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Title: A mixed-methods assessment of perceptions of lower anterior malalignment and need for orthodontic re-treatment.

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Abstract: INTRODUCTION: Post-orthodontic occlusal change may stem from true relapse or as a consequence of characteristic temporal changes. The aims of this research were to identify occlusal discrepancies related to the lower labial segment prompting a decision to undergo orthodontic re-treatment.

METHODS: A mixed-methods assessment was undertaken comprising of a qualitative analysis involving focus groups of lay groups exploring the relative importance of a range of occlusal features in the decision to undergo retreatment and investigating the motives for seeking retreatment. Quantitative assessment of a range of occlusal discrepancies was undertaken by 50 lay and 50 professional raters.

RESULTS: A range of themes were identified in the qualitative analysis with dental aesthetics a major motive in seeking retreatment while variation both in the perception of relapse and retainer wear were identified. Horizontal irregularities of the lower anteriors were consistently perceived as the most severe. Professionals had a slightly higher odds for suggesting need for re-treatment than laypeople, although this was not of statistical significance (OR=1.23, 95% CI 0.52-2.19; p=0.65).

CONCLUSIONS: Perception of lower labial segment irregularity and its influence on need for orthodontic re-treatment is complex and multifaceted. Nevertheless, horizontal discrepancies of the lower incisors were regarded as most significant both by lay and professional raters.

Dear Dr Behrents,

Many thanks for your comments and for those of your reviewers. We have attempted to revise the article accordingly and have highlighted the changes in the revised submission. We have responded to each comment **in bold** individually below.

Reviewers' comments:

Reviewer #1: The current article is very interesting one. In the revised copy, the authors satisfied the reviewers' comments.

We are grateful to the reviewer for these comments.

Reviewer #3: The authors made a revision addressing some reviewers' suggestions. I would like to read on text their explanation about sample size:

The sample size for the qualitative component is based on the feasibility of running a coherent and information-rich focus group. Typically focus groups incorporate a maximum of 8 participants. We chose to include 6 in ours. Moreover, the number of groups (and hence the overall sample size) is based on data saturation (i.e. reaching a point where no original information or themes arise). The number of raters chosen (100) was a trade-off between feasibility and credibility i.e. larger numbers were more likely to produce reliable results. Their justify on text.

We have now included this explanation in the Discussion section as the reviewer has suggested.

Two of the reviewers suggested changes in the results to make it more objective. The authors removed some information in this section but inserted it in a new section (appendix). This way, I'm not sure if they have met the journal's guidelines.

We have liaised with Chris Burke today to ensure that our approach is in keeping with journal guidelines and word counts. She is happy that this is the case.

Reviewer #4: The authors have made the changes I suggested. My only problem is that the paper is still too long, so it will be interesting to see if the other reviewers agree. This is indeed a paper which is difficult to shorten, as previously indicated. It seems to have been done by creating an appendix and I do not know of its appropriateness for AJODO. This is for the editor to decide.

See previous comments. We have liaised with Chris Burke today to ensure that our approach is in keeping with journal guidelines and word counts. She is happy that this is the case.

A mixed-methods assessment of perceptions of lower anterior malalignment and need for orthodontic re-treatment.

Short Title: Perceptions of relapse

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HIGHLIGHTS

- This study highlights the multi-faceted nature of a decision to undergo orthodontic retreatment within adult patients
- Both patients and professionals are particularly sensitive to horizontal irregularity of the lower anteriors
- While perceptions of lower anterior irregularity are relatively consistent among lay and professionals, professionals have lower tolerance levels for occlusal discrepancies in respect of the perceived need for retreatment

HIGHLIGHTS

- Many factors contribute to an adult's decision to undergo orthodontic retreatment
- Patients and clinicians are sensitive to irregularity of the lower anterior teeth
- Perceptions of lower anterior irregularity are consistent among lay and professionals
- Professionals have lower tolerance levels for occlusal discrepancies

INTRODUCTION: Post-orthodontic occlusal change may stem from true relapse or as a consequence of characteristic temporal changes. The aims of this research were to identify occlusal discrepancies related to the lower labial segment prompting a decision to undergo orthodontic re-treatment.

METHODS: A mixed-methods assessment was undertaken comprising of a qualitative analysis involving focus groups of lay groups exploring the relative importance of a range of occlusal features in the decision to undergo retreatment and investigating the motives for seeking retreatment. Quantitative assessment of a range of occlusal discrepancies was undertaken by 50 lay and 50 professional raters.

RESULTS: A range of themes were identified in the qualitative analysis with dental aesthetics a major motive in seeking retreatment while variation both in the perception of relapse and retainer wear were identified. Horizontal irregularities of the lower anteriors were consistently perceived as the most severe. Professionals had a slightly higher odds for suggesting need for re-treatment than laypeople, although this was not of statistical significance (OR=1.23, 95% CI 0.52-2.19; p=0.65).

CONCLUSIONS: Perception of lower labial segment irregularity and its influence on need for orthodontic re-treatment is complex and multifaceted. Nevertheless, horizontal discrepancies of the lower incisors were regarded as most significant both by lay and professional raters.

