($n = 23$, 33%) and providing orthodontic treatment ($n = 15$, 22%).

3.2 | General experience and confidence with IOTN and referral

Self-reported familiarity with using IOTN and making orthodontic referrals is given in Figure 1. A quarter of participants reported that they had used IOTN before in a clinical setting, whereas those with higher levels of familiarity reported having used the index more than twice in a clinical setting or case-based seminars. Twenty-eight participants (41%) felt generally confident applying the IOTN. The free comments suggested that confidence was related to clinical experience, and the level of clinical experience was variable. A number of participants reported that the majority of clinical experience arose from examinations in the Paediatric Dentistry clinic, rather than specific orthodontic assessment (Table S1).

Familiarity with orthodontic referrals was lower than familiarity with IOTN. Only one participant reported having actually made an orthodontic referral:

> "Completed a referral once, found it challenging and did not know what to include".

Approximately a third of participants ($n = 20$, 29%) felt confident referring for orthodontic advice or treatment and again, experience was an important determinant of confidence. The free text comments indicated participants felt they received limited teaching and they would like more information about what to include in a referral letter (Table S2). There were some comments that demonstrated misunderstanding and limited knowledge about appropriate referrals:

> "From what I understand, early referrals are made for patients eligible for interceptive orthodontics. Other patients should be referred from around age 8 if their IOTN fits the NHS."

> "I feel I will refer all patients for orthodontic advice due to limited knowledge".

Due to low numbers, it was not possible to formally examine whether familiarity with IOTN and making orthodontic referrals correlated with correct answers, however, no trends were identified that would suggest this was the case.

3.3 | Ability and confidence in selecting IOTN DHC

Table 2 summarises the proportion of participants who provided the correct IOTN score and the reason for an incorrect score. Most

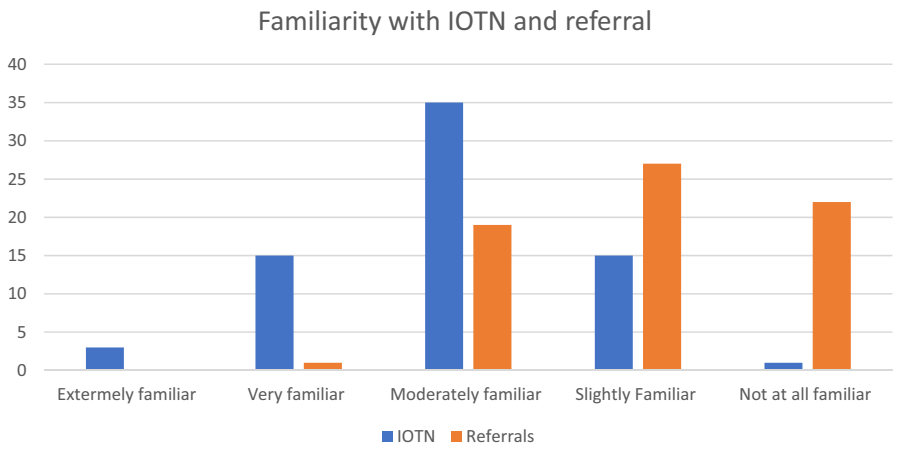

FIGURE 1 Participants self-reported familiarity with the IOTN and orthodontics referrals

correct scoring was seen in cases with a large overjet, with the correct IOTN DHC provided by 47 (68%) participants for the 14 mm overjet (5a) case and 36 (52%) participants for the 9 mm overjet (4a) case. Incorrect scores were most commonly due to correct grading but without the trait, however, often overjet was mentioned in the comments.

The two cases with tooth impaction were correctly scored as 5i by 30 (43%) participants for the impacted canine and 18 (26%) for the impacted premolar. For the impacted canine case, nearly one-third (n = 21, 30%) of participants graded it 2 or 3, suggesting low need for treatment. Incorrect IOTN was most common in the hypodontia cases with only 13 (19%) participants correctly identifying mild hypodontia (4h) and 19 (28%) identifying severe hypodontia (5h). During manuscript preparation, an error in the case information for the 5h case was identified, stating the maximum overjet 12 mm rather than 2 mm. The study models showed the correct overjet but 22 participants (32%) scored case 5a, presumably based on the case information. No free text comments were made that suggested participants had identified the discrepancy between the information and study models. The error, although undesirable, usefully highlights a lack of understanding of the hierarchy of the occlusal traits. This was also demonstrated in the 4h case, which had a reverse overjet of 3 mm that was commonly scored above the missing teeth.