INTRODUCTION

Orthodontists are increasingly resigned to instability associated with the majority of tooth movements. Post-treatment change may stem from true relapse due either to unstable tooth positioning or physiological recovery of investing tissues, or from characteristic time-related changes.^{1,2} As such the requirement for indefinite retention and occasionally the need for orthodontic re-treatment when retention is unsuccessful are well-established. The latter may arise due to poor compliance with removable retainers, detachment or residual activity of fixed retainers, or as a consequence of iatrogenic changes during a period of fixed retention.

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Orthodontic relapse and indeed maturational changes often manifest in the lower anterior region. Such changes may include contact point displacements, rotations, angulation or inclination changes, or vertical movements either in isolation or in combination. These lower

anterior changes are brought into sharper focus by increased lower incisor exposure and reduced upper incisor exposure with age. The decision, however, to undergo or indeed recommend orthodontic retreatment remains arbitrary. Clinicians typically have a lower tolerance for orthodontic irregularity than patients.⁶⁻⁸ However, the majority of research has focused on upper anterior discrepancies. Moreover, while Little's irregularity index, the most accepted for quantifying relapse, solely accounts for horizontal displacements, there is little appreciation of the relative importance of this and other possible manifestations of malalignment.

Furthermore, little emphasis has been placed on the implications of relapse and lower anterior discrepancies from a patient-centred perspective. It is accepted that malocclusion may have socio-psychological effects and implications on oral health related quality of life.⁹ It is, therefore, important that the relationship between occlusal discrepancies, social consequences and motives for correction are more clearly understood. The premium on appropriate re-treatment decisions is intensified by failure of previous treatment and the potential for iatrogenic damage, including root resorption, associated with potentially protracted, albeit intermittent, treatment.

Qualitative methods have been adopted relatively recently in orthodontic research being utilised to shed light on decision making in patients undergoing combined orthodontic-surgical treatment.¹⁰ These approaches may afford a more detailed appreciation of patient-centred factors complementing established quantitative techniques. The aims of this research were therefore to identify a threshold level of lower labial segment irregularity prompting a decision to undergo orthodontic re-treatment among adults and to evaluate the relative importance of a range of lower anterior discrepancies in the decision to undergo orthodontic re-treatment. A secondary aim was to compare lay and professional opinion related to the relative importance of occlusal features on the decision to undergo orthodontic re-treatment. The null hypothesis was that there is no specific occlusal feature or severity level associated with a decision to re-treat an orthodontic patient due to lower labial segment irregularity.

SUBJECTS AND METHODS

The study had a mixed-methods design incorporating a qualitative component involving layperson focus group interviews to explore opinions relating to changes affecting the lower anterior teeth and attitudes to occlusal discrepancies prompting a decision to undergo

orthodontic re-treatment in adulthood (Part 1) followed by a quantitative, cross-sectional analysis to determine the severity of specific occlusal discrepancies (Part 2). The study was approved by the Queen Mary University of London Research Ethics Committee (QMREC 1330d).

PART 1: FOCUS GROUP INTERVIEWS

Laypeople were recruited via posters circulated in boroughs neighbouring the Royal London Hospital, Barts and The London School of Medicine and Dentistry. Inclusion criteria for participants were aged 18 years or older, fluent English speakers and not professionally linked with the field of dentistry. A maximum of six participants were permitted per focus group with equal numbers of male and female subjects, where possible. Basic participant demographics were obtained prior to the interviews to facilitate participant allocation to a specific group to ensure ethnic diversity and gender balance.

A topic guide was designed as an *aide-mémoire* to improve consistency of data collection during the focus group interviews and to ensure salient issues were covered in a systematic fashion. Semi-structured, open-ended focus group interviews were facilitated by one interviewer (MKK) in a non-clinical setting. All interviews were audio recorded and continued until no further comments were proposed by the participants. The interviews were supplemented with visual aids, where appropriate, including study models of aligned and malaligned dental arches, removable retainers, and photographs of dental malalignment and fixed retainers. Interviews were transcribed verbatim and evaluated using framework analysis.¹¹ Framework analysis allowed an overview of the textual data from the interview transcripts, facilitating visualisation and examination.

PART 2: CROSS-SECTIONAL ANALYSIS OF STUDY MODELS

Fifty orthodontic professionals and 50 laypeople were invited to assess study models reflecting a range of lower labial segment discrepancies, and to complete a corresponding questionnaire. The study models (n=18) were fabricated from impressions of a range of typodont set-ups with each altered to represent one of five specific occlusal discrepancies of the lower labial segment likely to be of concern to prospective patients, reflecting opinion derived from the focus group interviews. The discrepancies were introduced manually on the typodont, with contact point displacements recorded using digital callipers and angulation,

inclination and rotational changes measured using a protractor and acrylic jigs, with readings re-measured on separate occasions, two days apart, to confirm repeatability.

Duplicate models were made of certain discrepancies (n=4) to confirm intra-examiner variability with one study model fabricated to represent the ideal alignment (control). An upper study model with ideal arch alignment was also constructed to facilitate occlusion with the lower study models and aid assessment, where applicable.