Self-reported confidence in selecting the IOTN score is given in Figure 2, based on whether the IOTN score was correct or not. Generally, those who answered incorrectly reported lower levels of confidence, however, a notable number were completely or fairly confident in an incorrect answer.

3.4 | Ability and confidence in the selection of orthodontic referral pathway

Table 3 summarises the decisions about making an orthodontic referral. For the majority of cases, incorrect answers were due to confusion between a Level 3a and 3b referral. A notable proportion of people selected Level 1, Level 2 or 'Not sure', suggesting poor understanding of the different options for care and how this aligns with case complexity. The fewest correct answers were given for Case 3, which was an ectopic canine with a high treatment need and

TABLE 2 IOTN DHC scores given for cases

Case	IOTN DHC score	Correct score n (%)	Incorrect score n (%)	Reason for incorrect score (n)		
				Correct trait but incorrect grade	Correct grade but without trait	Incorrect trait and grade
1	4a	36 (52)	33 (48)	6	17	10
2	5a	47 (68)	22 (32)	1	16	5
3	5i	30 (43)	39 (57)	0	4	35
4	4h	13 (19)	56 (81)	3	12	41
5	5h	19 (28)	50 (72)	3	16	31
6	5i	18 (26)	51 (74)	0	50	1

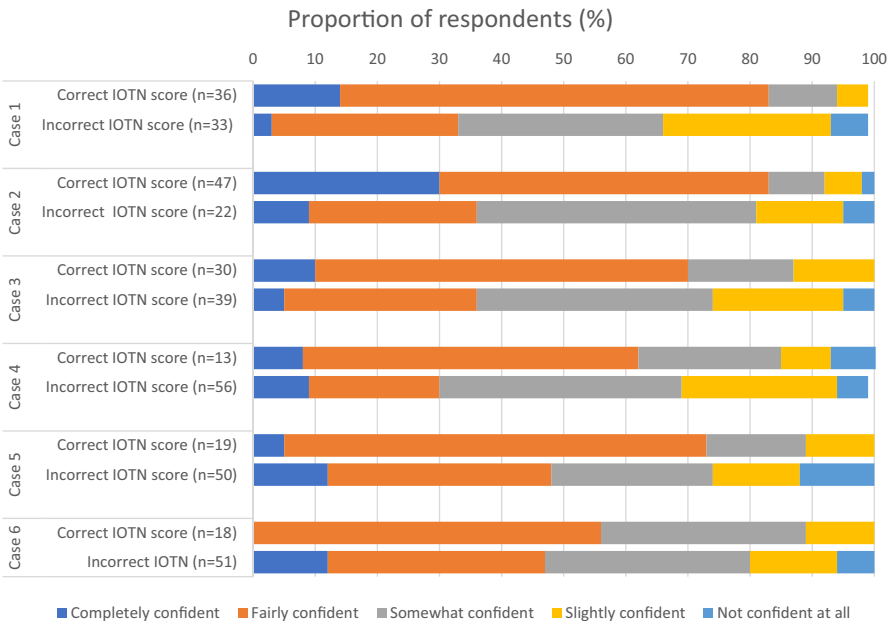

FIGURE 2 Respondents confidence in identifying the referral pathway, reported per case based on whether the correct referral pathway was selected

TABLE 3 Respondents' choice of referral pathway and timing for cases (italics indicate correct answer)

		Number of respondents (%)					
Case number		1	2	3	4	5	6
Would you refer?	Yes	*69 (100)*	*69 (100)*	*55 (80)*	*65 (94)*	*69 (100)*	*69 (100)*
	No	0 (0)	0 (0)	14 (20)	4 (6)	0 (0)	0 (0)
Referral pathway	No referral	0 (0)	0 (0)	7 (10)	3 (4)	0 (0)	0 (0)
	Level 1	1 (1)	1 (1)	5 (7)	3 (4)	1 (1)	1 (1)
	Level 2	7 (10)	3 (4)	10 (14)	13 (19)	6 (9)	2 (3)
	Level 3a	*49 (71)*	*46 (67)*	*23 (33)*	33 (48)	42 (61)	*42 (68)*
	Level 3b	1 (1)	13 (19)	20 (29)	*8 (12)*	*13 (19)*	19 (28)
	Not sure	11 (16)	6 (9)	4 (6)	9 (13)	7 (10)	5 (7)
Referral timing	Immediately	*63 (91)*	*67 (97)*	*52 (75)*	*58 (84)*	*68 (99)*	*66 (96)*
	In the future	6 (9)	2 (3)	17 (25)	11(16)	1 (1)	3 (4)

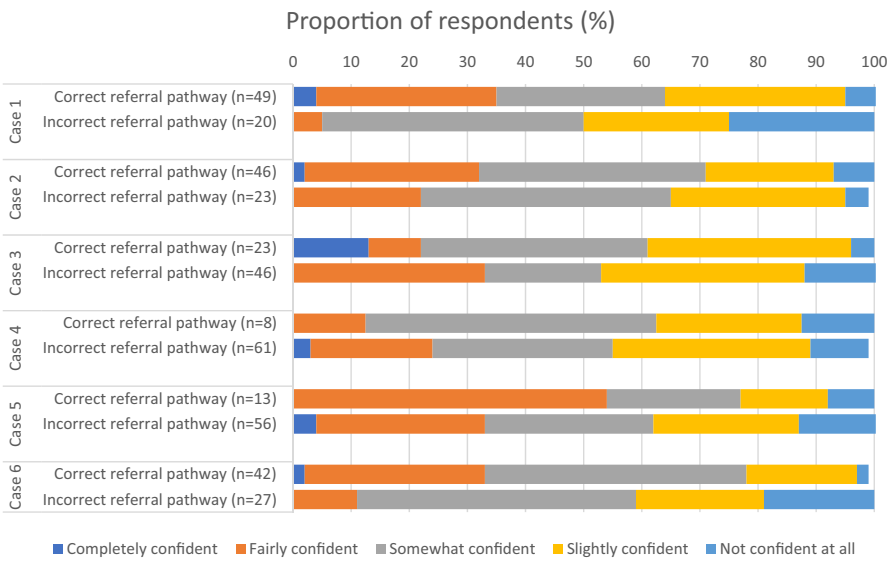

FIGURE 3 Reported confidence in identifying referral pathway, based on the selection of the correct referral pathway for each case

a requirement for specialist referral. Cases 4 and 5 required interdisciplinary management, but only a minority of participants identified their high level of complexity and the implications of this for referral.

Figure 3 shows self-reported confidence in determining appropriate referral. Few people felt completely confident in their answers in any of the cases. The most common response was somewhat or slightly confident, regardless of whether the answer was correct.

It should be noted that for Cases 3 and 4, 14 and 6 participants, respectively, stated that they would not refer, but some then provided an answer about their preferred referral pathway and timing.

4 | DISCUSSION

The findings from this study suggest that UK dental students are not consistently able to apply the IOTN correctly and identify the complexity of the case to refer appropriately. A number of participants did not provide a complete IOTN DHC score, omitting either the grade or letter, suggesting a lack of familiarity with the components of the IOTN. Incorrect grading is concerning because this is directly associated with perceived treatment need, so a low assessment of treatment need may prevent timely referral. A previous study found dental foundation trainees who had no further IOTN teaching after undergraduate training achieved poor to fair agreement with expert scores.[6] This indicates that those who do not learn IOTN adequately as undergraduates will require the insight and resources to seek focused teaching to develop these skills later.

Participants were most able to identify the correct IOTN score in cases where the worst trait was a large overjet. This supports the findings from a previous study, which demonstrated that 92% of undergraduate students were able to identify key features of class II division I malocclusion.[8] Recognition of treatment need associated with an increased overjet is important because of the association with trauma[9] and the age limitations of some forms of treatment, such as functional appliance therapy. However, there is evidence from this study that a large overjet or a reverse overjet may inhibit a full assessment and identification of other important occlusal anomalies, such as impacted teeth.