Initial piloting of the response questionnaires on both orthodontic professionals and laypeople and assessment of readability using the Flesch Reading Ease (54.0) and Flesch Kincaid Grade Level (8.1) were undertaken indicating appropriateness for a reading age of 13 years. Thereafter, the professional group was recruited at the British Orthodontic Society (BOS) Conference held at the Edinburgh International Conference Centre (September 2014). The lay group was recruited from the Orthodontic Department at Whipps Cross University Hospital, London, incorporating either friends or relatives of patients attending the department. No NHS patients undergoing treatment were recruited.

The models were divided into 3 groups of 6 (Table 1) with participants ranking each occlusal feature in order of severity using a numerical grade of 1-6, with 1 representing the least severe and 6 indicative of the most severe occlusal feature. Participants were then asked to select which occlusal features required orthodontic re-treatment. Higher severity ratings were associated with a greater perceived need for re-treatment, while a severity score of 3 generated equal numbers of responses for need for re-treatment and no need for re-treatment, therefore a severity score of 3 was selected as the threshold level above which orthodontic re-treatment was indicated.

The completed questionnaires were coded to assist data transfer into Stata[®] for Windows, version 13, (StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP). To assess intra-examiner repeatability, 10 participants were invited to assess the study models and complete the questionnaire on two separate occasions, two weeks apart.

STATISTICAL ANALYSIS

Descriptive statistics related to rater characteristics and outcome data were presented with inferential statistical tests also undertaken. Intra-examiner agreement was assessed using weighted kappa values for categorical data. Assessment of the need for orthodontic re-treatment, based on the nature and extent of lower anterior irregularity and rater

characteristics, was assessed using random effects logistic regression analysis. The samples were tested for normality and a pre-specified significance level of $p < 0.05$ used.

RESULTS

PART 1: FOCUS GROUP INTERVIEWS

Twelve subjects participated in the interviews and three focus groups interviews were held over a two-week period. Of the 12 participants, two were aged 18-24 years, nine were aged 25-33 years and one was aged 34-45 years. There were an equal number of male and female participants, with ethnic backgrounds including Asian Caucasian, White Caucasian and African-Caribbean. Five participants had had previous orthodontic treatment, with one participant currently undergoing orthodontic re-treatment.

The interview transcripts were analyzed line by line and six key themes were identified. Each theme was then further sub-divided into sub-themes that characterized the main theme (Table 2). More detailed results from the focus group interviews are given in the Appendix.

FACIAL AESTHETICS

A variety of opinions were raised regarding the influence of facial aesthetics, with some participants conscious of the impact on professional careers and social interactions: *“Once we are more likeable, we tend to be more successful.”* Cultural and social differences were also explored with the idea of differing aesthetic norms raised by one participant, who felt that perception of aesthetics was dependent on cultural background: *“... some cultures don't really worry about that type of physical aspect.”* Another participant developed the topic further by stating: *“American culture and western society makes you think that image is more important – clothes, make-up, hair and everything all ties in.”*

PERCEPTION OF MALALIGNMENT

Many of the participants believed that society played a role in the perception of dental perfection, while dental appearance influenced self-concept with impact upon self-confidence and conduct: *“I definitely do think that people do tease and taunt at a young age, if there's a big imperfection, I do think there's a lot of people who do look for perfection.”*

When the perception of age-related dental changes was discussed, the responses were split. Some participants believed that dental changes had an impact upon facial aesthetics as “it’s changing what they’re used to looking at in the mirror on a daily basis” with one participant undergoing orthodontic re-treatment in order *“to maintain myself, because obviously, like, you always deteriorate as you get older.”*

ORTHODONTIC TREATMENT

Personal commitment and effort influenced the decision to seek orthodontic treatment while some participants preferred appliances that would not greatly affect their day-to-day appearance and lifestyle: *“Something more discreet and would require less maintenance, to me that would be a big seller.”* Another participant stated that she would refuse orthodontic treatment as she was of the opinion that it was less aesthetically acceptable for an adult to have fixed appliances and related brace treatment to a younger population: *“...it’s more of a younger teenage thing. When you see somebody who’s in their mid-20s and they have braces, it’s quite young isn’t it?”*

Conversely, some participants were keen for treatment or knew family members who were eager to have orthodontic treatment for the lower labial segment due to an internally driven motivation to achieve dental perfection or due to lack of treatment during adolescence and the long-standing desire to correct the irregularity: *“I would get ones (braces) for my lower teeth because I do think they are really crooked..”*

ORTHODONTIC RE-TREATMENT

Opinions regarding orthodontic re-treatment were mixed across the focus groups with some believing that the financial cost and time implications influenced the decision relating to re-treatment: *“I think the length of time is a factor. The cost may be completely unattainable and just completely unrealistic, so I think that is a big thing as well. But sometimes financial plans can’t even be achievable.”* While others felt the need for orthodontic re-treatment was more important and outweighed the potential cost implication: *“For me it is not a cost issue. I would pay £3000 if I thought it would straighten my smile.”*

Previous orthodontic treatment played a role in the decision to seek re-treatment as previously treated patients are *“more open to get the little fix to be done again”*, and more conscious of slight post-treatment irregularities, thus prompting a decision to pursue re-

treatment. The acceptability of orthodontic re-treatment was explored and the majority of participants felt that conventional, labial fixed appliances had a negative aesthetic, professional and social impact as *“it makes you look younger as well, maybe not taken seriously in life.”* Conversely, one person noted a change in social perception and acceptance regarding fixed appliances over time and believed that re-treatment was *“almost, like, acceptable...as opposed to 20 years ago, it was not, it was considered geeky whereas it’s so standard now.”*

PERCEPTION OF RETAINERS

Several participants held a negative view toward retainers, both removable and fixed retainers, and believed that the commitment of wear, long-term maintenance and potential financial cost for replacement would be inconvenient and prevent compliance with the proposed retention regime: *“We are lazy and we want convenience, I want it and I know it’s terrible to say and you want image, so you want it all with the minimum of burden.”* There were conflicting opinions regarding the aesthetic and social impact of retainers with some participants reporting embarrassment with removable retainer wear in public, while others were aware of friends wearing removable retainers, though had not noticed them as *“obviously you can’t see them, they are transparent.”* Other participants viewed retainers as an *“investment”* and were willing to accept the long-term commitment of retainers.

PERCEPTION OF RELAPSE

The focus groups were shown a series of photographs displaying various levels of post-treatment relapse to stimulate conversation regarding relapse. It was noted that the perception of relapse correlated with the degree of post-treatment change and the severity of the original malocclusion: *“If they were really wonky in the beginning I’d be quite happy with that (minor degree of relapse).”*

The severity of relapse was also reported as stimulus for re-treatment, with some participants willing to accept minor changes of the lower anterior teeth, while others believed that relapse was due to poor orthodontic treatment and required further treatment to correct: *“I would have been annoyed against my dentist. I would probably go to another dentist to get it fixed.”* Some participants, however, were conscious of the limitations of re-treatment and the risk of further relapse: *“It’s almost like orthodontic treatment, it’s blasé... it’s not considered a major process now, it’s not, but there’s a lot with it, you know.”*

PART 2: CROSS-SECTIONAL ANALYSIS OF STUDY MODELS

One hundred participants (50 orthodontic professionals and 50 laypeople) were involved in this part of the study (Table 3). Intra-examiner reliability was assessed using kappa coefficient with kappa values ranging from 0.41 to 1, indicating fair to substantial agreement.

Significant horizontal movements of the lower incisors of 5mm were ranked as the most severe discrepancy, ranging from 34% to 71%. Conversely, rotational movements of the lower incisors (20°) and inclination issues associated with the mandibular canines were almost universally considered to be a problem of much lower significance (Table 4). The discrepancies typically ranked as the least severe were ideal alignment, followed by vertical displacement of the lower central incisors and inclination changes (10°) associated with the canines (Table 5). Vertical displacement of 1mm was deemed the least severe occlusal feature (90%) in Group 1. For Group 2, lower canine inclination change of 10° was recorded as the least severe occlusal feature (64%) followed by 2mm vertical discrepancy of the lower central incisors (21%).

When re-treatment need was assessed per group, a horizontal discrepancy of the lower incisors was consistently found to be the feature most likely to require retreatment (Table 6). Specifically, a 5mm horizontal discrepancy of the lower right central incisor was deemed to have the highest need for re-treatment for Group 1 (90%). For Group 2 a horizontal discrepancy of the lower central incisors by 5mm was also noted by 90% of participants as having a re-treatment need. Finally, horizontal displacement of 5mm for the lower left central incisor was recorded as the highest need for re-treatment within Group 3 (90%) with similar frequencies noted between the groups for lay and professional raters (82% - 98%).

Random effects logistic regression analysis was performed to compare the perceived need for re-treatment relative to ideal alignment in Group 3. The need for re-treatment was the dependent variable with the range of occlusal problems and rater category, layperson or professional, as the independent variables. Professionals had a slightly higher odds for suggesting a need for re-treatment than laypeople, although no statistical difference was found (OR=1.23, 95% CI 0.52-2.19; $p=0.65$). When adjusted for profession, the odds for re-treatment for all the occlusal features compared with ideal alignment were overall higher and statistically significant, with the exception of the vertical occlusal discrepancy.

When horizontal discrepancies were analysed in isolation the odds of re-treatment for a horizontal change of 3mm of the lower central incisors was lower compared with a 5mm discrepancy (OR=0.21, 95% CI 0.05-0.90; $p=0.036$). Similarly, a horizontal discrepancy of 5mm for the lower right and lower left central incisors, was considered more likely to require re-treatment than a horizontal discrepancy of 3mm for the lower right central incisor (OR=5.26, 95% CI 1.36-20.34; $p=0.016$), respectively. Regression analysis focusing on

canine inclination revealed that a discrepancy of 20° had a significantly higher odds for re-treatment compared with 10° (OR=161.87, 95% CI 35.29-749.60; p <0.001). The consistency of assessments was confirmed by the finding that an inclination discrepancy of 10° on separate models was not found to be statistically different (OR=1.74, 95% CI 0.68-4.46; p=0.248).