The selection of appropriate IOTN DHC score was lower for cases with impacted and missing teeth. For the impacted canine case, the majority of incorrect answers included errors in both grade and trait, with 30% of participants grading as 2 or 3, suggesting a borderline need for treatment. In comparison, for the impacted premolar case, all but one person graded it as 5, but mostly with the incorrect trait. This suggests that participants identified aspects of malocclusion which raised concerns, but this may not necessarily have been the impacted tooth. It should be noted that this case had the overjet incorrectly reported as 12 mm. More severe hypodontia was recognised more readily than a single missing tooth but generally, recognition of missing teeth appeared low. The single missing incisor may have presented challenges to score if participants assumed tooth loss was traumatic, because there is a common misconception that the 'h' trait refers only to developmentally absent teeth due to the use of the term hypodontia in the descriptor.

Obtaining the correct IOTN score did not always facilitate appropriate referral, suggesting some inconsistencies in clinical reasoning around complexity, treatment need and the most appropriate treatment provider. It appeared most participants recognised cases that required specialist care, but found it most difficult to ascertain whether the complexity meant referral should be to an orthodontic specialist or an orthodontic consultant. This is likely to be a result of limited orthodontic teaching and clinical experience resulting in poor understanding of case complexity and referral pathways. Despite increasing use of prompts within electronic referral management systems, there is evidence that the problems with inappropriate referrals continue.[10,11]

Misplaced confidence in those who provided an incorrect IOTN score and/or referral indicates a lack of insight into knowledge and competency. The free text comments highlighted mixed levels of experience and confidence, with a general trend that greater clinical experience enhanced confidence. Interestingly, there did not appear to be greater accuracy with increased experience with either IOTN or referrals, but the small sample meant this could not be formally tested. On the whole, participants expressed a desire for more teaching and clinical experience, which is supported by the findings of a previous survey of self-rated preparedness for practice.[12] This raises important questions about the trend to reduce the clinical component of orthodontic teaching[13] and the impact of this on achieving the goal of dentists being able to both manage the developing dentition and accurately assess their own capabilities set out in the General Dental Council document *Preparing for Practice*.[14] It should be noted that at the time of questionnaire distribution, there had been disruption to normal teaching due to the COVID-19 pandemic and many courses were undergoing rapid changes to facilitate non-contact teaching using online methods; it would, therefore, be worthwhile exploring undergraduate's teaching needs at a more 'normal' time.

Inconsistencies in answers about teaching between participants from the same dental school suggest either ambiguity in the questions, a lack of attention during questionnaire completion or more importantly, that there may be genuine confusion about how and when orthodontics is taught. Due to the low number of participants, it was not possible to undertake a subgroup analysis based on university or teaching methods. This, alongside more detailed examination of misunderstanding around the IOTN and referrals, would be interesting to inform future orthodontic undergraduate teaching. Previous studies have found success with different approaches to orthodontic teaching including combined seminars, case-based discussions and generic orthodontic teaching over a period of 3 months,[4] and computer presentations, instruction manuals and practice on models.[15]

The main limitation of this study is the low response rate and the limited number of cases, which together limit the scope for generalising the findings and making recommendations for improvement. The low engagement could be attributed to the challenges of the COVID-19 pandemic, which caused significant disruption to teaching and may have focussed attention into other areas. It must, however, also be acknowledged that low rates of participation may be because students are not confident with the topic. This in itself is an important finding when discussing the purpose of undergraduate orthodontic teaching and how to best use limited time to prepare students for their future career. Further work to assess student's ability to use the IOTN for different malocclusion, ideally in real clinical encounters, and to explore which factors in undergraduate education are important is warranted.

5 | CONCLUSIONS

- Undergraduate dental students reported low confidence and limited experience in applying the IOTN.
- Ability to apply IOTN was variable, with most success in cases with a marked overjet and least accuracy in cases with missing teeth.
- Students appear to have limited understanding of which occlusal traits take priority and the components of a complete IOTN score.
- Students do not adequately understand case complexity and how this aligns with NHS orthodontic referral pathways.
- Evaluation of confidence in relation to correct IOTN and referral pathway indicates a lack of insight into areas for improvement.

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CONFLICT OF INTEREST

All authors have nothing to disclose.

DATA AVAILABILITY STATEMENT

The full anonymised dataset is available on reasonable request from the authors.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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