DISCUSSION

The purpose of this study was to holistically explore factors associated with the decision to seek orthodontic treatment for lower anterior irregularity. Qualitative methods were therefore used to obtain a range of opinion and to inform the quantitative component. Focus groups were undertaken as this form of interview technique encourages data generation by interaction among participants, allowing presentation of participants' own opinions and reflection on what others bring to the discussion, which in turn spontaneously triggers further responses making the conversation synergistic until the discussion becomes more refined. Disadvantages of group interviews include insufficient depth and richness and reluctance of participants to share sensitive information among strangers.¹² To overcome these disadvantages, a topic guide was formulated in the present study specifically to guide the discussion, with a semi-structured interview style employed with an emphasis on open-ended questions.^{13, 14}

Based on the qualitative component improvement in dental aesthetics was integral in the decision to seek orthodontic treatment. Previous qualitative research has revealed that a desire for an improved smile and straight teeth were the main motivating factors for adults seeking orthodontic treatment.¹⁵ Increased self-perception of dental appearance has been linked with the decision to undergo orthodontic treatment which correlates with our finding that participants who demonstrated an increased awareness of dental aesthetics were more proactive in seeking orthodontic re-treatment as they were conscious of *"how good the teeth could look"*.^{16,17} Participants who had received previous orthodontic treatment were more conscious and critical of minor irregularities in keeping with previous research.¹⁸⁻²⁰

The appearance of the orthodontic appliance was raised during the interviews and some participants expressed concern regarding societal perception toward adult orthodontics at *"the age where your appearance counts more than any other."* This aesthetic awareness may influence the decision to seek orthodontic re-treatment in adulthood and may impact upon the type of appliance deemed acceptable. Indeed, in the present study conventional labial fixed appliances were consistently associated with negative aesthetic, professional

and social impacts, in keeping with previous cross-sectional analysis based on undergraduate dental students.²¹ Visually discreet appliances, including lingual appliances and clear aligners, were regarded by some participants in this study as more socially acceptable and considered as an “*exclusive*” treatment.

The perception of relapse was associated with the severity of the original malocclusion and the amount of post-treatment change, with some willing to accept a degree of lower labial segment relapse, dependent on the severity of the original occlusion. This was related to the perceived limitations of re-treatment and the risk of further relapse. Shared responsibility for treatment has been identified as being instrumental in treatment success with dissatisfaction with treatment outcomes increasing when responsibility for stability is placed on anyone other than the patient.²²⁻²⁵ In the present study, opinion relating to retainers was diverse with some participants considering retainers to be an “*investment*”, while others regarded them as an onerous commitment and financial burden.

Analysis of occlusal feature severity revealed that overall a horizontal discrepancy of 5mm of the lower central incisors was deemed to be the most severe feature, with professionals more critical than laypeople. Results from the present showed that horizontal discrepancy of 5mm of the lower central incisors had the highest re-treatment need overall. The professional group tended to be more critical in keeping with an earlier study where orthodontic professionals were initially more critical of lower labial segment horizontal irregularity than laypeople with a history of orthodontic treatment, while laypeople without a history of orthodontic treatment were even less critical and ignored horizontal discrepancies of the lower incisors up to 2mm.⁷

Intra-category logistic regression analysis confirmed that an increase in occlusal severity resulted in an increased likelihood for re-treatment need, especially with regards to horizontal irregularity of the lower incisors where a 5mm irregularity of a lower central incisor was perceived more likely to require re-treatment in comparison with a 3mm irregularity. This trend correlates with the findings of an earlier study where increased horizontal irregularity signified an increased need for treatment, although the threshold level for treatment was significantly lower at 1mm.⁷ Smaller increments were not used in the present study as our aim was to assess a range of manifestations, not solely horizontal displacements; this necessitated the use of fewer examples of individual discrepancies to reduce the length of the exercise for the participants. In terms of recommendation of retreatment, professionals also appeared more likely to recommend re-treatment need than laypeople, although this was not of statistical significance ($p=0.645$). This is in accordance with earlier studies where

orthodontic professionals tended to be more critical of dental irregularities compared with laypeople.^{6, 8}

In terms of limitations, the precision of some of the potential thresholds prompting decisions for re-treatment in the present study was limited by the necessity to include a limited number of examples (typically 3) within each category to allow a significant range of features to be assessed. More detailed analysis may therefore be undertaken in the future. Moreover, the generalizability of these findings may be contested as the assessments were undertaken on study models. However, this approach allowed clear visualization and appreciation of the occlusal features considered. The analysis was complemented by an upper model with ideal alignment. It could be argued that lower occlusal irregularity is often coupled with similar problems in the maxillary arch clinically. However, the focus on the present investigation was on the lower dentition as maxillary arch changes occurring in tandem with late lower incisor crowding are unpredictable in nature. In terms of sample size the numbers included in the qualitative component was based on the feasibility of running a coherent and information-rich focus group. Typically focus groups incorporate a maximum of 8 participants. We chose to include 6 in ours. Moreover, the number of focus groups, and hence the overall sample size, is based on data saturation i.e. reaching a point where no original information or themes arise. The number of raters in the quantitative study was arbitrarily chosen as a trade-off between feasibility and credibility with larger numbers more likely to produce plausible results. The premium on sample size calculation is, however, much lower in research of this nature than is the case in clinical trials, which involve competing interventions.²⁵

There is at present no holistic tool evaluating lower labial segment relapse and need for re-treatment, with most orthodontic indices devised to assess malocclusion without consideration of previous orthodontic treatment and most ignoring features, other than horizontal movements of the lower incisors, on the potential requirement for re-treatment. In terms of a hierarchy of manifestations of relapse that are of concern both to patients and clinicians, it appears that horizontal displacements are most important. This trend was observed consistently throughout the 3 groups. Torque, angulation and vertical changes were considered of lesser significance. This finding is important as the existing objective indices evaluating intra-arch occlusal discrepancies including the Index of Orthodontic Treatment Need, Peer Assessment Rating and Little's Irregularity Index place greatest emphasis on horizontal displacements. The present study therefore confirms that this

approach is appropriate, although deviations with respect to other features are also important and may be worthy of consideration.

It is accepted that a patient's desire for treatment may not correspond with objective need for treatment and current orthodontic indices fail to consider the patient's perception regarding their own malocclusion and neglect the need for re-treatment based on psychosocial factors including quality of life.²⁶ A further major disadvantage of current orthodontic indices is the risk of insensitivity to the potential needs and motives of patients. Future research may assist in the development of an index specifically designed to assess the need for orthodontic treatment or re-treatment among adult groups with analysis of the patient's perception of the irregularity, evaluation of the motivation for re-treatment, accounting for the severity of the occlusal discrepancy in relation to initial malocclusion and risk of further relapse. This may become particularly useful both from a public health perspective and also as insurance providers begin to include provision for adult orthodontic treatment within their policies.

CONCLUSIONS

The study highlights the complex and multifaceted perceptions of lower labial segment irregularity and its influence on need for orthodontic re-treatment. However, the severity of specific displacements correlated with perceived re-treatment need with horizontal discrepancies of the lower incisors regarded as most significant both by lay and professional raters.

Acknowledgement

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Legends for illustrations

Table 1. Occlusal discrepancies generated on study models (n=18) reflecting a range of occlusal discrepancies.

Table 2. Themes and subthemes emerging from focus group interviews.

Table 3. Demographic and clinical characteristics of rater groups (n= 100)

Table 4. Frequency of ranking of individual discrepancies as the most severe.

Table 5. Frequency of ranking of individual discrepancies as the least severe.

Table 6. Frequency of rating specific discrepancies as requiring retreatment.

Table I. Occlusal discrepancies generated on study models (n=18) reflecting a range of occlusal discrepancies.

<u>Occlusal Feature / Discrepancy</u>	<u>Group</u>		
	<u>1</u>	<u>2</u>	<u>3</u>
Combined: Horizontal and Angulation (A)	3mm Horizontal Discrepancy and LR1 & LL1 7°	3mm Horizontal Discrepancy and LR1 & LL1 10°	Ideal Alignment
Inclination (B)	LR3 & LL3 20°	LR3 & LL3 10°	LR3 & LL3 10°
Rotation (C)	LR1 & LL1 Mesio Buccal 20°	LR1 & LL1 Mesiolingual 20°	LR1 & LL1 Mesiolingual 20°
Horizontal (D)	LR1 & LL1 3mm	LR1 & LL1 5mm	LL1 3mm
Horizontal (E)	LR1 5mm	LR1 3mm	LL1 5mm
Vertical (F)	LR1 & LL1 1mm	LR1 & LL1 2mm	LR1 & LL1 1.5mm

Table II. Themes and subthemes emerging from focus group interviews.

<u>MAIN THEMES</u>	<u>Facial Aesthetics</u>	<u>Perception of Malalignment</u>	<u>Orthodontic Treatment</u>	<u>Orthodontic Re-treatment</u>	<u>Perception of Retainers</u>	<u>Perception of Relapse</u>
SUB-THEMES	Professional impact	Societal perception	Personal commitment	Treatment implications	Compliance	Degree of change
	Social interactions	Self-concept	Self-concept	Motivation for re-treatment	Comfort	Motivation for re-treatment
	Self-concept	Age related changes	Acceptability of treatment	Influence of previous treatment	Long term implications	Awareness of relapse
	Cultural differences	Importance of upper and lower anterior teeth	Motivation for treatment	Acceptability of re-treatment	Social impact	
	Social background	Best and worst image			Maintenance	
		Best and worst study model				

Table III. Demographic and clinical characteristics of rater groups (n= 100)

		Overall (n)	Layperson (n)	Professional (n)
Age (in years)	18-24	2	2	0
	25-33	41	8	33
	34-45	34	19	15
	46-55	21	20	1
	55+	2	1	1
Orthodontic status	Previous orthodontics	52	25	27
	No orthodontics	48	25	23
Re-treatment status	Received orthodontic re-treatment	7	4	3
	No orthodontic re-treatment	93	46	47

Table IV. Frequency of ranking of individual discrepancies as the most severe.

Group	Occlusal Feature / Discrepancy	Overall (n=100)	Layperson (n=50)	Professional (n=50)
1	Horizontal LR1 5mm	52%	46%	58%
	Inclination LR3 & LL3 20°	25%	28%	22%
	Horizontal LR1 & LL1 3mm	10%	8%	12%
	3mm Horizontal Discrepancy and LR1 & LL1 7°	8%	10%	6%
	Vertical LR1 & LL1 1mm	4%	6%	2%
	Rotation LR1 & LL1 Mesio Buccal 20°	1%	2%	0%
2	3mm Horizontal Discrepancy and LR1 & LL1 10°	50%	64%	36%
	Horizontal LR1 & LL1 5mm	34%	22%	46%
	Horizontal LR1 3mm	7%	2%	12%
	Vertical LR1 & LL1 2mm	5%	8%	2%
	Inclination LR3 & LL3 10°	4%	4%	4%
	Rotation LR1 & LL1 Mesio lingual 20°	0%	0%	0%
3	Horizontal LL1 5mm	71%	64%	78%
	Rotation LR1 & LL1 Mesio lingual 20°	8%	12%	4%
	Ideal Alignment	8%	8%	8%
	Horizontal LL1 3mm	6%	6%	6%
	Vertical LR1 & LL1 1.5mm	6%	10%	2%
	Inclination LR3 & LL3 10°	1%	0%	2%

Table V. Frequency of ranking of individual discrepancies as the least severe.

	Occlusal Feature / Discrepancy	Overall (n=100)	Layperson (n=50)	Professional (n=50)
1	Vertical LR1 & LL1 1mm	90%	84%	96%
	Rotation LR1 & LL1 Mesiobuccal 20°	4%	6%	2%
	Horizontal LR1 & LL1 3mm	3%	0%	0%
	Horizontal LR1 5mm	3%	4%	2%
	Inclination LR3 & LL3 20°	2%	4%	0%
	3mm Horizontal Discrepancy and LR1 & LL1 7°	1%	2%	0%
2	Inclination LR3 & LL3 10°	64%	58%	70%
	Vertical LR1 & LL1 2mm	21%	28%	14%
	3mm Horizontal Discrepancy and LR1 & LL1 10°	10%	8%	12%
	Horizontal LR1 3mm	2%	4%	6%
	Horizontal LR1 & LL1 5mm	2%	2%	2%
	Rotation LR1 & LL1 Mesiolingual 20°	1%	0%	2%
3	Ideal Alignment	80%	74%	86%
	Inclination LR3 & LL3 10°	8%	6%	10%
	Horizontal LL1 5mm	5%	8%	2%
	Vertical LR1 & LL1 1.5mm	5%	10%	0%
	Rotation LR1 & LL1 Mesiolingual 20°	1%	2%	0%
	Horizontal LL1 3mm	1%	0%	2%

Table VI. Frequency of rating specific discrepancies as requiring retreatment.

Group	Occlusal Feature / Discrepancy	Overall (n=100)	Layperson (n=50)	Professional (n=50)
1	Horizontal LR1 5mm	90%	82%	98%
	Horizontal LR1 & LL1 3mm	83%	78%	88%
	Inclination LR3 & LL3 20°	82%	78%	86%
	3mm Horizontal Discrepancy and LR1 & LL1 7°	80%	70%	90%
	Rotation LR1 & LL1 Mesiobuccal 20°	16%	14%	18%
	Vertical LR1 & LL1 1mm	4%	4%	4%
2	Horizontal LR1 & LL1 5mm	90%	84%	96%
	3mm Horizontal Discrepancy and LR1 & LL1 10°	85%	82%	88%
	Horizontal LR1 3mm	81%	74%	88%
	Rotation LR1 & LL1 Mesiolingual 20°	58%	58%	58%
	Vertical LR1 & LL1 2mm	20%	20%	20%
	Inclination LR3 & LL3 10°	13%	12%	14%
3	Horizontal LL1 5mm	90%	84%	96%
	Horizontal LL1 3mm	83%	76%	90%
	Rotation LR1 & LL1 Mesiolingual 20°	70%	82%	58%
	Inclination LR3 & LL3 10°	18%	18%	30%
	Vertical LR1 & LL1 1.5mm	13%	12%	14%
	Ideal Alignment	6%	2%	10%

A mixed-methods assessment of perceptions of lower anterior malalignment and need for orthodontic re-treatment.

Mary-Kate Kearney, Nikolaos Pandis, and Padhraig S. Fleming

Appendix

FACIAL AESTHETICS

A variety of opinions were raised regarding the influence of facial aesthetics, with some participants conscious of the impact on professional careers and social interactions: *“Once we are more likeable, we tend to be more successful.”* Cultural and social differences were also explored with the idea of differing aesthetic norms raised by one participant, who felt that perception of aesthetics was dependent on cultural background: *“... some cultures don't really worry about that type of physical aspect.”* Another participant developed the topic further by stating: *“American culture and western society makes you think that image is more important – clothes, make-up, hair and everything all ties in.”* While one participant believed that social and economic status could be inferred on the basis of facial aesthetics: *“...it tells a lot about your social background. People could judge you.”*

PERCEPTION OF MALALIGNMENT

Many of the participants believed that society played a role in the perception of dental perfection, while dental appearance influenced self-concept with impact upon self-confidence and conduct: *“I definitely do think that people do tease and taunt at a young age, if there's a big imperfection, I do think there's a lot of people who do look for perfection.”*

“I have a twin who had a snaggle tooth and she was much shyer than me. She had lower self-esteem because she used to get teased about that one snaggle tooth.”

When the perception of age-related dental changes was discussed, the responses were split. Some participants believed that dental changes had an impact upon facial aesthetics as *“it's changing what they're used to looking at in the mirror on a daily basis”* with one participant undergoing orthodontic re-treatment in order *“to maintain myself, because obviously, like, you always deteriorate as you get older.”*

The importance of upper and lower dental irregularities was debated among the participants with the majority of the opinion that the upper labial segment was aesthetically more important: *"People don't see the lower teeth as much."*

ORTHODONTIC TREATMENT

Personal commitment and effort influenced the decision to seek orthodontic treatment while some participants preferred appliances that would not greatly affect their day-to-day appearance and lifestyle: *"Something more discreet and would require less maintenance, to me that would be a big seller."* Another participant stated that she would refuse orthodontic treatment as she was of the opinion that it was less aesthetically acceptable for an adult to have fixed appliances and related brace treatment to a younger population: *"...it's more of a younger teenage thing. When you see somebody who's in their mid-20s and they have braces, it's quite young isn't it?"*

"Yeah, it doesn't look pretty, if you want to start brace treatment when you're 28."

"... I'll feel uncomfortable because my words may affect (sic.) and I smile a lot so my teeth are visible."

Conversely, some participants were keen for treatment or knew family members who were eager to have orthodontic treatment for the lower labial segment due to an internally driven motivation to achieve dental perfection or due to lack of treatment during adolescence and the long-standing desire to correct the irregularity: *"I would get ones (braces) for my lower teeth because I do think they are really crooked. I would not mind the discomfort - pain is beauty."*

"In their minds they wanted it all to be perfect even where people don't see those lower teeth that are slightly crooked."

"Some people when they were young didn't have the option, and then they get to early 20s and they really hate their teeth and are like, you know what I am going to do something about it."

ORTHODONTIC RE-TREATMENT

Opinions regarding orthodontic re-treatment were mixed across the focus groups with some believing that the financial cost and time implications influenced the decision relating to re-

treatment: *"I think the length of time is a factor. The cost may be completely unattainable and just completely unrealistic, so I think that is a big thing as well. But sometimes financial plans can't even be achievable."* While others felt the need for orthodontic re-treatment was more important and outweighed the potential cost implication: *"For me it is not a cost issue. I would pay £3000 if I thought it would straighten my smile."*

Regarding the motivation for re-treatment, severity of the irregularity was deemed influential. One participant admitted to undergoing three separate episodes of orthodontic treatment for dental relapse because *"...I knew people could see in my, in my pictures and I could see it (dental irregularities)."* Interestingly, another interviewee stated that he was aware of a friend who had undergone re-treatment with Invisalign™ as the treatment was deemed *"exclusive."*

Previous orthodontic treatment played a role in the decision to seek re-treatment as previously treated patients are *"more open to get the little fix to be done again"*, and more conscious of slight post-treatment irregularities, thus prompting a decision to pursue re-treatment. The acceptability of orthodontic re-treatment was explored and the majority of participants felt that conventional, labial fixed appliances had a negative aesthetic, professional and social impact as *"it makes you look younger as well, maybe not taken seriously in life."* Conversely, one person noted a change in social perception and acceptance regarding fixed appliances over time and believed that re-treatment was *"almost, like, acceptable...as opposed to 20 years ago, it was not, it was considered geeky whereas it's so standard now."*

PERCEPTION OF RETAINERS

Several participants held a negative view toward retainers, both removable and fixed retainers, and believed that the commitment of wear, long-term maintenance and potential financial cost for replacement would be inconvenient and prevent compliance with the proposed retention regime: *"We are lazy and we want convenience, I want it and I know it's terrible to say and you want image, so you want it all with the minimum of burden."* There were conflicting opinions regarding the aesthetic and social impact of retainers with some participants reporting embarrassment with removable retainer wear in public, while others were aware of friends wearing removable retainers, though had not noticed them as *"obviously you can't see them, they are transparent."* Other participants viewed retainers as an *"investment"* and were willing to accept the long-term commitment of retainers, including bonded retainers, in order to safeguard against post-treatment relapse: *"I think that should*

be actually, erm, mandatory after every treatment...just the number of people that are almost frustrated that they went through this treatment of braces under the NHS and had relapse."

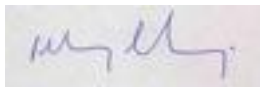
PERCEPTION OF RELAPSE

The focus groups were shown a series of photographs displaying various levels of post-treatment relapse to stimulate conversation regarding relapse. It was noted that the perception of relapse correlated with the degree of post-treatment change and the severity of the original malocclusion: *"If they were really wonky in the beginning I'd be quite happy with that (minor degree of relapse)."*

"If I knew that it's going to go right to its original state then maybe I would not have opted for braces in the first place."

The severity of relapse was also reported as stimulus for re-treatment, with some participants willing to accept minor changes of the lower anterior teeth, while others believed that relapse was due to poor orthodontic treatment and required further treatment to correct: *"I would have been annoyed against my dentist. I would probably go to another dentist to get it fixed."* Some participants, however, were conscious of the limitations of re-treatment and the risk of further relapse: *"It's almost like orthodontic treatment, it's blasé... it's not considered a major process now, it's not, but there's a lot with it, you know."*

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A rectangular box containing a handwritten signature in purple ink. The signature is cursive and appears to read 'P. Fleming'.

Dr Padhraig Fleming

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